COCONUT RESEARCH BOARD

COCONUT RESEARCH INSTITUTE OF SRI LANKA

REPORT FOR 2007

COCONUT RESEARCH INSTITUTE - REPORT FOR 2007

COCONUT RESEARCH BOARD

REPORT OF THE

COCONUT RESEARCH INSTITUTE

FOR 2007

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as at 31 st December 2007

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Mr. I.R. Wickramananda	Member
Mr.S.H.S. Senaratne	Member

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Deputy Director (Administration & Finance) : E P Gunapala, A.P.F.A. B.Com (Sp)
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W E R C Fernando
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A R U Ratnesekara, B.Sc.(Agric),
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W G L Rodrigo

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Mrs. H M W S Athauda

Stenographer(English)

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B M Jayathilake Banda

Senior Typist (English)

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Senior Internal Audit Clerk

Mrs. M M J R Fernando

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Accountant

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Senior Book Keepers

N M R Sarathchandra, B.Com
R D Sumanasiri, HND(Accountancy)
Chartered Preliminary
S M Sirisoma

Senior Shroff

M C H N Fernando

Senior Store Keeper

M B U Wijetunga

Senior Audit Clerk

M R U Attanayake

Senior Accounts Clerks

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Mrs. A S M S Abeywickrama

Accounts Clerks

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D J M Leelaratne

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Mrs. A A N P Kanthi

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Works Superintendent

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Foreman (Building)

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Senior Foreman (Mechanical)

R Vithanage

Senior Draughtperson

Mrs. R M S Ratnayake

Senior Clerk/Typist

Mrs. N R Ayagama
K T G N W Perera

Clerk/Typist

M Somasiri

Senior Mortor Mechanic

R M S G Rantnayake

Senior Meson

W M Dhanapala

Senior Carpenter

A A K Amarasinghe

Linesman

R S P Jayamanna

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Assistant Livestock Officer

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M P W Fernando
A G B G Silva
A A Sirinimal

Ratmalagara Research Centre

Superintendent

G B A Wijesekara

Assistant Superintendent

H B S Herath

Senior Supervisor

T M Keerthiratne

Ambakelle Genetics Resources Centre

Superintendent

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Assistant Superintendent

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Senior Clerk/Typist

J A R Reginold

Supervisor

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Assistant Superintendent

D M I S K Dewameththa, B.Sc.(Agric)

Field Officer

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Middeniya Research Centre

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N Gamage

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Officer-in-Charge

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Officer-in-Charge

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Clerk/Typists

D M Jayawardena

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A P C Pradeep

Makandura Genetics Resource Centre

Assistant Superintendent

H W N Nandakumara

Pallama Genetic Resource Centre

Assistant Superintendent

T M P A K Thilakaratne, B.S.(Agric)

Senior Supervisor

W W A P R Fernando

Clerk/Typist

H M Podiratne

THE COCONUT RESEARCH INSTITUTE
LUNUWILA

The Board and Institute

The Coconut Research Institute was founded in 1929 as the Coconut Research Scheme under the Coconut Research Ordinance No. 24 of 1928. The scheme established its head quarters at Bandirippuwa Estate, Lunuwila with three Technical Divisions namely Genetics, Chemistry and Soil Chemistry. Following the enactment of the Coconut Research Act No. 37 in 1950, it was renamed as the Coconut Research Institute of Ceylon. Under the Coconut Development Act, No. 46 promulgated in 1971, the Coconut Research Board was set up in 1972 to function as the Board of Management of the Coconut Research Institute.

Mission of the CRI

Our Mission is through Innovative Research and Development

- Increase productivity and profitability of coconut
- Develop appropriate technologies to increase income from coconut lands through intercropping and animal husbandry on sustainable basis
- Provide eco-friendly appropriate technologies for integrated management of pests and diseases
- Develop new products and to improve quality, value and marketability of traditional products by generating cost effective technologies and transferring them to end-users, by employing a qualified and dedicated team of Scientists.

Functions of the Institute

As given in the Coconut Development Act No. 46 of 1971, statutory functions of the Coconut Research Board are:

1. The conducting and furthering of scientific research in respect of the growth and cultivation of coconut palms. The growing of other crops and engagement in animal husbandry in coconut plantations and the prevention and cure of diseases and pests.
2. The establishment and maintenance of Research Institutes, Experimental Stations and Nurseries.
3. The conducting and furthering of scientific research in connection with the processing and utilization of coconut products.
4. The establishment and maintenance of pilot plants for the processing of coconut products and fabrication of experimental processing equipment.
5. The training of advisory and extension workers to assist the coconut industry.
6. The guiding and advising of the coconut industry on all matters of technical nature.

The Coconut Research Board

The governing body of the Institute is the Coconut Research Board. In terms of the Coconut Development Act, the Board shall consist of 07 members, appointed by the Minister in-Charge. One member is appointed as the Chairman of the Board. The members hold office for 03 years and are eligible for reappointment.

The members of the Board and their attendance record up to December 2007 are given below:

Name	Record of attendance
Dr D B T Wijeratne, Chairman	12/12
Dr M H J P Fernando, Member	09/12
Mr N Mithraratne, Member	08/12
Mr J V R Dias, Member	07/12
Dr J D H Wijewardana, Member	10/12
Mr W J L S Wijayaweera, Member	10/12
Mr Jagath Wellawatta, Member	0/12
Mrs J M S D Rathnayake, Member & Treasury Representative	04/12
Mr P G Dassanayake, Member	12/12
Dr Newton Peiris, Advisor/MCD	0/12
Dr H A J Gunathilaka, Member	08/12
Dr (Mrs) C Jayasekara, Director, CRI/Member	12/12

Mr Jagath Wellawatta resigned in March.

The Research Committee

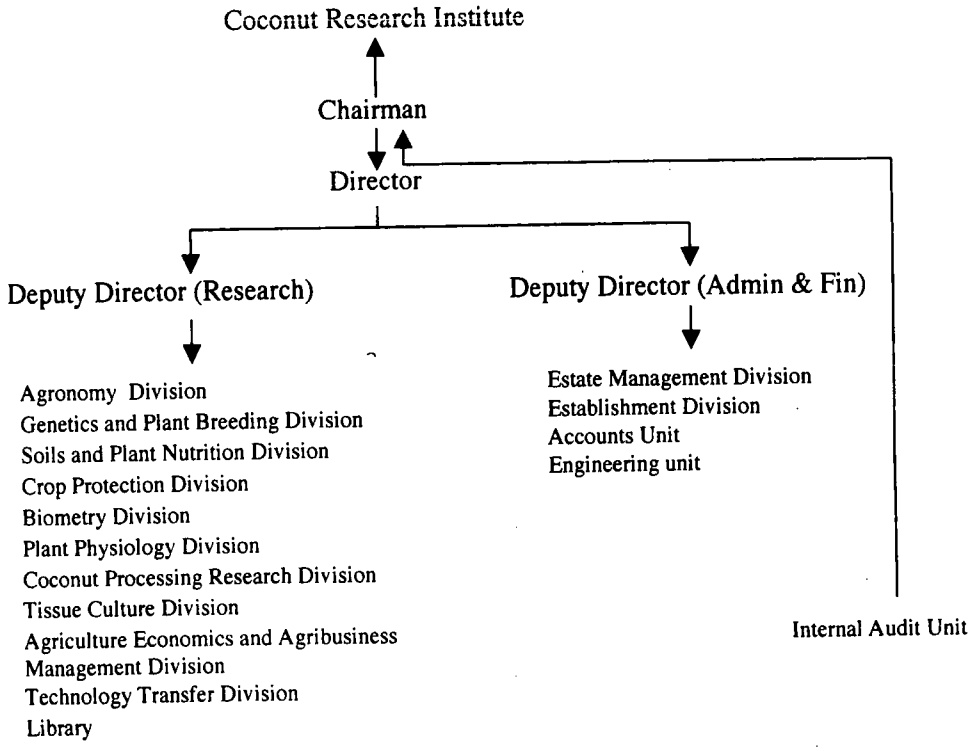
The members of the Committee and their attendance are given below:

Name	Record of attendance
Dr D B T Wijeratne, Chairman, CRB	1/4
Dr (Mrs) C Jayasekara, Director, CRI	3/4
Dr U Pethiyagoda, Member	3/4
Dr D T Wettasinghe, Member	2/4
Mr Denzil Aponso, Member	1/4
Dr Ray Wijewardena, Member	2/4
Mr Parakrama Jayathilaka, Member	4/4
Prof. M de S Liyanage, Member	1/4
Prof. Sumith Jayasekara, Member	2/2
Dr Anil Jayasekara, Member	1/1
Prof. Tilak Attanayake, Member	1/1
Dr Shantha Ramanayake, Member	1/1
Dr D S P Kuruppuarachchi, Member	1/1
Prof. R B Mapa, Member	1/1
Dr Chandra Jayasinghe, Member	1/1
Dr L Rodrigo, Member	1/1
Prof. J M De Costa, Member	1/1
Dr Janaki Gooneratne, Member	1/1
Prof. R O Thatil, Member	1/1
Dr J M U K Jayasinghe, Member	1/1

Management

The Director who is responsible for the implementation of all policies and programs laid down by the Board and direction and supervision of all research and administrative functions of the Institute.

Deputy Director (Research) and Deputy Director (Administration and Finance) directly supervise the Research and Service Units of the Institute respectively as given below:



The Internal Auditor is directly responsible to the Chairman.

REPORT OF THE DIRECTOR
C. Jayasekara, Ph D

1. GENERAL

1.1 An Overview of the Coconut Industry

The extent under coconut is 394,836 hectares according to the survey of Census and Statistic Department conducted in the year 2000, this area is equivalent to 20% of the cultivable land area in the country. Due to fragmentation of coconut lands approximately 60,000 hectares of coconut lands have gone out of coconut. The fragmentation of coconut lands predominantly taking place in the coconut triangle due to rapid urbanization, industrialization and poor returns for investment cost of the grower. According to the production trends observed in Sri Lanka in the past decade, coconut production fluctuates between 2500-3000 million nuts per annum.

The estimated national coconut production for 2007 by the Coconut Research Institute was 2935 million nuts and bimonthly averages for Jan/Feb, Mar/Apr, May/June, and Jul/Aug were 588,462,597, and 497 respectively. District level crop data (excluding North and East) collected and interpreted for the entire area revealed that estimated production up to December was 2798 million nuts and this was 4.7 percent reduction from the estimated yield. Generally, Sri Lanka experiences short supply of coconuts during the period from November to February, hence price also high during this period. This year notable increase in coconut prices was observed compared to previous years. The monthly nut requirement in 2007 was around 245 million nuts whereas, it was 228 million in 2006 showing higher rate of nut utilization in 2007 than in 2006. At present, coconut oil and desiccated coconut industries are the main coconut utilizing industries. In previous years coconut oil production was very low (20,000 MT) with the availability of substitute oils at a cheaper price. At that time, growers suffered with low farm gate prices. When the demand for nuts was low from coconut oil sector, nut prices were depend on the demand for desiccated coconut sector. Therefore, tariff adjustments were done time to time to safeguard the coconut producer.

The increase in nut utilization in this year was due to the increased coconut oil production under the favourable conditions created in the market. It utilizes approximately additional 15 million nuts each month. Palm oil was conventionally a cheaper substitute for coconut oil in the past. The increased demand for palm oil in the world market as a source of bio-diesel made the price of palm oil to rise. Apart from that the high rate of inflation also affected the nut price to move up parallel to the price increase in other commodities. This present scenario has shown the risk of depending on imports of edible oils for local consumption giving less attention to the local coconut oil industry.

1.2 Staff Performance

The performance of Scientists, Extension staff as well as staff in the Services Divisions maintained at a higher level with team spirit to achieve the set targets of the Institute. New proposal on salary structure and scheme of recruitments was submitted to the Salaries and Cadre Commission and approval is pending. Permanent staff strength of CRI was 314 as at October 2007. In addition 440 daily paid labour force working in 07 Research Sub Stations and 05 Genetic Resources Centers. During the year no positions were filled. Regular monthly staff meetings were held to discuss the implementation of the annual work

programme and every attempt was made to maintain good employer-employee relationship and to assist in all welfare activities.

Research Programme of the Institute with multidisciplinary approach in some areas maintained with an appreciable progress and significant research output. New findings will be translated into simple technology packages to reap the benefit to the growers and the industry. It was noteworthy that some research achievements are well recognized by the local and international communities and brought pride to the Institute. Winning a Presidential award for the "Improved Copra Kiln and manufacturing process" developed by the Processing Research Division and Development of double haploid coconut plants first time in the world through anther culture by the Tissue Culture Division of the Institute were noteworthy achievements during the year.

2. ALLOCATION OF FUNDS

As a public sector organization, Coconut Research Institute receives funds from three main sources namely (i) Consolidated Fund (ii) Coconut Cess Fund as Development funds (iii) Donor assisted funds.

The total allocation from the Treasury in the year 2007 as Capital, Recurrent and Development (Cess) Funds was Rs.136.855 million, Rs 41.9 million and Rs 75 million respectively (Figure 1). Actual releases from the Treasury to Capital and Recurrent, and Development grants were Rs 31.4 million, Rs 122.1 million, and Rs 56.5 million respectively. The Contribution from the Coconut Cess fund to the Institute for the last five years is given in Figure-2. The allocation of Recurrent and Capital funds for different programmes of the institute is given in the Figures 3 a & b. Difficulties in getting funds from the Treasury and getting approval of the line ministry for items over Rs 500,000/=, were the main impediment for implementing some projects and for low spending of development funds during the year. All the Research Sub Stations and Genetic Resource Centers maintained as self financed units. The income and expenditure of these stations are given in Figure-4. The total net income from the research sub stations and Genetic Resource Centers amounted to Rs 18 million.

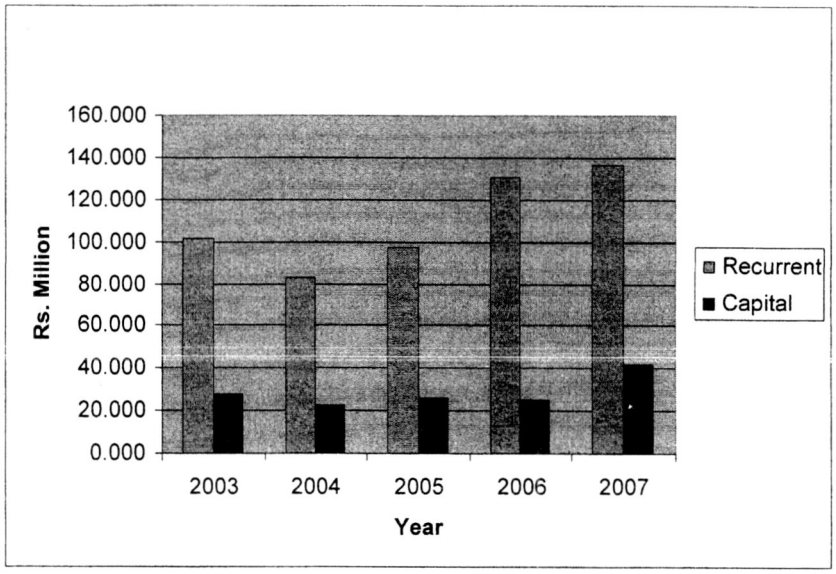


Figure 1: ***Recurrent and Capital Estimates from 2003-2007***

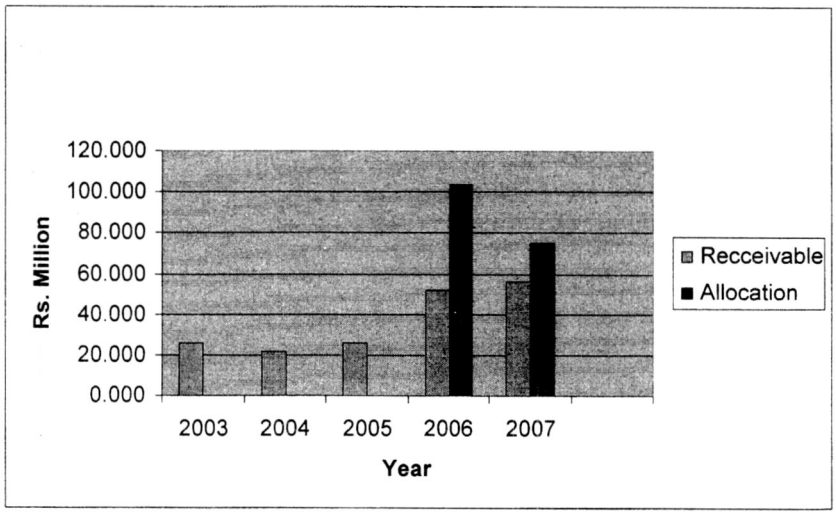


Figure 2: ***Treasury Allocation and Receivable for Development Projects from CESS Fund***

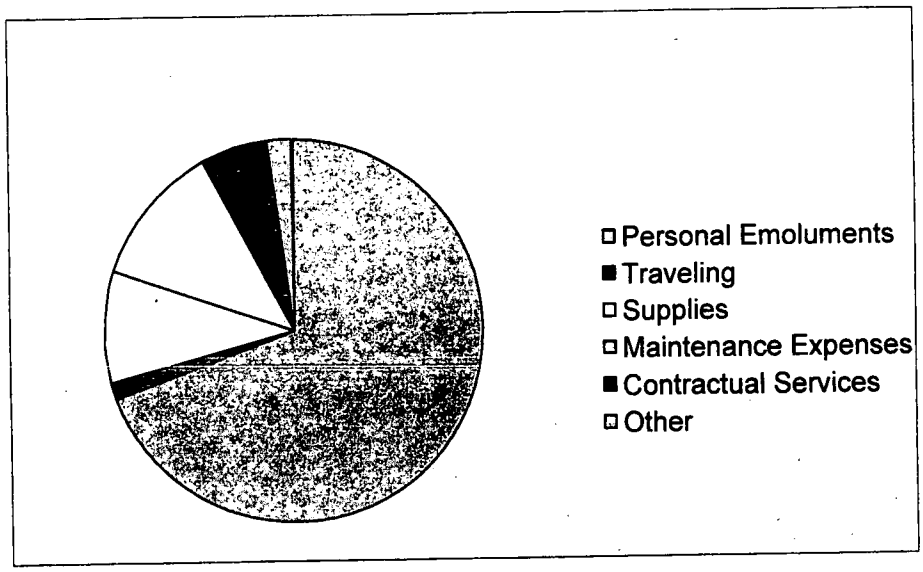


Figure 3 a: ***Allocation of Recurrent Estimate - 2007***

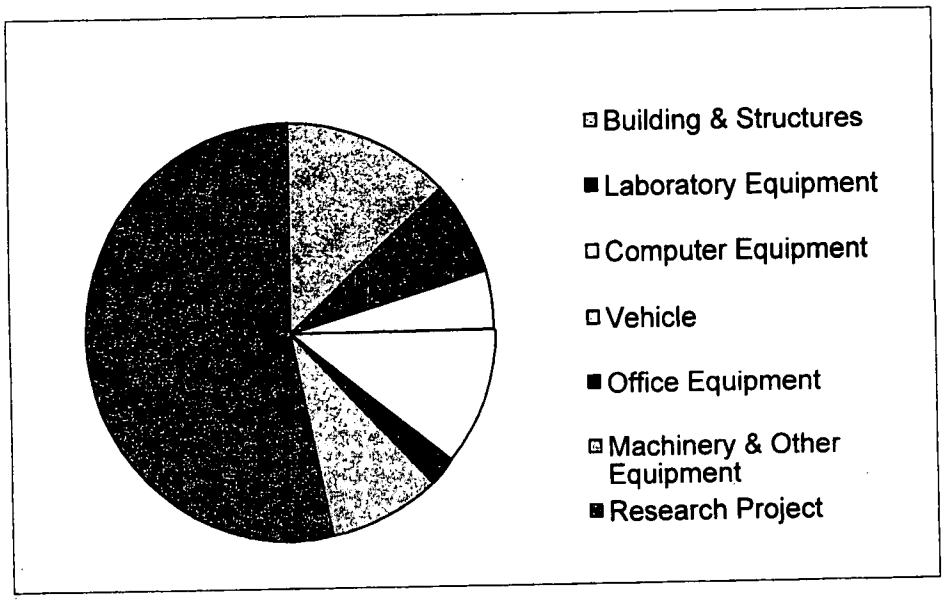


Figure 3 b: ***Allocation of Capital Estimate - 2007***

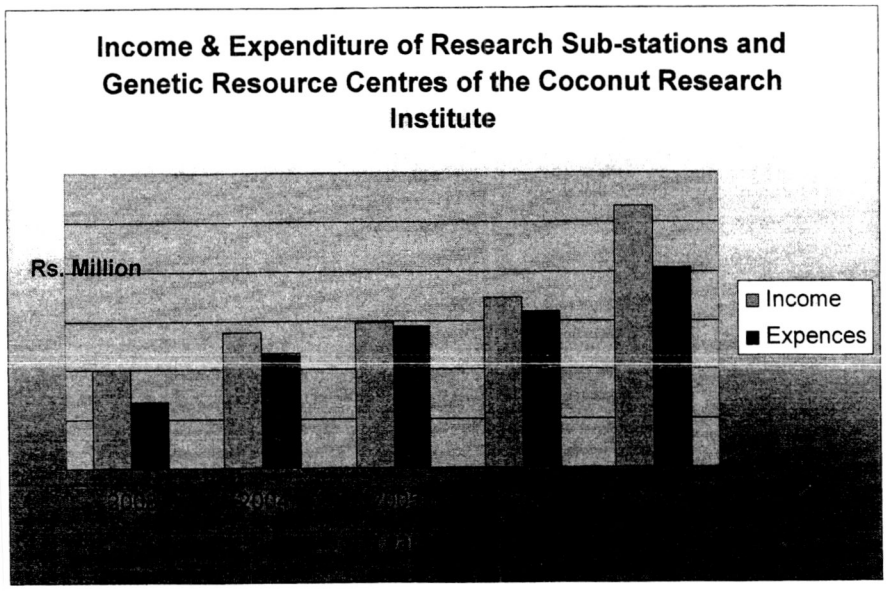


Figure 4: ***Income & Expenditure of Research Sub-stations and Genetic Resource Centers of the Coconut Research Institute***

Funding from various donor-assisted projects amounted to Rs 0.928 million for 2007. This amount received for the on going projects and new donor assisted projects were not received during the year. Direct Fund for International Development (DFID), Common Fund for Commodities (CFC), and Asia Pacific Coconut Community (APCC) funded project on "Integrated Management of Coconut Pests" concluded this year. Bioversity through COGENT continued to fund the poverty alleviation project site at Dodanduwa and helped tsunami affected families to develop new income generating activities.

3. RESEARCH ACHIEVEMENTS AND HIGHLIGHTS

Major research achievements and highlights are presented in the summary form under five main thrust areas namely crop improvement, crop production, crop protection, processing and value addition, and technology transfer as given below:

3.1.1 Crop Improvement

Large stature and height of tall palms have become serious concern in home gardens in urban areas due to severe shortage of pickers. Therefore, the Genetics & Plant Breeding Division initiated a crossing programme between different dwarf forms aiming at producing a hybrid with anticipated hybrid vigour for nut size combined with short stature. Yellow dwarf x brown dwarf, red dwarf x brown dwarf, brown dwarf x green dwarf were selected crosses under the programme. The ongoing experiments are Evaluation of existing cultivars, Evaluation of progenies, Evaluation of new coconut cultivars in farmers fields (adaptive trials), Evaluation of dwarf brown crosses in multi-locations, Development of new cultivars involving exotic varieties, Development of cultivars tolerant to Aceria mite, Maintenance and expansion of existing gene banks and coconut genome rapping continued successfully during the year.

The confirmation of pathogen of the "Weligama Coconut Leaf Wilt Disease" (WCLWD) and Leaf Rot disease in the Southern Province was carried out in the Genetics & Plant Breeding Division using the molecular marker technology. Different tissues of WCLWD and Leaf Rot disease affected palms were collected during the year and DNA extracted from these samples were subjected to Polymerase Chain Reaction (PCR) analysis. DNA from Leaf samples gave positive PCR signals for the presence of phytoplasma. Sequencing of PCR product confirmed the result.

Checking parentage by genotyping with molecular markers for identifying legitimate progeny of the genome mapping population was continued in the first quarter of 2007 and 278 identified individuals were field planted at Walpita Estate. This progeny will be used for future coconut genome mapping work with the assistance of Generation Challenge Programme (GCP).

The pollination program aiming at production of coconut cultivars mixing local germplasm with exotic germplasm continued successfully during the year. As a result of last year pollination, 847 Tall x Rennel Island Tall, 772 Tall x Tagnanan Tall, 1105 Tall x Malayan Red Dwarf, 140 Dwarf green x Rennel Island Tall, 168 Dwarf green x Tagnanan Tall nuts were harvested and nursery laid. These seedlings will be planted in multi-locational trials next year.

Seedling certification which was confined to certificates of polybaged seedling of cultivars CRIC 60 and CRIC 65 was extended to certify Moorock tall cultivar this year. During the year, from eleven new coconut estates 6538 new palms were selected for the supply of plus palm nuts for the National Replanting Programme.

Under the seed garden establishment and expansion programme, 439 self pollinated San Raman seedlings and 257 tall x tall seedlings were field planted at Pallama seed garden and Maduru Oya Seed Garden respectively. Three hundred and sixty six self pollinated San Raman seed nuts and 1611 hand pollinated TxT seed nuts were also laid in the nursery at Pallama Seed Garden under this programme.

Generation of double haploid coconut plants by anther culture was a major accomplishment made during the year. Micro satellite marker analysis of tested tissues (calli, embryoids and plantlets) revealed, diploid chromosome compliment present in these cells was double haploid. This will lead to generation of homozygous pure lines of coconut for future breeding purposes. This is the first successful attempt of anther culture in any palm species.

Thirty eight successfully laboratory grown exotic coconut plants were handed over to Genetics & Plant Breeding Division for field planting. A few of the plants raised from Ivory Coast material are at acclimatization stage where as 67 of them still growing in culture medium.

To improve the callus induction in different media using combination of oven dried different grade coconut shell charcoal samples were test. It was found that coconut shell charcoal can be used for immature zygotic embryos culture. The callusing frequency could be increased by incorporating glutamine (900 mg/L) into the medium.

Several experiments were conducted to improve somatic embryogenesis and plant regeneration. These studies clearly showed that regeneration potential of calli is highly genotypic dependent. Unfertilized ovary of coconut was found to be a promising explant for clonal propagation.

A total of 382 Dikiri embryos were cultured during the year and 173 in vitro-raised plants were transferred to soil for acclimatization. Forty embryo-cultured Dikiri plants were field planted at Middeniya Research Station. The growth of tissue cultured coconut plants established at Bandirippuwa Estate, Lenawa Estate and Daisy Valley Estate as well as Pallama Seed Garden was found to be satisfactory and nearly 50% of them are at flowering or bearing stage.

3.2 Crop Production

In order to increase coconut production and productivity of coconut lands, Agronomy division gave more emphasis on soil moisture conservation, weed management, coconut based organic farming systems, vermin-composting, bio-energy production, intercropping and animal husbandry. Research programme of the Soils and Plant Nutrition Division gave high priority on soil fertility improvement, soil moisture conservation and promotion of organic fertilizer usage to substitute chemical fertilizers.

The soil quality and nutrient depletion due to long term cultivation of coconut was compared with adjoining virgin forest soils. It was revealed that soil pH, electrical conductivity and field capacity were reduced by 5 – 15%, 17 – 47%, and 10 – 40% respectively, due to long-term cultivation of coconut. The depletion of essential nutrients such as N, P, K and Mg was in the range of 9 - 70%, 25 – 58%, 23 – 67% and 30 – 90%, respectively, while organic carbon content in the soil was reduced by 10 – 66%. These results clearly show that long-term cultivation of coconut reduced the soil quality and major nutrient in the soil. Hence, supplementation of nutrients is essential to maintain sustainable yield.

The experiment conducted at Mangala Eliya (DL_3 Borupan series, S_2 soil) showed very significant increase in (82%) nut yield from the palms receiving 1400 g urea, 1050 g Imported Rock Phosphate, 2800 g Muriate of Potash, and 1750 g Dolomite over the control (no fertilizer) and 28% yield increase with the recommended dose of fertilizer (800 g Urea, 600 g Imported Rock Phosphate, 1600 g Muriate of Potash and 100 g Dolomite) treated palm. The same experiment at Sirigampola (IL, Madampe series – S_2) showed 53% increase in nut yield with high close of fertilizer compared with control (no fertilizer) and 38% increase in yield with recommended dose of fertilizer. The same experiment at Kobeigane (IL_1 Wariyapola series – S_3), Naiwala (WL_2, Boralu soil series – S_4) and Welllawa (IL_1 – Kurunegala series – S_2) gave 37%, 81% and 49% yield increase respectively with high dose of fertilizer as given above compared with control (no fertilizer) and 16%, 15% and 14% nut yield increase respectively from the palm receiving recommended dose of fertilizer. These results were obtained 5 years after application of fertilizer in Borupan, Madampe, Wariyapola and Boralu series soils where as after three years in Kurunegala soils.

Comparison of the efficiency of organic and green manure against inorganic fertilizers (APM) showed 48% increase in yield of palm receiving poultry manure over the control (no fertilizer) palms.

The waste biomass (weed, plantation residues and animal wastage) could be easily converted to compost fertilizer within 5 to 6 weeks through mediation of worms. Vermin composting was introduced to coconut growers to reduce the cost of production.

Intercropping bud grafted cashew with coconut reached early flowering and yielded within two years. At the age of 5 years these cashew trees yielded over 5.0 kg/tree/year. To increase productivity of coconut lands and to introduce cut foliage cultivation as an intercrop in coconut lands, an experiment was conducted with three foliage plant varieties namely; Cane palm, Queen palm, and Cordiline species named "Prince Albert"

Twenty model farms were established to popularize organic coconut production. These model farms are being supervised and monitored with necessary guidelines and inputs such as livestock and other planting material whenever necessary. To improve soil fertility and organic matter content in coconut lands an experiment was conducted with three plant species namely *Gliricidia sepium*, *Panicum maximum,* and *Tithornea diversifolia.*

A new experiment was established by Plant Physiology Division with the objective of introducing soil moisture management practices for the mini coconut triangle. To collect rain water small reservoirs (Pathaha) were dug and collected water will be used for irrigation purposes during the dry period.

During the period of January to December 2007 the percentage increase of yield per palm due to monthly picking was compared with bimonthly picking in different land suitability classes. Irrespective of land suitability class on average 22% yield increase was observed. The lowest yield increase was obtained from S_3 land suitability class.

3.3 Crop Protection

The research programme of the Crop Protection Division was mainly focused on investigation on coconut mite, leaf rot disease and a new disease outbreak of "Weligama Coconut leaf wilt disease" which was reported from all areas of Matara District and Habaraduwa AGA Division of Galle District.
The CARP funded collaborative project with Rinzen Laboratories (Pvt) Ltd to develop an electronic device to detect red weevil infested palms was completed. Field testing proved that it could detect infested palms with an accuracy of 97%. The device was recommended to the coconut growers and manufacturing was commenced by the Renzen Laboratories (Pvt) Ltd.

Using Polymerase Chain Reaction (PCR) with phytoplasma specific primers it was confirmed that the causal agent for Weligama Coconut Leaf Wilt Disease (WCLWD) is a phytoplasma. Staining of cross sections of roots and immature inflorescence stalks produced bright bluish colouration, which supported the results of PCR. A study on the effect of oxytetracycline on remission of symptoms in WCLWD affected palms was commenced.

An experiment was commenced to study the effect of nutrients on the leaf rot affected palm at 3 sites in Matara District by applying 50 kg of compost per palm in addition to the normal fertilizer dose. No considerable improvement in the treated palms was observed.

The multidisciplinary research programme on coconut mite include (i) Studies on ecology of the pest and its natural enemies, (ii) identifying tolerant coconut cultivars and (iii) developing

management strategies using biological and chemical methods. The study on population dynamics of coconut mite and predatory mites, *Neoseiulus baraki* and *N. paspalivorus* revealed that pest reached peak populations during June – August in Kalpitiya, Madurankuliya, Rajanganaya and Lumuwila area while it peaked in February at Gampaha and Kurunegala area. Irrespective of the season, the highest number of 1103 mites/nut and the lowest of 545 mites/nut were recorded from Kurunegala and Gampaha areas respectively. *N. baraki* was reported from all sites, but *N. paspalivorus* was reported only from the Gampaha area.

The collaborative project with the Industrial Technology Institute to develop and test mycoacaricide formulation of Hirsutella thompsonii fungus was continued.

Field testing of soil application of different doses of neem granules (Azadiraclitin 1500 ppm), spraying of NeemAzal 1% at 3 monthly intervals and root feeding of 10 ml of Neemraj supreme continued. None of these Azadirachtin preparations reduce the pest damage less than 60%. The pilot trials continued with application of mixture of 20% Palm/vegetable oil and 0.05% wettable sulphur indicated that the damage on young nuts and at harvest was considerably reduced after treatment.

The tolerance levels of three coconut cultivars Dwarf Yellow x Tall (DYT), Dwarf Green x Tall (DGT) and Tall x Tall (TT) against coconut mite was continued at Thammenna estate by using an index developed to measure the tolerance level. DYT recorded the highest tolerance level confirming the results of the previous year with population level and other nut characters. Evaluation of four crosses DY x SR, DG x SR, DY x T and DG x T at Ratmalagara is continued.

A survey carried out in the CCB regions of Marawila, Kurunegala and Anuradhapura to find out the impact of mite infestation on nut production in these areas revealed that the mean percentage of nut losses from infested palms was 10.2%. The results revealed that the percentage nut loss due to mite infestation was considerably lower during 2007 compared to 2006. The highest percentage loss irrespective of the location was reported from March – April period.

Evaluation of integrated pest management methods for Oryctes beetle (Black beetle) viz. Oryctes phoromone, green muscardine fungus (GMF), Oryctes virus (OrV), OVR & GMF conducted under the CFC/DFID/FAO/APCC project was completed. There was no significant difference in the damage levels between different treatments, but it was lowest in the blocks installed with pheromone traps. Seventy five farmers and Coconut Development Officers were trained on the technologies developed for on-farm production of green muscardine fungus.

3.4 Coconut Processing and value addition:

Meeting the international Quality standards for Sri Lankan coconut products is a challenge to the coconut processing sector in order to survive in a competitive marketing environment. In the future overseas buyers may insist on the implementation of total quality management to the processing sector. A study was conducted to identify the prevailing constraints and motivational factors in adopting HACCP by the white edible copra and virgin coconut oil industries. The results revealed that lack of food safety regulations in Sri Lanka is a major

impediment for not adopting HACCP by the industries. It further revealed that organizing training programs focusing on food safety and HACCP implementation are highly important for these two industries.

The coconut meal or residue is the by product of coconut oil production. The coconut meal is rich in protein and fiber. Coconut flour is prepared from the coconut meal obtained from virgin coconut oil production, which is done in controlled and hygienic environment. The proximate composition of coconut flour and wheat flour was compared and it was found that coconut flour is rich in fiber, protein, sugar, and minerals than wheat flour. Coconut flour substitution up to 20-30% could be possible in the preparation of non-fermented traditional food items such as Roti, and pittu. Similarly, coconut flour substitution is possible for fermented traditional foods like Tosai and hoppers.

Storage of fresh coconut in the frozen form is advantageous for export market. Therefore, a study was conducted to evaluate the keeping quality of deep-frozen fresh mature coconut in different forms of servings. Coconut chips, scrapped coconut and coconut cream were frozen in pouches and quality of them was monitored measuring Free fatty acid (FFA) and peroxide values. Results show that FFA content increased gradually with time but peroxides were not detected. Even though marginal changes were observed total plate counts of the samples were increased with storage time.

The conventional retting process takes around six to twelve months. Therefore microbial flora in saline, brackish and fresh water was studied and microorganisms which enhance retting process was were isolated. Twelve microbial strains capable of degrading pectin and phenolic compounds were isolated and identified. Laboratory studies have shown that these consortia of microorganisms can complete the retting process within 6-8 weeks. A pilot study on retting with these microorganisms is in progress.

A prototype gasifier was developed using crushed coconut shells as the fuel source. A combustible producer gas generated through burning of coconut shell coming out of the cyclone separator was passed on to the burner fabricated from locally available material. When the gas was passed into the burner, it gave a yellowish red coloured flame with a temperature reaching 850^0C. Most importantly the flue gas coming out of the burner is colorless satisfying the requirement for environmental pollution control.

3.5 Technology Transfer:

Technology Transfer Division adopted several new strategies to promote dissemination and adoption technologies in the cultivation and processing sectors. To update the knowledge of CCB regional extension staff and to maintain regular feedback on technology needs and field problems, series of meetings were held with regional staff of Marawila, Kuliyapitiya, Kegalle, and Gampaha. New extension tools, such as CD's and flash cards, were also distributed among them to be used in field extension programmes. Several seminars and workshops conducted for the CCB staff to promote interim recommendation on coconut mite management, new coconut based products, and Weligama coconut leaf wilt and leaf rot diseases.

A series of training programmes conducted for trainees attached to different state and private sector organizations. Over hundred CRUPANISA officers attached to the Agrarian Services

Department in Hambantota District were trained at the Middeniya sub station. Several Training of Trainers (TOT) programmes were conducted for officers of the Export Development Board, Science and Technology Officers attached to the Vidatha Centers, agriculture and science teachers at Zonal educational level, Lalan Rubber Private Ltd., and Chilaw Plantations Ltd.

The most popular one day educational programme series was conducted during the year with the participation of over 200 coconut growers. On the request of VIDATHA centers in coconut growing areas, over 25 workshops were conducted in collaboration with the Processing Research Division of the Institute. The impact of these programmes was evaluated. Farmer Field School (FFS) approach as an effective tool effective tool in promoting technology adoption in resource poor farmer groups was implemented in several rural areas in collaboration with CCB extension staff. Over 28 FFS programmes were conducted during the year. In addition several crop clinics, seminars, workshops, were also conducted for the benefit of growers and processors.

The CRI journal COCOS Vol 15, Technology Bulletin on coconut products were also produced for island wide educational programmes to manage coconut mite and Weligama Coconut Leaf Wilt Disease. Mass media programmes in the form of new paper articles, Radio programmes, TV documentaries, Video documentaries were done during the year. The Institute participated in over 20 exhibitions held in various parts of the island.

4. HUMAN RESOURCE DEVELOPMENT

4.1 Local Trainings/Workshops

Programme	Commenced during the year	Continued during the year	Completed
Local Diploma Courses	3	-	-
Local Postgraduate training leading to Ph D degree	1	2	1
Overseas Postgraduate training leading to Ms C degree	-	-	1
Overseas Postgraduate training leading to Ph D degree	3	-	-
Overseas short-term training	-	-	3

4.2 Awards and Recognition

- Miss. J.M.M.A. Jayasundera was honored with a Presidential Award for her research work on charcoal fired modified copra kiln.

5. ACKNOWLEDGEMENTS

The Co-operation extended by the Deputy Director (Research), Deputy Director (Admin. And Fin), Heads of Divisions, and staff of the Research and Service Divisions contributed to the successful implementation of annual action plan is gratefully acknowledged.

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

Continued support given by the following organizations is also acknowledged.

- Ministry of Plantation Industries
- General Treasury
- 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
- Department of Botany, University of Peradeniya
- Industrial Technology Institute
- National Science & Technology Commission (NASTEC)
- Kurunegala Plantations Ltd.
- International Mycological Institute, UK
- Food & Agricultural Organization (FAO)
- Common Fund for Commodities
- Direct Fund for International Development (DFID)
- Generation Challenge Programme

REPORT OF THE AGRONOMY DIVISION

Acting Head - S.H.S. Senarathne, Ph D

1. GENERAL

The Agronomy research program was primarily aimed at increasing the coconut production and land productivity through development of innovative agronomic practices. In this contest, priority was given to research on rehabilitation of low yielding coconut plantations, soil moisture conservation, bio energy production, weed management, intercropping, vermicompost production, popularization of coconut based organic farming systems and animal husbandry as well as on utilization and management of nitrogen fixing trees in coconut lands. The total allocation of consolidated fund for the above studies was Rs 4.168 million. In addition two projects conducted from donor funds namely Poverty Reduction in Coconut Growing Communities project (IPGRI), Bio-energy development in coconut land (Alternate energy project, Ministry of Science and Technology).

Experiment conducts to determine biomass production revealed that plant density had significant effect on the wood and foliage biomass yield of gliricidia after four years of planting. The highest wood and foliage biomass was recorded in plots with three rows and two rows of gliricidia respectively while the lowest was in plots with a single gliricidia row. However, plots with higher plant densities had a low wood and foliage biomass yield per tree. Although treatments (Gliricidia planting two raw system(1mx1m) and three raw system (1mx1mx1m) had equal plant densities, the wider spacing gave higher wood and foliage biomass yields.

The study on short rotation forestry tree species showed that, three *Acacia* species namely *A. auriculiformis, A. mangium-1* and *A. mangium-2* followed by *Tectonia grandis* had the highest growth rates as measured by stem girth at 30 cm and 130 cm above ground. The growth rate of *Calophyllum eletum* (Domba) remained significantly low as in the previous years. Growth of *Gliricidia sepium* and *Grewia tilifolia* was also low during the year.

Application of glyphosate at the rate of 1.44ai ha^{-1} and cover cropping (Pueraria) were found to be cost effective in controlling weeds in mature plantations, compared with slashing, harrowing and ploughing methods. These methods are very effective to reduce the density of soil weed seed bank in the soil, because the amount of soil weed seed bank is the main indicator of the future weed population in the land. How ever, mechanical methods are helpful to bury weed seeds in deeper soil layers and create more favourable environment to germinate weed seeds in the soil. Therefore, depth of emergence of weed seedlings was very high in mechanical weeding plots and this information is very helpful to develop a sustainable weed management strategy in coconut plantations.

Intercropping cashew with coconut did not adversely affect coconut yield as observed in previous year indicating cashew as a potential intercrop under coconut. Grafted cashew reached early flowering and yielded within two years of planting followed by air-layered cashew plants. At the age of seven, both vegetative propagated cashew produced cashew yield of over 5.0 kg $tree^{-1}year^{-1}$. Cashew propagated by seeds took more than five years to flower, but from the 7^{th} year onwards, produced the highest yield among other types. To increase the productivity of coconut plantations, a new coconut based intercropping system was initiated to introduce foliage plant species under coconut. The objective of this study was

determining a suitable foliage plant species for intercropping with mature coconut in the low country wet zone. Three foliage varieties, Cane palm (*Areca lutescens*), Queen Palm and Cordiline were selected to cultivate at the experimental site due to the current demand in the export market.

Under the bio-energy development project, the model developed consists of six buffalos, out side supply of paddy straw and green pasture from 1.0 ha land of gliricidia + coconut with natural pastures. In this system bio gas generated for house cooking using buffalo dung. Testing was carried out to run an engine using biogas for generate electricity and it can be used to run water pump to irrigate coconut palms. The objectives of this study were to study total energy picture in a coconut land, total economic out put of coconut buffalo + gliricidia + paddy straw feeding system and to use biogas to uplift the estate activities in coconut lands. Initial results revealed that 1.0 ha model of coconut + gliricidia + natural pasture with out side paddy straw is sufficient to feed six buffaloes.

The project on "Improvement of Soil Fertility in Coconut Lands through Vermiculture" showed promising potential for adapting this technology to recycle farm land waste biomass in coconut plantations. The waste biomass (weed and plantation residues and animal wastes) can be very easily to convert to compost fertilizer within 5 to 6 weeks by the mediation of earth worm species.

Prolong cultivation of coconut without proper management of the land has lead to degradation of soils in many areas of the country. To rehabilitate the coconut grown soils, a project was started with the objective of developing a suitable method to rehabilitate the coconut cultivated soils. Three different plant species *Gliricidia sepium, Panicum maximum, Thitonia diversifolia and Gliricidia sepium+ Thitonia diversifolia* namely and their combinations were grown in coconut plantations and incorporation of their biomass into the soil to improve the soil fertility.

Twenty model farms were established in the coconut triangle under the Popularization of Organic Coconut Production and Processing Project. These model farms are being supervised and monitored with necessary guidance and inputs such as livestock and other planting material when and where necessary. Under this project two field experiments were established to develop an organic fertilizer based coconut planting system with the objective of evaluating the prospects and constraints of raising coconut seedlings using 100% organic inputs and to study the effect of organic manure application on the yield of coconut.

To develop the animal husbandry sector in coconut plantations, an animal breeding project was started in 1999 to develop a smallholder goat and buffalo farming systems under coconut with the objective of increasing the profitability and fertility in coconut lands. Sixty male and female goats were sold to coconut growers to initiate the goat farming units in their estates and six Mura stud buffaloes were sold to buffalo farming units in Pollonnaruwa district to improve the heard quality and production at a concession of price. Sheep farming is a very effective method to control problematic weeds and improve soil fertility level in coconut lands. Thus to develop and popularize sheep farming in coconut plantations, one field demonstration was initiated in Bandirippuwa estate.

2. RESEARCH PROJECTS

PROJECT 1: REHABILITATION OF LOW YIELDING PLANTATIONS

Experiment 1.1: Effect of root pruning and fertilizer application on yield of coconut palms with heavy root mat formation on Coastal Regosols (DL_4/S_5), Palavi - 1996

The experimental design was a Randomised Complete Block Design (RCBD) with three replicates containing nine effective palms per plot. The soil was 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 2006, root pruning by disk harrowing (15 cm depth) and application of 3.0 kg of APM + 1.0 kg of dolomite/palm were continued according to treatments given in Table 1.

Table 1: Effect of three different treatments on the yield of coconut at Palavi

Treatments	Nuts palm^{-1}year^{-1}				
	2003	2004	2005	2006	2007
T_2-Harrowing + Fertilizer	56	58	48	53	48
T_3-Harrowing only	40	49	29	36	36
T_4-Fertilizer only	49	58	44	60	54
Significance	n.s.	n.s.	n.s.	*	*
LSD (P=0.05)					16

The analysis of data in year 2007 showed that T_3 is significantly different from T_4 but there was no significant difference between T_2 and T_4 (Table 1). This indicates that there are no any significant effects from harrowing in the coconut square. However, Research Committee of the CRI suggested harrowing to be done in the manure circle itself. (T_1 was removed due to unavoidable circumstances).

The experiment is in progress.

H A J Gunathilake, K V N N Jayalath and E M G Banda

Experiment 1.2: Rehabilitation of degraded coconut soils through short-term forestry in Andigama Soil Series (shallow phase) at Ratmalagara Estate (IL_1/S_5), Madampe - 1999

This experiment was initiated in October 1999 to investigate the possibility of improving soil quality of degraded coconut lands through short/medium term forestry for sustainable coconut production. The forest tree species used in this experiment have been planted in a Randomized Complete Block Design (RCBD) with three replicates (Table 2).

In year 2007, the three *Acacia* species showed higher growth rates as measured by stem girth at 30 cm and 130 cm above ground (Table 2). *A. auriculiformis* showed a significantly high stem girth at 30 cm and 130 cm above ground levels when compared with all other species.

The growth rate of *Calophyllum eletum* (Domba) remained significantly low as in the previous years. Growth of *Gliricidia sepium* was also low during the year.

Table 2: Growth of selected forest tree species

Treatments	Stem girth (cm) (at 30 cm above ground)		Stem girth (cm) (at 130 cm above ground)	
	2006	2007	2006	2007
T_1 *A. auriculiformis*	82	78	66	70
T_2 *A. mangium-1*	66	70	62	48
T_3 *A. mangium-2*	62	58	58	50
T_4 *Calophyllum elatum*	22	25	18	19
T_5 *Grewia tilifolia*	35	54	24	44
T_6 *Macaranga paltata*	58	51	51	44
T_7 *Gliricidia sepium*	35	35	37	31
T_8 *Tectonia grandis*	54	49	44	49
T_9 *Swieteria macrophylla*	36	50	29	40
T_{10} *Bridella mooni*	49	42	41	39
Significance	n.s.	*	n.s.	*
LSD (P=0.05)		7.2		9.45
CV%		8.3		12.75

The experiment is in progress.

H A J Gunathilake, K V N N Jayalath, H A Abeysoma and I M Thilakerathne

Experiment 1.3: Use of different plant species to rehabilitate the coconut cultivated soils

Experiment 1.3.1: Rathmalagara Estate (IL_1/S_4) - 2005
Experiment 1.3.2: Ridigama Oya Estate (IL_1/S_4) - 2006

The objective of the experiments was to develop a suitable method to rehabilitate coconut soils, because prolong cultivation of coconut leads to degradation of soil in many areas of the country. The soil organic matter levels decreased gradually in these lands due to high temperature and some other factors inherent to tropical soils. The organic matter content in coconut soil lies in the range of 0.05% - 2%, which is very low. To maintain high soil fertility in coconut lands, the organic matter content and other properties have to be improved. This can be done by incorporation of different plant materials into the soil.

Therefore, two experiments were established at Rathmalagara Estate and Ridigama Oya Estate using following treatments on a Randomized Complete Block Design with three replicates. There were 8 effective palms per plot.

Treatments: T_1- Planting *Gliricidia sepium*
T_2- Planting *Gliricidia sepium* + *Tithonia diversifolia*
T_3- Planting *Panicum maximum*
T_4- Planting *Tithonia diversifolia*
T_5- Planting cover crop (*Puereria phasioloides*)
T_6- Control (no plant species)

Table 3: ***Effect of four different treatments on the yield of coconut (nuts palm^{-1}year^{-1}) at Ratmalagara and Ridigama in 2007***

Treatments	Ratmalagara	Ridigama
T_1- Planting *Gliricidia sepium*	45	45
T_2- Planting *G. sepium* + *T. diversifolia*	48	52
T_3- Planting *Panicum maximum*	46	51
T_4- Planting *Tithonia diversifolia*	49	42
T_5. Planting cover crop (*Puereria phasioloides*)	57	52
T_6- Control (no plant species)	43	45
Significance	*	ns
LSD (P=0.05)	13	-

During the year nut yield of coconut as affected by the application of different soil rehabilitation practices showed significantly different at Ratmalagara experiment and not significant differences at Ridigama experiment (Table, 3). The highest nut yield was recorded in cover crop (*Puereria phasioloides*) planted plots in both experiments. Soil samples were collected and are being analyzed.

The experiments are being continued.

S H S Senarathne, K C P Perera, I.Costa, R Sawarnathilake , W.R.O.Fernado, B.Perera and S. Fernando

Experiment 1.4: Performance of two different varieties of coconut on Andigama Series Lateritic Soils and the effect of irrigation on the growth of deep plant coconut seedlings.

Experiment 1.4.1: Bandirippuwa Estate (IL_1/S5) - 2005

The objective of the experiment was to determine the effect of irrigation on two cultivars of coconut deep planted in Andigama Series Lateritic (deep gravel) soils. Experiment was established at Bandirippuwa estate using following treatments on a Two Factor Factorial Randomized Complete Block Design with three replicates. There were 8 effective coconut seedlings per plot. Seedling holes (4ft x 4ft x 4ft) were excavated by using a backhoe machine. Irrigation was done during the drought periods. Seedling growth was measured and expressed as seedling girth and rate of leaf production.

Treatments: T_1 - With Irrigation + Tall x Tall seedlings
T_2 - With Irrigation + Plus palms seedlings
T_3 - Without Irrigation + Tall x Tall seedlings
T_4 - Without Irrigation + Plus palms seedlings

Table 4: ***Effect of different treatments on the growth of coconut seedlings (expressed as the seedling girth.***

Treatments	Seedling girth (cm)				
	May 2006	Aug 2006	Dec 2006	May 2007	Dec 2007
T_1 - With Irrigation + Tall x Tall seedlings	30	41	57	47	53
T_2 - With Irrigation + Plus palms seedlings	32	39	50	47	58
T_3 - Without Irrigation + Tall x Tall seedlings	28	36	49	44	48
T_4 - Without Irrigation + Plus palms seedlings	29	36	52	43	52
Significance	ns	ns	ns	ns	*
LSD (P=0.05	-	-	-	-	8

Table 5: ***Effect of different treatments on the growth of coconut seedlings (expressed as the rate of leaf production).***

Treatments	Rate of leaf production		
	Dec 2006	May 2007	Dec 2007
T_1 - With Irrigation + Tall x Tall seedlings	2.42	2.60	3.26
T_2 - With Irrigation + Plus palms seedlings	2.71	2.73	3.06
T_3 - Without Irrigation + Tall x Tall seedlings	2.36	2.40	2.93
T_4 - Without Irrigation + Plus palms seedlings	2.56	2.20	2.86
Significance	ns	ns	*
LSD (P=0.05	-	-	0.39

Growth of coconut seedlings are expressed as seedling girth (cm) and the rate of leaf production (Table, 4 & 5). Both growth parameters were significantly affected by the treatments in December 2007. Coconut seedlings growth in irrigation with Plus palm seedling grown under irrigation (T_2) showed highest seedling girth than the other treatments (Table, 4). Tall x Tall seedling with irrigation treatment (T_1) showed higher growth rate in terms of leaf production rate than the other treatments (Table, 5)

The experiment is being continued.

S H S Senarathne, K C P Perera, R Sawarnathilake, and B. Perera

PROJECT 2: SOIL MOISTURE CONSERVATION

Experiment 2.1: Effect of husk burial, irrigation and fertilizer application on coconut yield, Rathmalagara Estate, Madampe, 2006

The study was aimed at evaluating the effect of husk burial, irrigation and fertilizer application on coconut yield. The treatments are shown in Table 6. Treatments were arranged in Randomized Complete Block Design with nine effective palms per plot. Coconut yield data were collected during the year 2007 to capture the pre-treatment variation. There were no significant differences between treatments during the year 2007.

Table 6: Effect of husk burial, irrigation and fertilizer application on coconut yield

Treatments	Nuts palm^{-1} year^{-1}	
	2006	2007
T_1- Fertilizer only	76	79
T_2- Irrigation only	83	85
T_3 – Husk pits only	94	87
T_4 - Irrigation + husk pits + fertilizer	90	82
T_5-Fertilizer + Irrigation into husk pits	86	84
Significance	ns	ns
LSD (P=0.05)		

H A J Gunathilake, K V N N Jayalath, H A Abeysoma and E M G Banda

PROJECT 3: IMPROVEMENT OF PRODUCTIVITY OF COCONUT SOILS THROUGH VERMICULTURE TECHNOLOGY

Experiment 3.1: Effect of vermin-compost on the growth of coconut seedlings under field conditions

Experiment 3.1.1: Mendis Estate, Badalgama (IL1/S4) - 2006
Experiment 3.1.2: Seram Estate, Iriyagolla (WL3/S4) - 2006

The objective of this experiment was to evaluate the effect of vermin-compost on the growth of coconut seedlings. Therefore, two experiments were established at Badalgama (Mendis Estate) and Iriyagolla (Seram Estate), using following treatments with Randomized Complete Block Design with three replicates. Seedling growth was measured and expressed by the seedling girth, height and the rate of leaf production.

Treatments: T_1 - Vermi-compost only (100%) + Dolomite
T_2 - Inorganic fertilizer (YPM 100%) + Dolomite
T_3 - Vermi-compost (50%) + Inorganic fertilizer (YPM 50%) + Dolomite

Table 7: Effect of different treatments on the growth of coconut seedlings (expressed as the seedling girth, height and leaf production rate at Badalgama in December 2007.

Treatments	Girth (cm)	Height (cm)	Leaf production rate
T_1 - V/ Compost (100%) + Dolomite	19	157	5.54
T_2 – (YPM 100%) + Dolomite	14	149	6.48
T_3 – V/Compost (50%) + Inorganic F (YPM 50%) + Dolomite	17	134	6.04
Significance	*	*	ns
LSD (P=0.05)	3	19	-

Table 8: ***Effect of different treatments on the growth of coconut seedlings (expressed as the seedling girth, height and leaf production rate at Iriyagolla in December 2007.***

Treatments	Girth (cm)	Height (cm)	Leaf production rate
T_1 - V/ Compost (100%) + Dolomite	28	239	5.89
T_2 – (YPM 100%) + Dolomite	21	147	5.85
T_3 – V/Compost (50%) + Inorganic F (YPM 50%) + Dolomite	24	139	6.11
Significance	*	*	ns
LSD (P=0.05)	3	38	-

During the experimental period, rate of leaf production was not significantly different in both experiments (Table 7 & 8). Seedling girth and height of the seedling as affected by the application of vermin-compost base fertilizer mixtures showed significant differences during the year in both experiment and the highest seedling height and girth was observed in 100% vermicompost with dolomite applied plots (T_1) (Table 7 & 8).

The experiments are being continued.

S H S Senarathne, M.J.I.Costa,
K C P Perera, K.D.D.Appuhamy and G.B.Ekanayake

Experiment 3.2: Production of vermin-compost by using different weed species, at Bandirippuwa Estate - 2006

The objective of this experiment was to produce vermicompost by using plant residues from different weed species which grow in coconut plantations. The experiment was established at Bandirrippuwa estate with following treatments on a Complete Randomized Design with four replicates. Worm multiplication percentages, nutrient content of vermin-compost and allilopathic effect of vermicompost on the growth of different vegetables are evaluated.

Treatments:

T_1 - Cow dung 1/3 (v/v) +Grass residues 2/3 (v/v)
T_2 - Cow dung 1/3 (v/v) +Grass residues 1/3 (v/v) + *Chromoleana odorata* residues 1/3 (v/v)
T_3 - Cow dung 1/3 (v/v) +Grass residues 1/3 (v/v) + *Lantana camara* residues 1/3 (v/v)
T_4 - Cow dung 1/3 (v/v) +Grass residues 1/3 (v/v) + *Hyptis suaveolens* residues 1/3 (v/v)
T_5 - Cow dung 1/3 (v/v) +Grass residues 1/3 (v/v) + NFT,s residues 1/3 (v/v)

i. **Worm population changes.**

Table 9: Effect of weed residues mixtures on development of worm population

Treatments	Worms population development %	
	1st round %	2nd round %
T_1 - Cow dung 1/3 (v/v) + only grass residues (*Panicum spp*) 2/3 (v/v)	231.3 b	212.0 b
T_2 - Cow dung 1/3 (v/v) + *Chromolaena* resi 1/3 (v/v) + Grass resi- 1/3 (v/v)	202.0 c	190.6 c
T_3 - Cow dung 1/3 (v/v) + *Lantana* resi 1/3 (v/v) + Grass resi- 1/3 (v/v)	193.0 d	184.6 c
T_4 - Cow dung 1/3 (v/v) + *Hyptis* resi 1/3 (v/v) + Grass resi- 1/3 (v/v)	163.3 e	176.6 d
T_5 - Cow dung 1/3 (v/v) + NFT resi 1/3 (v/v) + Grass resi- 1/3 (v/v)	270.6 a	286.6 a
Significance	**	**
LSD (P=0.05)	8.09	7.15

Table 10: Effect of weed residues mixtures on the nutrient content of vermi-compost

Treatments	N (mg/g)	K(mg/g)	P(mg/g)	O.M.	pH
T_1	10.416	20.242	11.016	25.24	9.32
T_2	13.104	16.012	10.231	23.17	8.58
T_3	11.536	15.826	8.958	19.44	9.13
T_4	13.972	18.301	7.952	25.97	9.04
T_5	14.116	22.787	8.369	25.63	9.34
Significance	**	*	*	*	-
LSD (P<0.05)	1.27	2.30	1.31	3.57	-

Different weed species residues were used according to the schedule to determine worm multiplication percentage. The experiment was conducted two rounds and compost samples were analyzed to measure the nutrient content. There was a significant difference among treatments on worm multiplication percentage (%). The highest worm multiplication percentage was observed in (T_5) Cow dung 1/3 (v/v) +Grass residues 1/3 (v/v) + NFT,s residues 1/3 (v/v) mixture and the lowest values were observed in (T_3 and T_4) *Lantana camara* and *Hyptis suaveolens* plant residues mixture in both rounds (Table, 9).

The highest N and K contents were recorded in the compost samples that was produced by T_5 and it shows a significantly ($P<0.05$) higher content than others (Table, 10). There was significant difference among treatments on organic matter content. The highest organic matter content was showed by T_1, T_2, T_4 and T_5. P content was significantly high in T_1 than other treatments (Table, 10).

The experiment is being continued.

S H S Senarathne, K C P Perera, R Sawarnathilake, and B. Perera

PROJECT 4: DEVELOPMENT OF BIOMASS ENERGY PRODUCTION SYSTEMS UNDER COCONUT

Experiment 4.1: Planting of Gliricidia to optimise the production of fuel wood and foliage biomass under coconut at Ratmalagara Estate (IL_1/S_5), Madampe - 2003

The experimental design was a Randomised Complete Block Design with four replicates. The following treatments were imposed with the objective of studying the effect of plant density on fuel wood and foliage biomass of Gliricidia.

T_1- Planting one row of Gliricidia at 1 m spacing (1275 trees ha^{-1})
T_2- Planting two rows of Gliricidia at 2 x 1 m spacing (2550 trees ha^{-1})
T_3- Planting two rows of Gliricidia at 1 x 1 m spacing (2550 trees ha^{-1})
T_4- Planting three rows of Gliricidia at 1 x 1 x 1 m spacing (3825 trees ha^{-1})

Treatments had significant effects on the wood and foliage biomass yield of Gliricidia after four years of planting (Table 5). The highest wood biomass was recorded in plots with three rows of gliricidia (T_4) while the lowest was in plots with a single gliricidia row (T_1). However, plots with higher plant densities had a low wood and foliage biomass yield per tree (data not shown). Although treatments 2 and 3 had equal plant densities, the wider spacing gave higher wood and foliage biomass yields.

Table 11: Wood and foliage biomass yield of gliricidia as affected by different planting densities

Treatment	Wood yield(kg ha^{-1})			Foliage biomass (kg ha^{-1})		
	2005	2006	2007	2005	2006	2007
T_1- One row (1275 trees/ha)	3 341	3 012	9975	1 335	2 080	1323
T_2- Two rows (2550 trees/ha)	5 432	5 656	12760	1 511	2 307	1845
T_3- Two rows (2550 trees/ha)	4 399	4 646	12974	1 020	1 383	1971
T_4-Three rows (3825 trees/ha)	7 698	5 902	13552	1 559	1 778	1764
Significance	*	*	*	*	n.s.	*
LSD (P=0.05)	1 923	2 139	4909	281		361
CV%	23		24	12		13

The experiment is in progress.

H A J Gunathilake, K V N N Jayalath, H A Abeysoma and E M G Banda

Experiment 4.2: Development of Gliricidia as a multipurpose tree for generation of Bio – Energy and Bio-Fertilizer – Rathmalagara Estate, 2006

Gliricidia is a multi-propose tree and one of it use as an animal feed. Gliricidia mix with pasture or straw makes excellent animal feed. Then cattle dung could be used to produce bio gas. Then, wood of Gliricidia directly produce energy and leaf is produced bio gas through cattle feeding.

Objectives of this study are:

a). Demonstration of the performance of coconut/cattle/gliricidia/paddy straw based farming system to maximize farmer income.

b). Development of environmentally viable integrated bio-energy production system in coconut land to fulfill energy requirements in coconut plantation.

Methodology:

One hectare of coconut land was planted with double rows of Gliricidia (1.0m x 1.0m) to a density of 2250 trees/ha. A cattle shed was constructed at a cost of Rs. 185,000 to accommodate six buffaloes. Buffaloes are fed with pasture, paddy straw mix with Gliricidia leaves. Dung has been directed to a bio-gas digester constructed with the advice of NERD (Capacity – 35.0-m^3; construction cost – Rs. 70,500/-)

The person selected for the pilot project is Mr.Nimal Bandara. He is a temporary watcher at the estate. He is a model farmer and his family consists of 3 children and 3 adults and all of them are engaged in his farming model.

Results:

a). Milk yield : Currently 3 milking buffaloes produce about 12 liters of buffalo milk daily. Milk they use to produce curd (500 ml size) and sell them at a price of Rs. 50/-. Curd pots they sell to retail shop nearby or during the rainy season milk is sold to the CT yogurt factory.

b). Cattle feed: For an animal of 600 kg weight 55kg of animal feed is needed daily. Of this 30% was Gliricidia and 30% was paddy straw. Balance 40% was given in the form of pasture/grass. Gliricidia produced 6-7 kg of leaves/tree/year.

c). Energy requirement: The milk is heated for 20 minutes using biogas. Currently the electricity requirement for the house is for two bulbs, and 22 " colour TV.

d). Bio gas production: With 6 buffaloes, biogas produced equalvent to 2 kWh electricity energy generated daily.

e). Electricity generation: Bio gas was purified removing H_2S by using a pipe placed with Fe particles. A generator of 1.0 cc capacity was placed and daily production of biogas was sufficient to run generator for 6 hours/day (1.5 kWh/day).

f). Self – sustainability of energy: It was appeared that 1.0 ha of coconut and straw plus Gliricidia based feeding system with 6 buffaloes was sufficient enough to meet energy requirement of 6 member family.

The experiment is in progress

H.A.J. Gunathilake, H.A. Abeysoma and P.G. Joseph (Ministry of Science & Technology)

PROJECT 5: ORGANIC COCONUT FARMING

Experiment 5.1: Effect of different sources of organic manure applications on the performance of mature coconut palms at Ratmalagara Estate (IL_1/S_5), Madampe - 2003

An experiment was started in year 2003 with the objective of assessing the effect of organic fertilizer application on soil fertility and coconut yield. Following treatments were imposed on a **non replicated single plot experiment** and each plot had 24 effective palms. Age of the palms was 55 years and planted at a spacing of 8.5 m X 8.5 m

T_1 - Application of 3 kg of APM + 1 kg of Dolomite
T_2 - Application of 50 kg of Gliricidia + 230 coconut husks + 600 g of ERP + 1 kg of Dolomite
T_3 - Application of 25 kg of goat manure + 130 coconut husks + 600 g of ERP + 1 kg of Dolomite
T_4 - Application of 30 kg of Gliricidia + 230 coconut husks + 600 g of ERP + 1 kg of Dolomite + Puraria cover crop

Table 12: Effect of different organic manure applications on coconut yield

Treatments	Coconut Yield (nuts palm^{-1} year^{-1})			
	2004	2005	2006	2007
T_1	63	74	86	65
T_2	79	55	85	57
T_3	51	75	104	65
T_4	62	60	79	58

Generally, coconut yield in the year 2007 showed considerable decline compared to the previous year 2006. There was no difference in nut yield among the treatments T_1 - T_4. However palms treated with goat manure supplemented with other organic and natural mineral sources T_2 and Adult Palm Mixture (APM) (T_1) showed higher nut yield than Gliricidia (T_3 and T_4) treatments (Table, 12). This indicates that as a source of organic N, goat manure seems to be beneficial over Gliricidia and application of APM may be the added advantage over Gliricidia. However, Gliricidia is cheaply available as in-situ N source in coconut lands.

The experiment is in progress.

H A J Gunathilake, B A S Manjula, H A Abeysoma and W A Hemawardena

Experiment 5.2: Effect of organic manure application on the performance of T x T coconut seedlings at Pallama Seed Garden (IL_1/S_4)-2006

The experiment was designed to evaluate the prospects and constraints of raising coconut seedlings using 100% organic inputs. Treatments were laid on Randomize Complete Block Design (RCBD) with three replicates and six effective palms per plot. During the year, experimental plots were treated according to the treatment plan mentioned in Table 13.

Treatments: T_1-Control (YPM + 1000 g of Dolomite)
T_2-Vermicompost 5 kg + 200 g of ERP + 250 g of Dolomite
T_3-Gliricidia 5 kg + 275 g of ERP + 250 g of Dolomite
T_4-Cattle or Goat manure 5 kg + 200 g of ERP + 250 g of Dolomite

Table 13: ***Treatment plan of the experiment at Pallama Seed Garden***

Treatment	Ingredients	Basal	0.5 yr	1 yr	1.5 yr	2 yr	2.5 yr	3 yr	3.5 yr	4 yr
T – 1	Urea (g)	250	150	180	180	240	240	300	300	360
	ERP (g)	750	340	405	405	540	540	675	675	810
	MOP (g)	250	150	180	180	240	240	300	300	360
	Dolomite (g)	1000	500	500	500	500	500	500	500	500
T – 2	Vermicompost(kg)	10	5	6	6	8	8	10	10	12
	ERP (g)	390	200	240	240	320	320	400	400	480
	Dolomite (g)	500	250	250	250	250	250	250	250	250
T – 3	Gliricidia (kg)	10	5	6	6	8	8	10	10	12
	ERP (g)	540	275	330	330	440	440	550	550	660
	Dolomite (g)	500	250	250	250	250	250	250	250	250
T – 4	Goat dung (kg)	10	5	6	6	8	8	10	10	12
	ERP (g)	390	200	240	240	320	320	400	400	480
	Dolomite (g)	500	250	250	250	250	250	250	250	250

Table 14: ***Effect of different treatments on growth performance of T x T coconut seedlings at Pallama Seed Garden***

Treatments	Average No of leaves 2006	Average No of leaves 2007	Average girth (cm) 2006	Average girth (cm) 2007	Average height (cm) 2006	Average height (cm) 2007
T_1-control	7	8	27	33	180	221
T_2-Vermicompost	6	7	29	32	190	225
T_3-Gliricidia	7	7	26	31	182	218
T_4- Goat manure	7	7	26	30	181	217
Significance	ns	ns	ns	ns	ns	ns

During the year, number of leaves per palm, basal girth and height of the palm have not shown any significant difference among treatments (Table, 14). This indicates that, vermicompost, Gliricidia, and goat manure are also equilent to application of Young Palm Mixture (YPM) so far.

Experiment is in progress.

B A S Manjula, R Marasinghe and W R O Fernando

Experiment 5.3: Development of green manure based fertilizer mixture for organic coconut farming systems

Experiment 5.3.1: Evaluation of growth performance of *Tithonia diversifolia* under coconut plantations in different agro-climatic zones.

Experiment a: Pothukulama Estate (IL_1/S_4)
Experiment b: Walpita Estate (IL_1/S_4)-2007

The objective of this experiment was to study the effect of different environmental conditions on growth of *Tithonia diversifolia* in coconut plantations. *Tithonia*, commonly known as Mexican sunflower, is a shrub belonging to the family Asteraceae. The biomass of *Tithonia* used for soil fertility improvement generally includes both green tender stems and leaves but not woody stems. The biomass nutrient content (4%-N, 0.56%-P and 4.8% - K) of *Tithonia*, as compared to green biomass of other shrubs and trees, is relatively high in Potassium.

Therefore, two experiments were established at Pothukulama and Walpita estates, using following treatments on a Randomized Complete Block Design with four replicates.

Treatments: Different pruning intervals

T_1 – Three months interval (4 times per year)
T_2 - Four months interval (3 times per year)
T_3 - Six months interval (2 times per year)

Biomass production and different soil properties were measured.

The experiment is in progress.

S H S Senarathne, K C P Perera, M.J.I.Costa, B Perera and R. Suwarnathilake

PROJECT 6: DEVELOPMENT OF LOW COST WEED MANAGEMENT SYSTEMS FOR COCONUT LANDS AND COCONUT NURSERIES

Experiment 6.1: Effect of different weed management systems on seed bank composition and distribution in coconut growing soil.

Experiment 6.1.1 Pallama Seed Garden (IL_1/S_4) - 2004

Treatments shown in Table 15 were laid on Nested design with three replicates and plot size was four coconut squares (coconut spacing of the square planting system is 8.2m x 8.2m). To control weeds, different weeding methods were applied according to the schedule. In the chemically weeded plots glyphosate (1.44 ai kg ha^{-1}) was applied two times per year at 6 monthly intervals, at the latter part of the rainy season. The cover crop was established to control weeds and the over grown conditions of cover crop was managed to overcome competition by twice a year. Tractor harrowing, slashing and ploughing were done at the latter part of the rain season at six monthly intervals.

During the year, more frequent sampling was practiced to understand the dynamics of weed growth in response to different cultural practices of weed management. The dry weight of both monocotyledonous and dicotyledonous weeds was measured separately every month from August 2004 to May 2006.

Soil samples were taken from May 2004 to August 2006 at 3 monthly intervals from five random places per plot using a 15cm diameter cylindrical steel soil sampler at three different depths to count the total number of germinating weed seeds. Each position was sampled to a depth of 30cm. The soils of the respective samples were distributed in plastic trays to a depth of approximately 3cm and placed in a covered shade house to prevent the extremes of temperature and excessive precipitation encountered in the field.

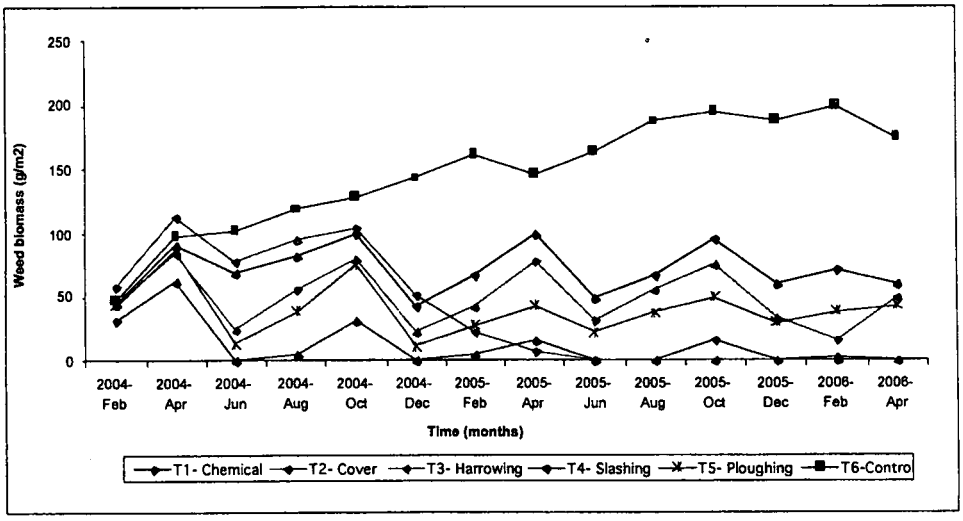
Factor 1: Five different weed control methods

a. Chemical weeding (Application of Glyphosate 1.44 kg a.i.ha^{-1})
b. Establishment of cover crop (*Puereria phasioloides*)
c. Tractor harrowing (once in six month)(0cm - 15cm depth)
d. Tractor slashing (once in six month)
e. Tractor ploughing (once in six months) (0cm - 45cm depth)

Factor 2: three different soil sampling depths

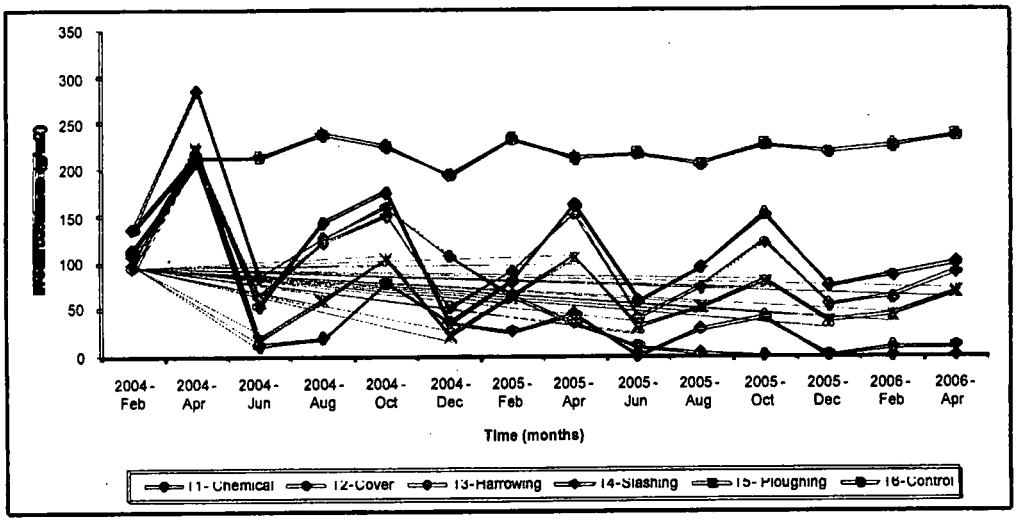
a. 0cm – 10cm
b. 10cm – 20cm
c. 20cm – 30cm

There were significant differences in weed biomass among treatments. The lowest weed biomass was recorded in Glyphosate applied and Pueraria cover plots. Pueraria cover was also equally effective to suppress weeds as in Glyphosate applied plots.



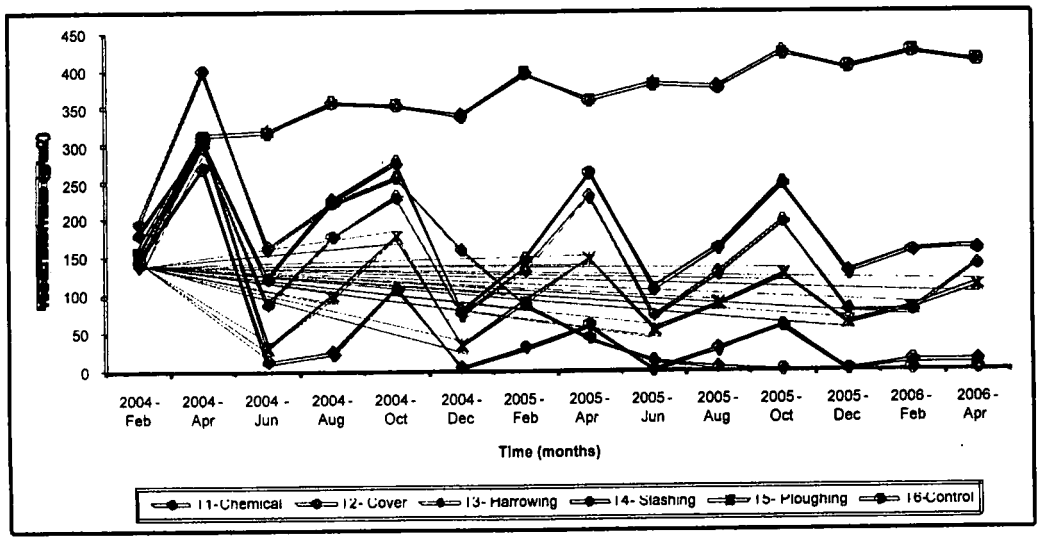
Treatments were applied in May 2004, October 2004, May 2005, October 2005 and May 2006.

Figure 1: ***Effect of different weed management systems on monocotyledonous weed biomass from February 2004 to April 2006.***



Treatments were applied in May 2004, October 2004, May 2005, October 2005 and May 2006.

Figure 2: ***Effect of different weed management systems on dicotyledonous weed biomass from February 2004 to April 2006.***



Treatments were applied in May 2004, October 2004, May 2005, October 2005 and May 2006.

Figure 3: ***Effect of different weed management systems on total weed biomass from February 2004 to April 2006.***

Application of glyphosate and cover cropping Pueraria to manage monocotyledonous weeds reduced the weed biomass significantly ($P<0.05$) of when compared to other mechanical methods such as harrowing, slashing and ploughing (Figure, 1). Initially *Pueraria*

phaseoloides took several months to establish a good cover. The weed biomass (monocotyledonous and dicotyledonous) was very high at the initial stages in cover cropped plots which declined gradually later (Figures 1 & 2). Initially, the three mechanical weeding treatments (Harrowing, Ploughing and Slashing) suppressed weed growth, but rapid re-growth was observed in monocot weeds than in dicotyledonous weeds (Figure 1 and 2). However, slashing monocotyledonous grass weeds at shorter intervals in coconut lands may not be cost effective. Disc harrowing and ploughing at six month intervals reduced the weed biomass significantly when compared to slashing.

Table 15: ***Effect of different weeding management systems on total weed seed bank reduction in the soil profile from March 2004 to September 2006.***

Treatments	0cm – 10cm	10cm -20cm	20cm -30cm
T_1 - Chemical weeding	87%_	92%_	82%_
T_2 -Cover cropping(*Puereria phasioloides*)	92%_	89%_	62%_
T_3- Tractor harrowing	43%_	175%_	72%_
T_4- Tractor slashing	52%_	57%_	68%_
T_5- Tractor ploughing	80%	407%_	1174%_
T_6- Control	09%	06%_	48%_

(Total germinating weeds seed count (_ -increasing and _ decreasing) percentages from March 2004 to September 2006).

Chemical weeding, cover cropping and ploughing treatments were very effective to reduce germinating weed seed count (monocotyledonous and dicotyledonous) in top soil layer (0-10cm) (Table 15). The decreasing percentage of germinated weed seed count values were over 80% in these three treatments. In any agricultural field, weeds seed count of top soil layers (0-10cm) has a significant impact on future weed populations. In deeper soil layers (10-20cm and 20cm – 30cm) germinating weed seed count was increased with time in harrowed and ploughed plots significantly ($P<0.05$) (Table 15). In the same soil depths of other treatments (chemical weeding and cover cropping) germinating weed seed count was decreased by over 80%.

Conclusion:

Application of glyphosate at 1.44 kg ai ha^{-1} and cover cropping with *Pueraria* were the most effective treatments for the control of weeds and germinated weed seed density in top soil layers when compared to other weeding methods. However, data on weed seed distribution show ploughing and harrowing shifts significant numbers of weed seeds to deeper soil profiles.

The experiment was terminated

S H S Senarathne, K C P Perera,
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PROJECT 7: SMALLHOLDER COCONUT FARMING SYSTEMS WITH ANNUAL/PERENNIAL CROPS IN THE INTERMEDIATE AND THE DRY ZONE

Experiment 7.1: Evaluation of the performance of grafted cashew under coconut

a. Rathmalagara Estate, Madampe (IL_1/S_4) - 1995

Treatments given in Table 16 were tested on a RCBD with three replicates. Each plot consisted of nine effective coconut palms.

Planting of cashew in coconut avenues did not affect coconut yield as in previous years suggesting cashew as a potential intercrop in coconut plantations (Table 16). Grafted cashew reached early flowering and yielded within two years of planting followed by air-layered cashew plants. At the age of seven, both vegetative propagated cashew produced cashew yield of over 5.0 kg $tree^{-1}year^{-1}$. Cashew propagated with seeds took more than five years to flower, but from the 7^{th} year onwards, produced the highest yield among other types. However the difference is not significant. Bud-grafted cashew produced the highest yield per unit basis.

Table 16: The effect of the plant-type of cashew on coconut yield

Treatments	Coconut yield (nuts $palm^{-1}year^{-1}$)			
	2004	2005	2006	2007
Coconut monoculture	79	50	80	70
Bud grafted cashew	75	51	70	77
Air-layered cashew	70	40	78	79
Seedling cashew	67	51	74	62
Significance (P=0.05)	n.s.	n.s.	n.s.	n.s.

The experiment is in progress.

H A J Gunathilake, H A Abeysoma and W. A.H emawardane

b. Pallama Seed Garden (IL_1/S_4) - 2000

Intercropping with cashew did not show any significant effect on coconut yield as observed in the previous year (Table 17). At Pallama site, cashew yields were not taken because of severe pest damage.

Table 17: Coconut yield as affected by intercropping with three different types of planting materials of Cashew

Treatments	Coconut yield (nuts palm^{-1}year^{-1})			
	2003	2005	2006	2007
Coconut monoculture	66	51	79	66
Bud grafted cashew	72	64	93	80
Air-layered cashew	68	61	92	75
Seedling cashew	69	58	90	71
Significance (P=0.05)	n.s.	n.s.	n.s	* 12

The experiments are in progress.

H A J Gunathilake, A Gunasekera and B Perera

Experiment 7.2: Inter cultivation high demanding foliage plant species (Areca lutescens, Cordyline Fruiticosa Red, Livistonia) under coconut in the low country wet zone. Molawatta Estate, Udugampola (WL3/S3) -2007

In recent years, much interest has been focused in the diversification of coconut lands for integrated tree farming on floriculture in the wet zone. Among the intercrops, ornamental foliage plant varieties are well adapted to the wet zone. However, information on the feasibility of inter cultivation foliage plants with coconut is scarce.

The above study was initiated in October 2007 to determine a suitable cut foliage plant varieties for inter cultivating with mature coconut in the low country wet zone. The foliage plant varieties were chosen on the basis of market potential and adaptability to the agro-ecological zone and cultivated in between coconut rows.

The experiment was arranged in a RCB design with three replicates. Each experimental plot was consisted with 6 effective palms.

Treatments:
T_1- Areca lutescens (Cane palm)
T_2- Cordyline Fruiticosa Red
T_3- Livistonia (Queen palm)
T_4-Control

Nut yield data of coconut palms and leaf formation rate of foliage plants are being collected.

The experiment is in progress.

B A S Manjula, K.C.P.Perera and W R O Fernando

PROJECT 8: **DEVELOPMENT OF SMALLHOLDER COCONUT FARMING SYSTEMS WITH LIVESTOCK (SMALL RUMINNENTS) INTERGRATION IN THE INTERMEDIAT AND DRY ZONE.**

Experiment 8.1: **Cultivation of Coimbatoor 3 (CO-3) fodder under coconut to improve the productivity of coconut lands. Bandirippuwa Estate. (IL1/ S4) - November 2006.**

Experimental design was Randomized Complete Block Design with 3 replicates with 6 effective palms per plot. Soil type of the experimental site was Boralu Series (S_4). Field establishment was commenced in October 2006 and continued through out the year 2007 during rainy seasons. To date, 60% of the field establishment of the total area to be established with CO3 (1.2 ha) was completed. Rooted CO3 stem cuttings were established (two per hole) in 2 rows in the coconut square and spacing within and between rows were 1x2 m. A kg of goat/sheep manure was applied to each hole after planting. There were 306 bushes per plot and ten CO3 plants per bush approximately.

Basal Dressing for CO3 – Veterinary Research Institute (Sri Lanka) Recommendations (per bush) Urea – 200 kg/ha/yr, TSP – 120 kg/ha/yr and MOP – 100 kg/ha/yr were applied after 6 months when the stem cuttings were well established in the field.

First and second harvests were carried out on September and November 2007 (45 day interval). Application of treatments was commenced in December 2007.

Treatments: Different Urea Fertilizer levels
T_1- Control (0kg of Urea/ha)
T_2- 30 kg of Urea/ha/year
T_3- 45 kg of Urea/ha/year
T_4- 60 kg of Urea/ha/year
T_5- 75 kg of Urea/ha/year

Table 18: ***Productivity of fodder CO3 (dry matter yield) cultivated under coconut in 2007***

Treatments	Dry Matter Yield (kg/ha)	
	September	October
T_1- Control (0kg of Urea/ha)	1,171	1,417
T_2- 30 kg of Urea/ha/year	1,268	2,155
T_3- 45 kg of Urea/ha/year	1,346	3,532
T_4- 60 kg of Urea/ha/year	574	594
T_5- 75 kg of Urea/ha/year	1,431	3,943

According to the Table 18, there is an significant increase in the dry matter yields in the second harvest except for treatment 4. Figure 4 shows that the CP% has been improved with every cut.

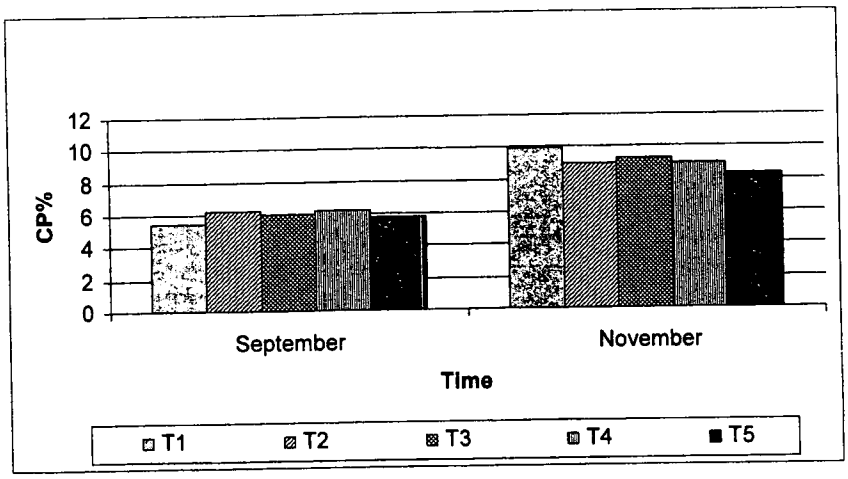


Figure 4: ***Effect of different treatments on nutritional composition of CO3 cultivated under coconut Crude Protein (CP) % of the First & Second cut - September & November 2007***

Average nut yield per treatment was 55 nuts (Table, 19). Soil nutrient status was also measured biannually. There is no significant difference in the N, P and K levels in soil (Table 20).

Table19: ***Effect of different treatments on nut yield in 2007.***

Treatment	Average Nuts per palm/ year	
	2006	2007
T_1- Control (0kg of Urea/ha)	18	50
T_2- 30 kg of Urea/ha/year	16	58
T_3- 45 kg of Urea/ha/year	18	53
T_4- 60 kg of Urea/ha/year	15	52
T_5- 75 kg of Urea/ha/year	16	61

Note: Nut yield record for 2006 was only for the 4th quarter – 2 picks and for 2007 there were 5 picks during the year

Table 20: ***Average nutrient content of the CO3 cultivated area (mg/kg)***

Treatment	Nitrogen (N) mg/kg	Phosphorus (P) mg/kg	Potassium (K) mg/100g
T_1- Control (0kg of rea/ha)	581	2.2	0.15
T_2- 30 kg of Urea/ha/year	550	2.2	0.1
T_3- 45 kg of Urea/ha/year	516	4.5	0.08
T_4- 60 kg of Urea/ha/year	565	2.7	0.16
T_5- 75 kg of Urea/ha/year	628	1.7	0.18

Soil nutrient status was measured biannually. According to Table 20, there was no significant difference in the N,P and K levels in soil.

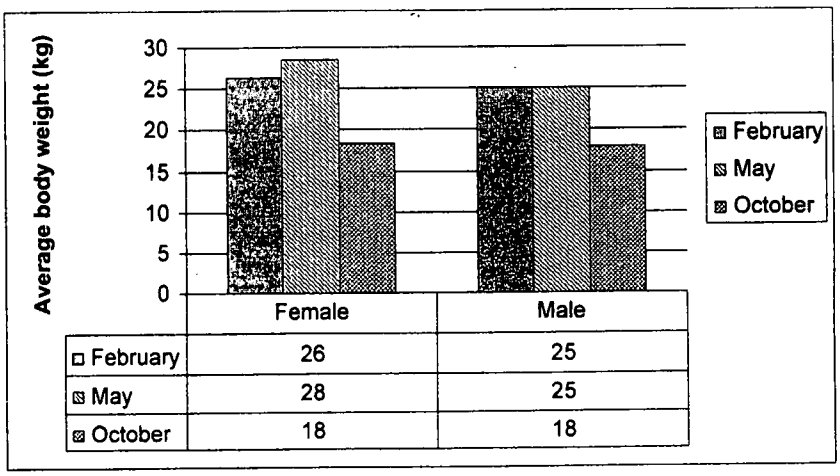
The experiment is in progress

S.C.Somasiri, H.A.J.Gunathilake, M.D.V.Saparamadu

Demonstration 8.1: Development of smallholder sheep farming system to increase the productivity of Coconut lands.
Bandirippuwa Estate. (IL1/ S4) - November 2006.

One cycle of grazing (6 months) was completed. Dry matter % at the starting and end of the cycle was 28% and 24% respectively. Average body weight of a doe and ram both were 24 kgs. Due to the outbreak of flukes and oestrus ovis, June 2007 to August 2007 live weight gain was drastically reduced (Figure 5). However, after the flock was vaccinated against the above diseases during latter part of the year they started to gain weight.

Kidding rate during the year was 90%. However, all the kids died suddenly after they were 2.5 months of age. When consulted the veterinary surgeon it was assumed due to food or water poisoning.



	Female	Male
February	26	25
May	28	25
October	18	18

Figure 5: Measurement of Average Body Weights of sheep (kg) in 2007

Total nut yield for the year 2007 was 2,738 nuts/ acre/year. In organic fertilizers are not applied to palms instead each palm at the sheep unit was applied with sheep manure at a rate of 30 kg/palm/year.

Cost for rearing sheep was also maintained. In addition to the routine de worming treatments an additional cost was born for the vaccines treated against flukes and tape worm.

The experiment is in progress

S.C.Somasiri, H.A.J.Gunathilake, M.D.V.Saparamadu

Experiment 8.2: Preservation of low cost feed to overcome the scarcity of feeds during dry season. Ratmalagara Estate. 2006

Funding source – National Science Foundation (NSF)

(This is a collaborative study of Postgraduate Institute of Agriculture, University of Peradeniya, Veterinary Research Institute, Gannoruwa and Coconut Research Institute, Lunuwila).

Objective of the experiment is to introduce Gliricidia Leaf Meal Block (GLMB) and/or complete feed block as a source of protein to ruminants.

Quotations for the manufacture of Briquette Machine were called and the Tender was awarded to CRISTO Industries, Demanhandiya.

A new field at Rathmalagara estate was selected and mapped. Gliricidia, Ipil Ipil, Calliandra and Acacia seedlings were established to RCBD design with 4 replicates. Plots were established at the middle of the coconut square. Plants were planted in 2 rows. Spacing was 1 m within row and 2m between rows. A soil analysis was also carried out prior to establishment of the different species.

This experiment is in progress.

S.C.Somasiri, Sujatha Premarathne, H.A.J.Gunathilake, H.A.Abeysoma, and M.D.V.Saparamadu , * Faculty of Agriculture, University of Peradeniya*

3. RESEARCH PROJECTS FUNDED BY OUTSIDE AGENCIES

3.1: Development of sustainable coconut-based income generating technologies in poor rural communities - (IPGR) Project

A project on Livelihood and Natural Resources Restoration for Tsunami Victims in Dodanduwa, Sri Lanka was implemented in Dodanduwa area with the objectives of restoring income generating activities of community based tsunami affected organization members in Dodanduwa and nearby areas, to establish CBO managed community activities that would foster enhanced food security and nutrition and to restore natural resources which include crops, animals, soil and water particularly through the production of high valued coconut products, intercropping, home gardening and livestock farming. The implementation of project activities were done through the community base organization called Dodanduwa Women Collective (DWC). The membership of this community is 350. Marketable products that can generate income for this community were identified. DWC was engaged in the production of coconut base high vale products such as fiber products (doormats, brushes, yarns and geo-textiles), ekel products (brooms) and coconut shell handicrafts. To improve the farming system knowledge of CBO members, five training programs on home garden farming systems were conducted at Dodanduwa area (250 participants participated), preparation of vegetable nursery bed, compost production, vegetable cultivation were emphasized in the training programs. Two training programs on coconut cultivation and doormat making were conducted at Dodanduwa area (250 participants participated). Two low cost coconut fiber extracting machines were established to produce fiber efficiently and enable them to produce coconut fiber ropes and doormats as quickly as possible. Now their

average income earning is about Rs. 250 – 300 per person per day. Second project on Enhancing Food Security, Nutrition and Micro credit Systems in Coconut Growing Communities in Sri Lanka in Dodanduwa and Dorabawila for enhancing of food security and nutrition in two communities. Under this project 250 home gardens were established and each home garden included five types of vegetables, fruit plants and coconut seedlings.

In addition, the introduction of coconut based livestock systems (poultry and cattle) and home garden based intercropping systems have generated a good income for these rural communities. Poultry and cattle farming have been identified as the most effective livestock intervention activity to generate income among tsunami affected people. Two incubators have been installed in two communities to loan out chicks among farmers.

S H S Senarathne and M J I Costa

4. SELF-FINANCED PROJECTS

4.1: Fuel wood plantation project - Pallama Seed Garden, 1998 (IL_1/S_5)

A fuel wood plantation with Gliricidia and Acacia has been established to study the potential of dendro-thermal power generation in coconut lands. Coconut lands categorized as S_4 and S_5 are the most suitable for planting Nitrogen Fixing Trees (NFT's) and this will generate an additional income to the grower.

At present, the fuel wood plantation covers 18 hectares with 32,000 and 5,000 Gliricidia and Acacia trees respectively. The production details are given in Table 21.

The total marketable wood yield has increased by only about 2% compared to the previous year. However, the increase in net profit is about 90% compared to the previous year mainly due to the reduction in total expenditure related to maintenance and operation of the plantation.

Table 21: Production details of the fuel wood plantation, Pallama Seed Garden

Description	
Number of harvests during the year	2
Wood yield per tree/year	14.2 kg
Total wood yield	66731 kg + 41770 sticks
Total income	Rs. 223,012.00
Total expenditure	Rs. 44,701.00
Net profit	Rs. 178,310.20

The project is in progress.

H A J Gunathilake, A Gunesekera and K D D Appuhamy

5. MISCELLANEOUS STUDIES

5.1: Demonstration farm, Thabbowa, Nattandiya

The farm, which consists of 2.5 ha is being managed on self-financing basis to demonstrate improved cultural practices in coconut lands and to increase productivity of lands by intercropping with selected crops such as cinnamon and pepper.

The farm had a net profit of Rs. **332,382.84** in year 2007 (Table 22).

Table 22: Annual income and expenditure of demonstration farm, Thabbowa

Income			Expenditure	
Item	**Quantity Nuts/Seedlings**	**Value Rs.**	**Item**	**Value Rs.**
a. Sale of coconut	31,740	540,642.00	a. Labour	472,025.19
b. Sale of coconut seedlings			b. Others	80,235.72
			c. Electricity	22,095.00
Poly bagged			d. Seed nuts	130,500.00
D x T	400	32,000.00		
R.D	18	1,260.00		
K.C	05	300.00		
Bare rooted T x T	11,726	418,206.00		
D x T	414	12,480.00		
c. Sale of other crops		32,350.75		
Total Income		1,037,238.75		704,855.91
Profit:		**332,382.84**		

H A J Gunathilake, S.H.S.Senarathne and P Fernando

5.2: Animal breeding program

The animal-breeding programme at Maduruoya and Potthukulama are being continued to develop the animal husbandry sector in coconut plantations, an animal breeding project was started in 1999 to develop a smallholder goat and buffalo farming systems under coconut with the objective of increasing the profitability and fertility in coconut lands. The number of male and female heads remained at each site at the end of the year are given below (Table 23). Sixty male and female goats were sold to coconut growers to initiate the goat farming units in their estates and net profit of this project was Rs. 317565.93 in year 2007. Six Mura stud buffaloes were sold to buffalo farming units in Pollonnaruwa district to improve the heard quality and production at concession price.

Table 23: Animal breeding program at Maduruoya Seed Garden and Potthukulama Research Station in 2007

Place	Breed	Adults		Calves		Total	
		F	M	F	M	F	M
Maduruoya S.G.	Moora	26	12	03	05	29	17
Potthukulama. R.S	Sri Lankan Boer	28	06	24	08	52	14

H A J Gunathilake and S H S Senarathne

6. FIELD DEMONSTRATIONS

6.1: Demonstration of effect of different cultural practices on yield of coconut grown in S_1 lands (S_1/IL1) Bandirippuwa Estate

Different cultural practices were imposed on coconut (Dwarf x Tall) grown in S_1 lands to demonstrate importance of them for production of nut yield. The soil was deep sandy loam and physical limitations for nut production were minimal.

Nut yield among different treatments varied highly. Coconut palms even without any maintenance practices including fertilizer application yielded 72 nuts $palm^{-1}year^{-1}$ mainly due to high suitability of soil (Table, 24). Coconut palms responded well to fertilizer plus green manure application which yielded 134 nuts $palm^{-1}year^{-1}$. The difference between fertilizer application vs no fertilizer was 55 nuts $palm^{-1}year^{-1}$ (Table, 24). A response for soil moisture conservation practices was not seen due to performance in S_1 lands.

Table 24: Nut yield as affected by different management systems in coconut plantations

Treatments	Mean yield (2001 – 2005)	Nut yield 2006	Nut yield 2007
T_1 – No management	110	120	72
T_2 – Weed control only	104	125	77
T_3 – weed control + moisture conservation only	94	119	86
T_4 – Weed control + fertilizer application	116	164	127
T_5 - Weed control + fertilizer application + moisture conservation	95	137	67
T_5 - Weed control + fertilizer application + moisture conservation + cover crop	111	151	115
T_6 - Weed control + moisture conservation + green manure (Gliricidia) + Supplementary inorganic fertilizer	119	184	134
T_7 - Weed control + fertilizer application + moisture conservation + supplementary organic fertilizer	101	143	99

H A J Gunathilake and K D D Appuhamy

6.2: Development and popularization of organic coconut production and processing in Sri Lanka

The project was implemented in the coconut triangle with the objective of development and realization of farm models, which promote organic agriculture with a prospect to offer a better income to the producers and to develop an alternative strategy over chemical coconut farming relying on biological processes in natural eco-systems and establish self-sufficient and sustainable coconut production systems/models with internationally accredited organic certificates.

This project is implemented in two phases as indicated below.

Phase I: Establishment of organic coconut farming models in main coconut growing areas of Sri Lanka

Phase II: Popularization of organic coconut farming among coconut small holders in the country

During the year, 15 sites were introduced to the project and seven models had to be abandoned due to failures of farmers. Out of the 29 models Pilassa, Uggalboda, Wathuwatta, Madampe, Walpitawatta and Thoranagedara sites were provided with four neat cattles and two buffalos to improve the organic manuring system and initial steps have been taken by the Uggalboda site to establish a bio-gas production unit. All the model sites are being functioned according to the organic farming guidelines and perennial intercrops are being established each site to improve the plant diversity.

Table 24: Organic model farms

Name of the Owner	Address
1. Mr M S Tennakoon	Dalupothawatta, Madawa, Pilassa
2. Mr A R S Anwar	Mallawapitiya, Kurunegala
3. Mr J A D K Jayasinghe	Gunawil, Bandawa, Polgahawela
4. Mr H B Dissanayake	Thalawa, Moragollagama
5. Mr N Wijenayake	Ridiuyanwatta Estate, Ridigama
6. Mr K H S Kumarasinghe	Sarasavi Integrated Farm, Dummalasuriya
7. Mr S Kaluarachchi	Boyawalana, Keppitiwalana
8. Mr Wikrama Rodrigoo	Velipenna
9. Mr Susantha Hapuarachchi	235, Puttalam Rd, Wariyapola
10. Mrs M S M de Silva	105 Hapitigama, Kal Eliya
11. Mr R S U Ranaweera	Dharmarama Mawatha, Gampaha
12. Mr R S Athulathmudali	Raiyadoluwa Estate, Uggalboda, Gampaha
13. Mr C P de Silva Jayaratne	Madampe Estate, Madampe
14. Mr Ervan Perera	Kandawatta, Block 2, Mugunuwtawana
15. Mr G D Gunawardena	Dekinda Estate, Madawalaulpatha
16. Nature Secrets	Horagalawatta
17. Mr A K Upali Amarasinghe	Kobbevehera, Mahamukalanyaya
18. Mr K A Jayarathne	Hangamuwa, Ibbagamuwa
19. Mr Paulu Perera	Tharuna Govipola, Thisogama
20. Mr N R M B Rathnayake	Thalahitiyagonnawatta, Maharachchimulla
21. Mr R Wimalasena	Holagamuwawatta, Holagamuwa, Narammala
22. Mr M M Podiappuhami	Thoranegedara, Kirimetiyawa
23. Mrs G R Chandrawathi	Kandegedara, Maharachchimulla
24. Mr W M Dissanayake	Diyatambe, Kattambuwawa, Koonwewa
25. Mr W M Punchibanda	Kattambuwawa, Koonwewa
26. Mr W A Piyasena	Diyatambe, Kattambuwawa, Koonwewa
27. Mr D M Kapurubanda	Thalakolawewa, Polpithigama
28. Mr Indika de Costa	Bannegamawatta, Hiripitiya, Kurunegala
29. Mr Kanishka Wanigasinghe	Seram Estate, Welauda, Iriyagolla, Yakwila

Nut production records, input and output relations, cost of production and net sales average of coconut are being collected.

The project is being continued.

B A S Manjula, R Marasighe, W R O Fernando, K D D Appuhamy, S Warnakula

7. ACKNOWLEDGEMENT

The cooperation extended by the staff of the Agronomy Division for carrying out the Divisional Research Program is greatly appreciated. The continued support of Dr T S G Peiris, Head and Principal Biometrician of the Biometry Division for designing of experiments and analysing data and the support of Head and the staff of the Soils and Plant Nutrition Division for analysing soil samples are gratefully acknowledged.

REPORT OF THE GENETICS AND PLANT BREEDING DIVISION
Head - Lalith Perera, PhD

1. GENERAL

Initiation of a crossing programme to produce dwarf x dwarf hybrids was the new research project initiated at the Genetics and Plant Breeding Division during the year 2007. The ongoing experiments; namely Evaluation of existing cultivars, Evaluation of progenies, Evaluation of new coconut cultivars in farmers' fields (adaptive trials), Evaluation of dwarf brown crosses in multi-locations, Development of new coconut cultivars using materials of exotic origins, Development of cultivars tolerant to *Aceria* mite, Maintenance and expansion of existing *ex-situ* gene-banks and coconut genome mapping project were continued successfully during the year. Identification of hybrids as higher yield respondents to better weather and soil combinations compared to tall cultivars as revealed by adaptability tests and the confirmation of superiority of Moorock tall at marginal soils in wet zone compared to other tall cultivars as revealed by genotype environment interaction analysis were the highlights of the conventional breeding programme this year. Identification and confirmation of pathogen of the Weligama Coconut Leaf Wilt disease in Southern province and the field establishment of the coconut genome mapping population were the highlights of the year in the molecular marker based research activities. Under the development and service functions of the division, extending the coconut seedling certification to Moorock tall cultivar, selection of six new plus palm estates for the national seed production programme, field establishment of seedlings at Pallama Seed Garden (PSG) and at Maduru-Oya Seed Garden (MOSG), establishment dwarf green within PSG as a mini-seed garden aiming at producing Kapruwana seed nuts, continuation of the self pollination of San Ramon (SR) at Andigama Farm, Giriulla and at Pottukulama Research Station (PRS), Pallma and carrying out a crossing programme among selected Sri Lanka talls (SLT) at PSG for production of planting materials for further expansion of PSG, expanding CRISL98 seed nut production by extending the hand pollination programme carried out at Isolated Seed Garden (ISG) at Ambakelle to PSG were noteworthy to be mentioned. Establishment of a research linkage with National Institute of Agricultural Botany (NIAB) at Cambridge, UK and collaboration from Genotyping Support Service of the Generation Challenge Programme (GCP) of the Consultative Group of International Agricultural Research (CGIAR) for genotyping the mapping population were other noteworthy achievements during the year.

The main event of note of the year was the initiation of a crossing programme between different dwarf forms. Large stature and difficulty in harvesting of tall palms are serious problems in coconut growing especially in home-gardens in urban areas. Thus production of a hybrid particularly aiming at hybrid vigour for nut size combined with dwarf stature was the objective of the study. Yellow dwarf x brown dwarf, red dwarf x brown dwarf, brown dwarf x green and Cameroon red dwarf x green dwarf were the selected crosses for the programme.

Nut yield data of the Evaluation of cultivars trials at Bandirippuwa (BE) and Suriyapura (SE) recorded lower nut yield this year than the yield recorded during the year 2006. Analysis of yield data in both sites confirmed the superiority of hybrids over the tall cultivars yet another year, but the differences were not drastic. During the year, long term yield data of BE, SE and Thammenna (TE) sites were analyzed to determine the response of cultivars to environments using a method similar to that of Finlay and Wilkinson. According to the analysis significantly greater yield response as measured by the slope of the regression line was shown by hybrids compared to tall cultivars in favorable years at BE and TE sites. This was not evident at SE,

where the soil is marginal for coconut cultivation. This implies the importance of perfect combination of both suitable weather conditions and soil characters for achieving the highest potential yield from hybrids. The analysis also revealed genotype x environment interaction, Moorock tall (MT) being significantly superior than tall x tall (TT) and Plus Palm tall (PPT) at SE site while TT and PPT performing better at BE when MT is maintaining the same yield as at SE at the BE also. Hence Moorock tall was identified as a suitable coconut cultivar for lateritic soils in the wet zone.

During the year the general nut yielding pattern of cultivars evaluated at progeny evaluation trials at Daisy Valley (DV) and RE listed from higher to low yield was, T x GD, GD x SR, T x T followed by T x SR. However sites at Puras, BE, Sirikandura and Mudalihamy did not reveal any statistically significant differences among the cultivars this year for yield. T x SR was the highest per nut kernel producer both at DV site and Puras, though the magnitude of the kernel weight per nut was low in Puras. DG x SR was the second highest for the same trait at both sites but the kernel content difference between T x SR and DG x SR was highest at Puras site. These observations can be explained by the comparative disadvantages of the marginal soils at Puras site.

During the year a new experimental site was established at BE for evaluation of brown dwarf crosses. Growth measurements were recorded in other three experimental sites at Raddegoda, RE and Wanathawilluwa at six monthly intervals. Physiological parameters were recorded at Raddegoda and RE sites. An observational block of T x BD was established at Middeniya research substation along with T x T, D x T, T x SR and Kapruwana.

The pollination programme aiming at production of improved coconut hybrids mixing local germplasm with exotic germplasm continued successfully during this year too. As a result of the last year pollination, 847 T x RIT, 772 T x TAGT, 1105 T x MRD, 140 DG x RIT, 168 DG x TAGT were harvested and nursery laid. These seedlings will be planted in multi-locational trials next year.

Pollination programme for production of CRISL98 (TSR) and Kapruwana was successfully continued this year too at ISG producing 4602 CRISL98 seeds and 1707 Kapruwana seeds. Fifty new SR palms at PSG were also included in the pollination programme for the first time for production of CRISL98 during this year. Total of 34 farmer fields comprising 18 CRISL98 and 16 Kapruwana sites were established during the year in 31 farmers' fields in 8 districts. For the first time an adaptive trial was established in Rathnapura district.

Checking parentage by genotyping with molecular markers for identifying legitimate progeny of the genome mapping population was continued in the first quarter of 2007 and 278 identified individuals were field planted at Walpita estate in July 2007. As a result of the project proposal submitted to Genotype Supporting Service of the GCP under the CGIAR, genotyping the mapping population with 70 SSR primers in an overseas laboratory at GCP cost was assured this year. Different tissues of Waligama Coconut Leaf Wilt disease and leaf rot disease affected palms were collected during the year and extracted DNA from them was subjected to PCR analysis. DNA from leaf samples gave positive PCR signals for the presence of phytoplasma. Sequencing of the PCR product confirmed the result. Morphological characterization of newly identified phenotypes from Southern province was completed this year and molecular characterization of them was commenced.

Six new local germplasm accessions at Middeniya research substation and 50 green dwarf, 20 red dwarf and 14 yellow dwarf seedlings at BE were planted this year under germplasm

conservation programme. The field gene banks were successfully maintained during the year, except at Margaret estate new gene-bank where many seedlings succumbed to rat damage and drought.

Seedling certification which was confined only to certification of polybaged seedlings of cultivars CRIC60 and CRIC65 last year was extended to certify Moorock tall cultivar also this year. During the year, six new coconut estates were designated as Plus palm estates for the supply of seed nuts for the National Replanting Programme and 6538 new plus palms were selected from them.

A pollination programme involving 50 selected SLT palms in various combinations at PSG and selfing programme of 25 SR palms at Andigama Farm, Giriulla and 19 SR palms at PRS continued successfully this year too. 366 self pollinated san ramon seed nuts and 1611 hand pollinated T x T were harvested and nursery laid for planting in the PSG in year 2008. During the year 439 self pollinated SR seedlings at PSG and 257 tall x tall seedlings at MOSG were field planted under the seed garden establishment and expansion programme. Acquiring of a suitable land for establishment of a seed garden for "Kapruwana" coconut hybrid was not happened this year too. 25 SR seedlings and 200 green dwarf seedlings in 1:8 ratio was planted within the PSG as a mini seed garden for producing Kapruwana seeds within PSG in addition to CRISL98 seed nuts production. During the year initiative was made with Green Field (Pvt.) Ltd to establish a private hybrid seed garden at Wanathawilluwa area in Puttalam district to produce CRIC65 seed nuts of yellow dwarf x tall. This work will be carried out in 2008.

2. RESEARCH PROJECTS

PROJECT: EVALUATION OF EXISTING CULTIVARS (1983/86)

Experiment 12.1.1 Evaluation of five improved cultivars; Green Dwarf x Tall (GD x T or CRIC65), Yellow Dwarf x Tall (Y x DT or CRIC65), Tall x Tall (T x T or CRIC60), Moorock Tall (MT) and Plus Palm Tall (PPT)

Design: Randomized block with 4 replicates **Plot size:** 20 palms/plot
Planting distance: 25' x 25' x 25' **Planting density:** 200 palms/ha

Locations and agro-climatic conditions

Exp. Number	Location	Year established	Soil type	Agro-ecological zone
12.1.1	Bandirippuwa (BE)	1983	Loamy sand (S2)	Wet intermediate
12.1.2	Thammenna (TE)	1983	Latasol (S2)	Dry
12.1.3	Palugaswewa (PE)	1985	Sandy clay loam	Dry intermediate
12.1.4	Suriyapura (SE)	1986	Lateritic-gravel/clayey (S4)	Wet

Yield recording (nuts/palm/pick) continued at sites at BE and SE during the year. The two hybrids, GD x T and YD x T at BE continued to outperform other tall cultivars (T x T, PPT and MT) under average management conditions with total annual yield of 12,355 nuts/ha and

11,113 nuts/ha respectively this year. The annual nut yield difference between two hybrids was not significant at BE, however the difference between GD x T and other three tall cultivars were statistically significant. The average annual yields (nuts/ha/year) of T x T, MT and PPT were 10,231, 9537 and 9430 respectively and there was no significant difference among these three cultivars.

The mean annual yield of the same experiment established at SE which is 3 years younger than BE site, representing the majority lateritic gravel soil in Gampaha district and the wet zone generally showed the same yield trend with respect to yield of hybrids and tall cultivars. The respective yields of GD x T and YD x T were 14,650 nuts/ha and 13,082 nuts/ha/year. The respective mean annual yields of three tall cultivars (T x T, MT and PPT) were 10,820 nuts/ha/year, 11,988 nuts/ha/year and 11,295 nuts/ha/year respectively and those yields were significantly different from yields of two hybrids.

During the year, long term nut yield data and fruit component data of these two sites and TE site were analyzed to see general trends and genotype environment interactions of the cultivars under evaluation. Nut yield data at 14 years after planting at BE, 10 years after planting at SE and 9 years after planting at TE were used in the nut yield analysis. Comprehensive analysis of nut yield data in all three sites confirmed the superiority of two hybrids over the tall cultivars even under less favourable conditions for coconut cultivation. Furthermore, GD x T showed the highest nut yield almost in every year at all three sites and in several years the nut yield difference between GD x T and YD x T was statistically significant, especially at SE and TE.

The average response of the cultivars to changes in the weather with in the site was analysed using a method similar to that of Finlay and Wilkinson. A regression line was developed for each cultivar at each site (Figure 1, 2 and 3) taking individual mean annual yields of each cultivar as the dependent variable and the environmental means ranked from lowest to highest as the independent variable. According to the regression analysis all cultivars at all sites has positively responded to favourable weather conditions, but a significantly greater yield response for better environment as measured by the slope of the regression line was shown by two hybrids compared to tall cultivars at BE and TE sites. However this G x E interaction was not evident at SE, where the soil is marginal for coconut cultivation. This implies the importance of ideal combination of all environment components and soil characters for achieving the highest potential yield from hybrids. This envisages the need of directing hybrid planting programmes to high potential areas for exploiting the maximum yield from hybrids. Furthermore this analysis indicated that GD x T was more capable in exploiting the improved weather and soil conditions than YD x T.

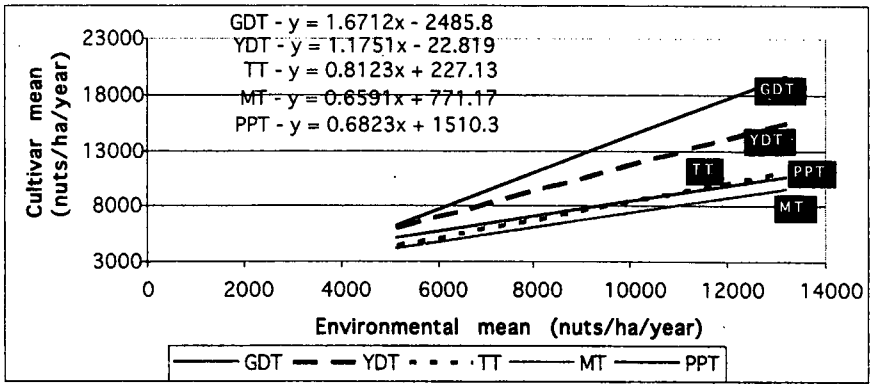


Figure 1: Regression lines showing the relative performance of cultivars against the environment mean – TE Site

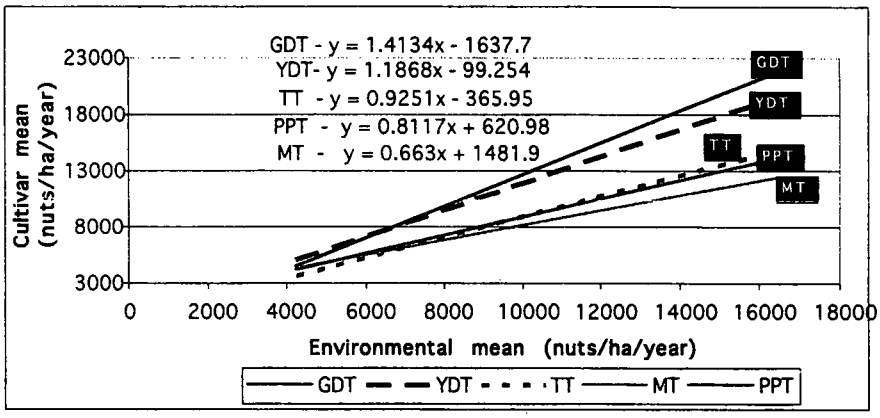


Figure 2: Regression lines showing the relative performance of cultivars against theenvironment mean – BE Site

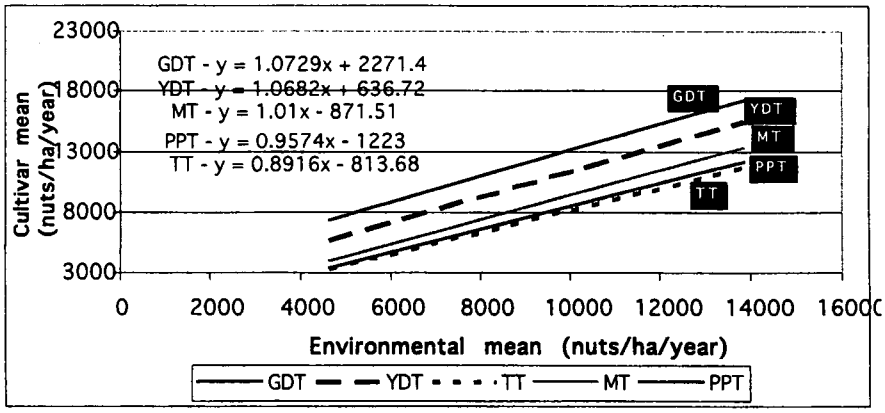


Figure 3: Regression lines showing the relative performance of cultivars against the environment mean – SE Site

The average nut yield of cultivars over a period of 8 years from yield stabilization (10 years after planting) at each site was plotted (Figure 4) and cultivar differences within each site was statistically analyzed. The best performance of cultivars was observed in the site at BE, followed by TE and SE indicating the importance of both soil type and the agro-climatic zone in determining productivity of coconut. The analysis also revealed genotype x environment interaction, T x T and PPT being statistically superior to MT at BE and TE sites when MT was statistically better than T x T and PPT at SE. This was because T x T and PPT were responding to better environments at BE and TE at a higher magnitude compared to the magnitude of yield increase of MT at BE and TE sites. Hence Moorock tall is identified as a suitable cultivar for lateritic soils in Gampaha district (wet zone).

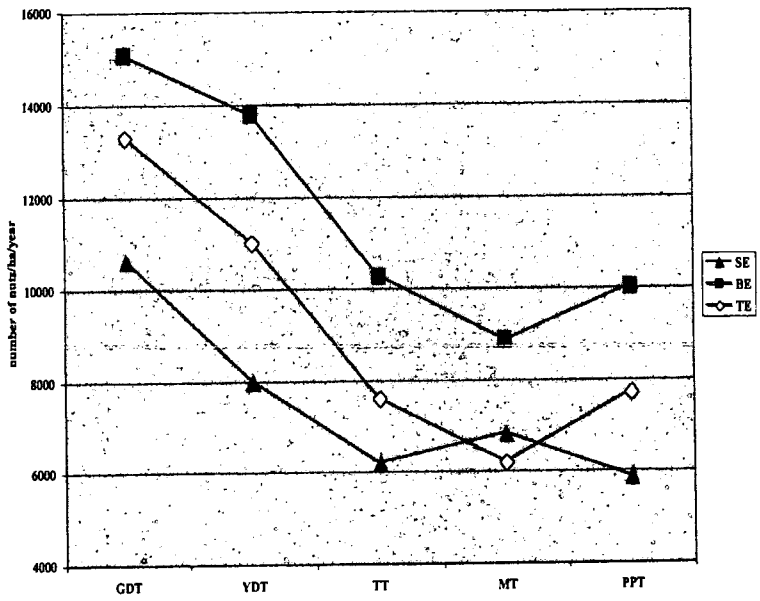


Figure 4: Average Nut yield of different cultivars at BE, TE and SE sites (10 – 18 years after planting.

The long term data of fruit components (fresh nut weight, husked nut weight, split nut weight and kernel weight) were analysed at three sites, BE, SE and TE. Figure 5 summarize the data obtained at three sites. In general, tall cultivars produce larger nuts than hybrids and the difference is significant. Further, YD x T produce larger nuts than GD x T at all sites and the difference is significant at BE & SE sites. Fruit components showed highest values at SE and lowest values at TE. This can be explained as the combined effect of negative correlation of nut number and nut weight and the combination of climatic and soil conditions which have direct influence on the net assimilates of coconut palm.

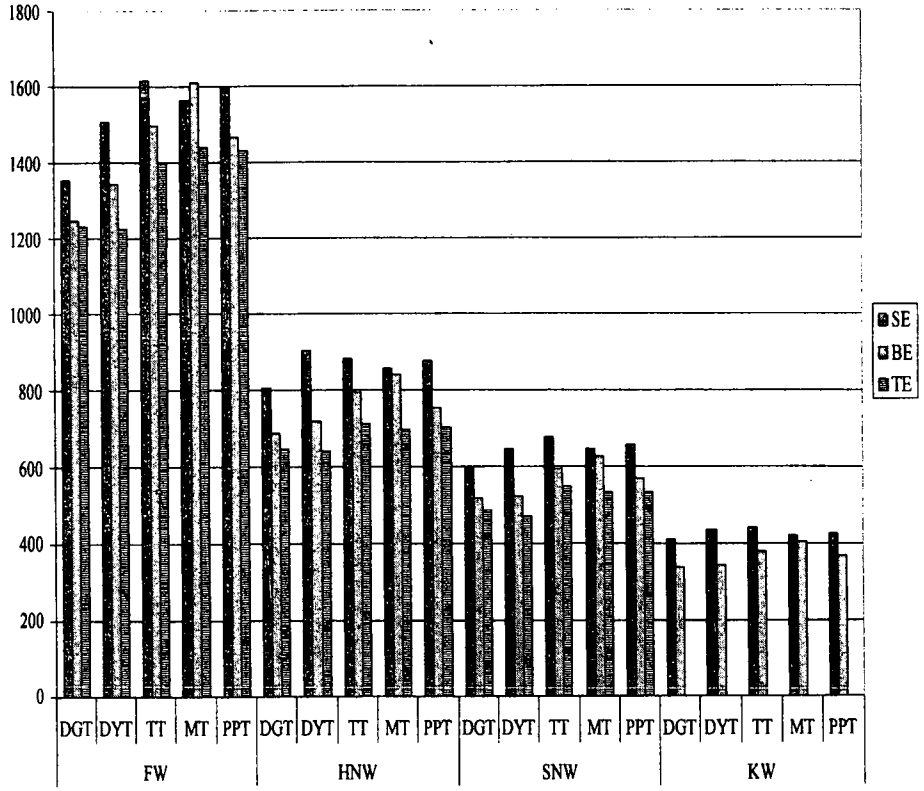


Figure 5: Variation in fruit components of five different cultivars at three different sites

At BE highest kernel weights per nut were given by MT and TT. These two cultivars were followed by PPT and the weight was significantly lower than former cultivars. At SE, highest kernel weight was recorded in TT and it was significantly higher than that of PPT and MT. This indicates that TT has been significantly responded to selection for kernel weight. This finding together with the finding that TT respond to better environment at a higher increasing rate than PPT with regards to nut number indicates the superiority of TT over PPT. This envisages the need of high input agriculture for TT cultivation in order to exploit its high genetic potential for yield.

H D M A C Dissanayake, L Perera, W B S Fernando, and R B Attanayake

PROJECT: ON-FARM EVALUATION OF NEW CULTIVARS

Experiment 12.1.2 Evaluation of CRISL98 (TSR or Tall x San Ramon) and Kapruwana (GDSR or Green Dwarf x San Ramon) under farmer conditions

Production of CRISL98 was continued at ISG by hand pollinating 100 tall palms with SR pollen from palms at PRS. This programme produced a total of 4602 seed nuts during the year 2007. Pollination programme with 50 tall palms was commenced at the Field 1 of the PSG for the first time. A total of 2796 seedlings were issued to 18 adaptive trial sites this year and that

included 5 sites in Puttalam district, 3 sites in Kurunegala district, 2 sites each in Matara and Moneragala districts and 1 site each in Gampaha, Kegalle, Galle districts and for the first time 3 sites in Rathnapura district. Monitoring of these sites was in progress.

Production of Kapruwana was continued at ISG during the year by hand pollinating 50 dwarf green palms with San Ramon pollen and a total of 1707 seed nuts were produced in 2007. The seeds were raised at ISG and issued to growers on the same conditions set out for issuing CRISL98. During the year, 2199 Kapruwana seedlings were issued to 16 growers; 3 each in Kurunegala and Galle and 2 each in Kegalle, Gampaha, Puttalum and Matara districts and for the first time 2 in Rathnapura district.

During the year 40 T x SR and Kapruwana sites established during the period 2005 to 2006 were inspected and 34 well maintained sites were selected for further monitoring.

M K Meegahakumbura, L Perera, S A S Chandrasiri and H M N B Herath

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

Experiment 12.2 Programme for the improvement in nut size and nut number in the Isolated Seed Garden (1993) at Ambakelle and Maduru Oya Seed Garden (1995)

These two trials were maintained successfully. Data collection not yet commenced.

L Perera and M H L Padmasiri

Experiment 12.7.3 Evaluation of Green Dwarf x Debarayaya Tall (Raddegoda)

This trial was maintained satisfactorily.

L Perera and G K Ekanayake

Experiment B-8.6 Evaluation of hybrid crosses utilizing local and exotic germplasm to test the potential for sap production and yield (1997)

This trial maintained satisfactorily as an observation trial. Since palms had not attained yield stability last year, Fruit Component analysis postponed to next year.

S A C N Perera L Perera and H M N B Herath

PROJECT: **EVALUATION OF PROGENIES OF SELECTED AMBAKELLE TALL PALMS CROSSED TO SELECTED TALL, GREEN DWARF, YELLOW DWARF AND SAN RAMON IN DIFFERENT COMBINATIONS AND EVALUATION OF THE PROGENY IN MULTILOCATIONAL TRIALS**

Design: 3 varieties in 3 sub plots in a randomized block design with 3 replicates (Blocks).

Plot size: No. of palms/variety/sub plot: 10 palms

No of palms/variety/Block: 30 palms

Locations and agro-climatic conditions

Location	Year of establishment	Soil type	Agro ecological zone
Bandirippuwa (BE)	1986	Loamy sand	Wet intermediate zone
Ratmalagara (RE)	1986	Lateritic	Dry intermediate zone
Andigama-Puras	1986	Lateritic	Dry intermediate zone
Andigama-Mudalihamy	1986	Sandy loam	Dry intermediate zone
Mangala Eliya	1987	Loamy sands	Dry zone
Daisy Valley (DV)	1987	Clay loam	Wet intermediate zone
Sirikandura	1989	Lateritic	Wet Zone

Crosses: Tall x Green Dwarf (T x GD), Tall x Tall (T x T), Tall x San Ramon (T x SR), Green Dwarf x Tall (GD x T) (only at DV site), Green Dwarf x San Ramon (GD x SR) (only at DV site and observation trial at Puras block in Andigama), Open pollinated tall (OP) (only at Mangala Eliya site), Yellow Dwarf x Tall (YD x T) (only at Sirikandura)

The experimental site at Mangala Eliya remained abandoned during the year 2007 too. Nut yield was recorded during the year at all the other sites and at DG x SR block at BE. Counting of nuts of the most mature 6 bunches at 4 monthly intervals was the procedure adopted for estimating the nut yield at Mudalihamy and Puras blocks at Andigama, Daisy Valley and Sirikandura for this year too. Statistically significant difference in nut yield was observed only for the sites at DV and RE. The per palm average nut yield listing from high to low at DV was 106 for T x GD, 102 for GD x T, 86 for GD x SR, 82 for T x SR and 81 for T x T. T x GD vs GD x T and T x SR vs T x T were not significantly different to each other. The site at RE followed the same yield pattern and the yields were 83 for T x GD, 76 for T x T and 67 for T x SR. Here again T x T and T x SR were not significantly different.

Fruit Component (FC) data were recoded at Daisy Valley, Sirikandura, Andigama Puras and the old DG x SR block at BE this year too. FC analysis was performed only for T x SR and GD x SR at DV site. FC analysis revealed the superiority of T x SR for all the nut components except at Sirikandura where the kernel weight of T x T was marginally higher than T x SR. However this difference was not statistically significant. The site DV was the best in terms of fruit components for both T x SR and DG x SR while the site Puras performed poorly in comparison to other sites. Figure 6 gives the kernel content of different crosses per unit area at selected sites. It shows the potential of T x SR and GD x SR for higher copra production per unit land area. However, the figure also indicates the reduction of the performance of GD x SR in marginal soils as showing at the site Puras.

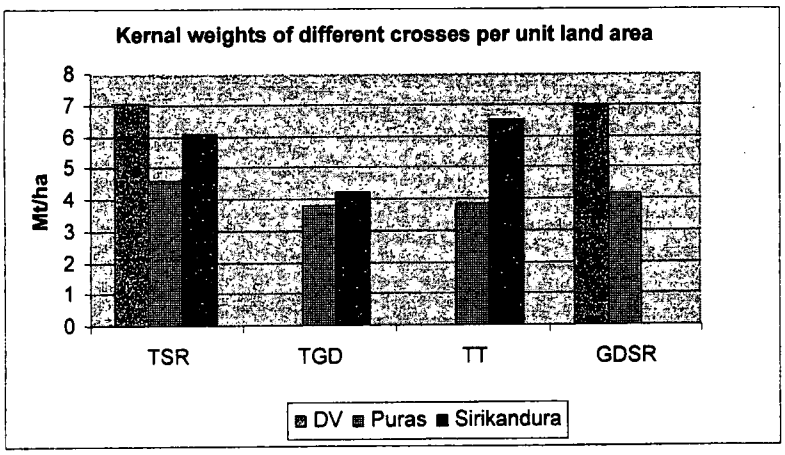


Figure 6: Kernal weights of different crosses per unit area.

S A C N Perera, L Perera, H M N B Herath, R B Attanayake and W B S Fernando

PROJECT : EVALUATION OF THE HYBRID VIGOUR OF BROWN DWARF X TALL, TALL X BROWN DWARF AND BROWN DWARF X SAN RAMON FOR YIELD AND TOLERANCE TO MOISTURE STRESS IN DIFFERENT AGRO-ECOLOGICAL ZONES

Design: Randomized block with 4 replicates **Plot size:** 6-9 palms/plot
Planting distance: 26' x 26' square **Planting density:** 64 palms/ac

Locations and agro-climatic conditions

Exp. N0.	Location	Year established	Soil type	Agro-ecological zone
4.1	Raddegoda	2004	Clay Loam	Dry intermediate
4.2	RE	2005	Lateritic gravel	Dry intermediate
4.3	Wanathawilluwa	2005	Latozols	Dry zone
	BE	2007	Sandy loam	Wet intermediate

During the year a new site was established at Bandirippuwa estate and the sites at Raddegoda, and Ratmalagara were maintained successfully. However at the end of 2006 the site at Wanathawilluwa was severely affected by water logged condition and 44 seedlings were replaced during the year. Growth measurements were recorded in all the sites in six months intervals.

In Raddegoda Estate only the number of leaves produced during 6 months period was recorded. In other two sites number of leaves produced during 6 months period, girth and height measurements were taken. According to the data obtained, the rate of leaf production is significantly higher in dwarf x tall hybrids than the tall x tall hybrids at all the sites.

The analysis of girth and height measurements 2 years after planting at three sites showed significant differences among cultivars however a general pattern could not be identified using the data.

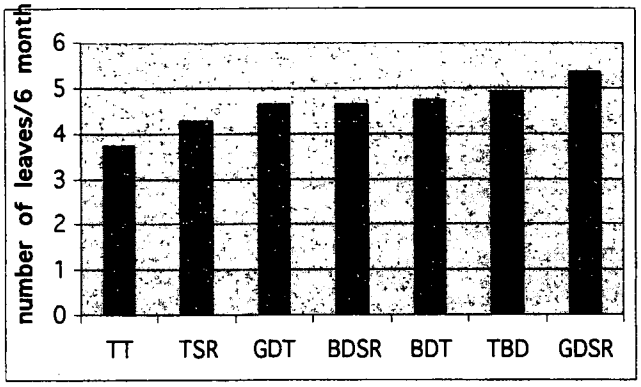


Figure 7: Variation in rate of leaf production at Raddegoda Estate (3 _ years after planting)

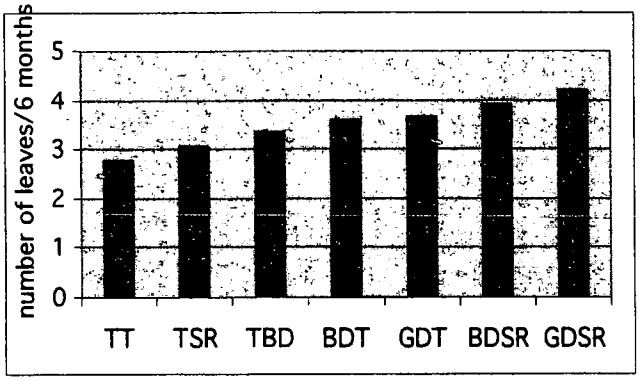


Figure 8: Variation in rate of leaf production at Ratmalagara Estate (2 _ years after planting)

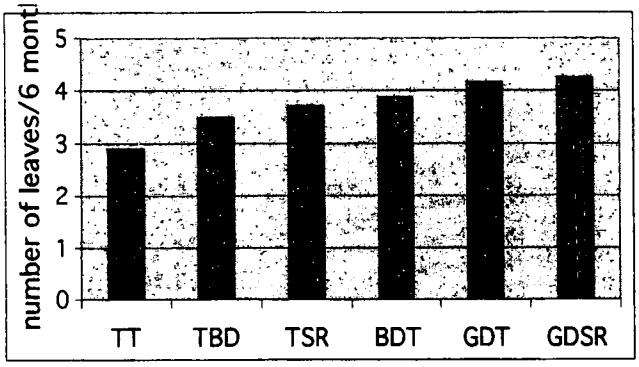


Figure 9: Variation in rate of leaf production at Wanathawilluwa Estate (2 years after planting)

During the year dwarf x tall hybrids of the sites at Raddegoda and Ratmalagara initiated flowering (15% and 2% palms respectively).

D M A C Dissanayake, L Perera, A Fernando and A Nainanayake (PPD)

PROJECT: **CROSSES OF SRI LANKAN TALL AND SRI LANKAN GREEN DWARF WITH EXOTIC POLLEN AT THE MARGEARET ESTATE, PALLAMA AND AMBAKELLE SEED GARDEN**

The crossing programme of three exotic coconut varieties; Rennel Island Tall (RIT), Tagnanan Tall (TAGT) and Malayan Red Dwarf (MRD) in various combinations with Sri Lanka Tall (SLT), San Ramon (SR) and Sri Lanka Green Dwarf (SLGD) successfully continued this year too. The summary of seed nuts produced is given in table 1 & 2. As sufficient seed nuts were obtained form crosses; SLT x RIT, SLT x TAGD, SLT x MRD, crossing programme to produce those three crosses carried out at Margaret Estate terminated at the end of the year.

Table 1: ***Summary of the pollination programme at the Margaret Estate, Pallama***

Cross	Total inflorescence pollinated	Buttons remained	Setting up to September 2007	Seed nuts laid at the BE nursery
T x RIT	229	5385	1598	847
T x TAGT	256	6227	2022	772
T x MRD	258	6178	1791	1105
SR x MRD	263	4830	787	-

Table 2: *Summary of the pollination programme Sri Lankan Green Dwarf with Exotic pollen at the ISG*

Cross	Total inflorescence pollinated	Buttons remained	Total setting after 3 months	Seed nuts laid at the BE nursery
DG x RIT	145	3075	1018	140
DG x TAGT	132	3123	915	168

Maradawila Farm (NLDB) in Bingiriya, Beligama Farm (NLDB) in Melsiripura, Raddegoda Estate in Kurunagala and Middeniya Research Substation in the South were identified as prospective sites for planting multi-locational trials with these crosses. Site inspection, soil survey and planting will be carried out in 2008.

M K Meegahakumbura, L Perera, S A C N Perera, M H L Padmasiri and S A S Chandrasiri

PROJECT: SCREENING OF COCONUT VARIETIES/CULTIVARS FOR MITE TOLERANCE AND DEVELOPMENT OF COCONUT HYBRIDS/CULTIVARS TOLERANT TO *ACERIA* MITE (2005)

1) Screening of coconut varieties/cultivars for mite tolerance

In the previous year it was shown that the yellow dwarf (YD) variety was more tolerant than green dwarf (GD) and tall varieties to coconut mite damage. However distinguished morphological differences within YD population at the ISG, Ambakelle were observed. Therefore entire YD population at ISG was divided into three groups (typical dwarf palm structure with no bole formation, tall like palms with bole formation, tall like palms without bole formation) and their response to mite was assessed separately during the year (see Report of the Crop Protection Division in this annual report for more details). Results showed that there was no relationship between the degree of mite incidence and the morphological difference of the YD palms indicating that with regard to the tolerance for mite damage, any palm within the block can be used as mother palms for producing mite tolerant coconut hybrids.

During the year two new crossing combinations; yellow dwarf x san ramon (DY x SR) and green dwarf x san ramon (DG x SR) planted as an observational trial at RE, Madampe where mite infestation seems to occur commonly was noted and the crosses were evaluated for their response to mite damage along with green dwarf x tall (DG x T) and yellow dwarf x tall (DY x T) as controls. Some tall palms in an adjacent block were also evaluated for comparison purpose. Data were recorded three times at four monthly intervals. Both DY x SR and DY x T where the mother palm was yellow dwarf and DG x SR had low indices in comparison to DG x T, though the differences were statistically not significant. However all four hybrids under evaluation had significantly low indices ($P < 0.05$) compared to ordinary tall control. The study will be continued.

Preliminary observations at BE indicated that the Gon thembili (GT) had a lower incidence of symptom initiation and subsequent expression of symptoms on the fourth bunch and therefore would be a potential tall form tolerant to mite damage. This observation was verified by making an assessment of the mite incidence on palms by means of the mite index that was developed in the previous year. The index of GT was recorded in comparison with ordinary tall and SR. Results showed that the color form GT had the lowest index ($P<0.05$) which indicates a low level of mite damage on nuts. The index increased in the order of GT, SR and tall showing a decreasing order of tolerance in the three varieties.

I R Wickramananda (CPD) and L Perera,

2) Development of coconut hybrids/cultivars for tolerance to mite

The crossing programme using local (SLT, GT and YD) and a few exotic varieties [Brazilian Green Dwarf (BGD), SR] was continued in 2007. The objectives of the crossing programme were to identify *Aceria* mite tolerant hybrids and exploit hybrid vigour for yield. The crosses included GT x BGD (20 palms), SR x BGD (17 palms) and YD x GT (05 palms) at BE, SLT x BGD (20 palms) at PSG, BGD x GT (05 palms) at PRS and YD x GT (05 palms) at ISG. Nine hundred and seventeen SLT x BGD, 174 BGD x GT and 22 DY x GT cross pollinated seednuts have been nursery laid in the year 2007 and the pollination programme is expected to continue in year 2008 in order to obtain sufficient numbers of seed nuts of the relevant crosses for field planting for evaluation.

S A C N Perera, S A S Chandrasiri and H M N B Hearth

3) Evaluating Gon thembili (GT) to assess its potential as a pure cultivar

GT has been observed to show a certain degree of tolerance to *Aceria* mite when it was screened for mite tolerance along with other varieties. Based on this observation studies were initiated in 2006 to assess the potential of GT to be recommended as a pure cultivar for highly mite infested areas. The nut counting and fruit component analysis programmes which were started in 2006 were continued in the year 2007. The collaborative study with Coconut Processing Research Division (CPRD) to assess the copra content of GT in comparison with TT was also continued this year. Studies were also extended to understand the nature of transmittance of GT characters to subsequent generations under open pollination conditions.

Nut counting in 52 GT palms at BE recorded an average of 71 nuts per palm with a standard deviation of 21.7 for the year 2006-2007 (mid 2006 to mid 2007). The reported nut yield of GT surpassed the yield of TT in an adjacent field comprising of 90 palms averaging 66 nuts per palm with a standard deviation of 28.1 in the year 2007.

Fruit component data [Fresh nut weight (FNW), Husked nut weight (HNW), Split nut weight (SNW), Kernel weight (KW)] and dry weight of 100 g of fresh kernel (DW) recorded at 3 times in a sample of 40 nuts are given in table 3.

Table 3: ***Fruit component data related to Gon Thembili. Means and the standard deviations (in parenthesis)***

	FNW	HNW	SNW	KW	DW
1 (March)	1808 (383.5)	769.8 (166.7)	602.7 (114.6)	373.3 (73.4)	-
2 (July)	1803 (298.6)	818.7 (171.2)	604.8 (98.2)	388.8 (73.4)	-
3 (September)	1389 (239.6)	627.9 (133.2)	498.9 (83.7)	329.1 (51.6)	55.5 (3.4)

CPRD conducted the analysis for comparative copra outturn per nut of GT and TT 7 times during the year 2007. The results given in table 4 indicate promising comparative performance of GT.

Table 4: Copra out turn per nut in GT and TT (no. of nuts sampled given in parenthesis)

	January	March	May	June	August	Sept	Nov
GT	162.1 (70)	189.4 (66)	215.0 (100)	245.5 (110)	215.6 (109)	152.0 (125)	134.3 (108)
TT	152.7 (70)	183.8 (80)	210.0 (100)	238.7 (111)	221.9 (116)	185.9 (121)	123.9 (109)

S A C N Perera, G K Ekanayake and C Yalegama (CPRD)

4) Development of a segregating population for mapping QTL governing tolerance to *Aceria* mite in coconut

In GPB annual report for 2006 it has been explained that approaches of molecular breeding provide useful tools for mapping QTL governing mite tolerance. Green Dwarf and many tall coconut varieties have been observed to be susceptible for *Aceria* mite while certain phenotypes of the variety Yellow Dwarf have been observed to be tolerant to the same. This morphological polymorphism in tolerance to mite among different varieties may be controlled genetically under the governance of quantitative trait loci. In 2006 studies were started to develop a segregating population for mapping QTL governing mite tolerance.

The hand pollination programme for crossing 19 mite tolerant yellow dwarf palms with pollen from a highly susceptible Sri Lanka Tall palm continued in the year 2006. However, the number of yellow dwarf female parents has been reduced to 15 due to low setting percentages of the remaining selected yellow dwarf mother palms. During the year One hundred and ninety nine seednuts resulting from this crossing programme has been laid at the BE nursery.

S A C N Perera, L Perera, and S A S Chandrasiri

PROJECT: DEVELOPMENT OF DWARF X DWARF COCONUT HYBRIDS

Planting and harvesting of coconut specially in home gardens in urban areas has become a big problem since recent past, as majority of commercially available coconut cultivars are tall in nature and labour for picking is expensive and is in shortage. Dwarf x tall hybrids seems to be a solution for this problem to a certain extent, but hybrids also grow tall as they become old. Dwarf coconuts provide ideal stature for this purpose but dwarfs are not commercially attractive as their nuts are small and quality and quantity of milk and copra are poor.

The dwarf x dwarf hybrids may be of a good strategy for this if they would be able to show up hybrid vigour for nut size and quality and quantity of kernel. The idea of dwarf x dwarf hybrids is not novel, as according to literature, few dwarf x dwarf hybrids have been produced in the world though they are not fully exploited. The coconut hybrid PB332 which is a cross between Malayan Yellow Dwarf and Malayan Red Dwarf produced in Ivory Coast is an example for such dwarf x dwarf hybrids which has shown a very good hybrid vigor for yield and uniformity.

Sri Lanka has several morphologically different dwarf coconut forms, for example the brown dwarf, which demonstrate fairly good tolerance to moisture stress and high nut number and the yellow dwarf, which is tolerant to mite and has comparatively bigger nuts. Thus a new crossing programme was commenced to produce various combination of dwarf x dwarf hybrids particularly aiming at developing an acceptable coconut cultivar for consumption with a short stature for home gardens in urban area.

For this experiment 09 brown dwarfs, 08 red dwarfs, 10 yellow dwarfs and 09 Cameroon red dwarfs were selected at the Pallama seed garden and tying hara was completed. Following crossing programme was initiated.

Crossing combination 1: brown dwarf x green dwarf
Crossing combination 2: yellow dwarf x brown dwarf
Crossing combination 3: red dwarf x brown dwarf
Crossing combination 4: Cameroon red dwarf x green dwarf

The pollination programme is in progress.

L Perera, M K Meegahakumbura and M H L Padmasiri

PROJECT: COCONUT GENOME MAPPING

Checking parentage by genotyping with molecular markers for identifying legitimate progeny of the mapping population was continued in the first quarter of 2007. Two hundred and seventy eight individuals were ultimately identified to form the genome mapping population of coconut. The identified individuals were field planted at Walpita estate in July 2007. Guard rows were planted with CRIC65.

Growth measurements were recorded in the field at the planting stage which recorded means and standard deviations of 18.1 and 2.51 for girth, 191.5 and 30.5 for height and 4.7 and 0.9 for the number of leaves.

As a result of a grant application submitted to Generation Challenge Programme of the Consultative Group of International Agricultural Research (CGIAR), a grant award for genotyping the mapping population with 70 SSR markers in an overseas lab was received this year. This activity will be done in 2008.

S A C N Perera, L Perera, W B S Fernando, A Fernando

PROJECT: COLLECTION CONSERVATION AND EVALUATION OF COCONUT GERMPLASM

ENRICHMENT OF COCONUT GERMPLASM

Importation of Coconut Germplasm

Attempts made to import cold tolerant coconut germplasm from Hainan island of China and distinctive coconut varieties from Vietnam failed this year.

The exotic gene-bank established at BE maintained satisfactorily this year and the present status of the gene-bank is give in Table 5.

Table 5: Status of the Exotic variety conservation block (BE) (2005/06).

Imported country	Variety	Young Palms	Seedlings
India	West Coast Tall	15	04
	Laccadive Ordinary Tall	11	-
	Andaman Tall	22	-
	Banawali Round Dwarf	05	02
Papua New Guinea	Kar Kar Tall	07	-
	Markem Valley Tall	16	-
	Rennel Island Tall	13	01
	Gezelle Peninsula Tall	-	08
	Malayan Red Dwarf	-	02
	Malayan Yellow Dwarf	-	11
	PNG Brown Dwarf	-	02
Ivory Coast	Tagnanan Tall	-	11
	Vanuatu Tall	-	11
	Tacunan Green Dwarf	-	02
	Tahitian Tall	-	02
	Niulekha Green Dwarf	-	06
	Tenga Tall	-	06
	West African Tall	-	09
	Catigan Green Dwarf	-	04
Total		**89**	**83**

L Perera, M.K.Meegahakumbura, R B Attanayake and A Fernando

EVALUATION OF CONSERVED COCONUT GERMPLASM

Collection and conservation of coconut biodiversity within the country

No new collections were made this year. The existing gene-banks including the exotic gene-bank were maintained satisfactorily. Census of the Crop Museum (BE), Kotakanda (BE), Dwarf palm conservation block (BE), Margaret gene bank (Field 7) were taken this year. The status report of the gene-banks at Lenawa, Middeniya, Gonagolla (Ampara), PRS, Margaret (Field 10) and at Raddegoda are to be taken.

Table 6: Current status of the Crop Museum at BE (1983)

Accession	Bearing palms	Seedlings	Vacancies	Total
Yellow Dwarf	02	-	05	07
Green Dwarf	04	-	03	07
Red Dwarf	04	-	03	07
King Coconut	05	-	01	07
Raththaran thambili	01	-	06	07
SanRamon (Russet)	06	01	-	07
SanRamon (Green)	07	-	-	07
Kamandala	04	01	02	07
Gon thambili	07	-	-	07
Nawasi	05	01	01	07
Bodiri	05		02	07
Pora-pol	01	-	06	07
Ranthambili	07	-	-	07
Dikiri	05	01	01	07

Table 7: Current status of the Kotakanada (BE) filed gene-bank (1988/89).

Accession	Bearing palms	young palms	Vacancies	Total
1. Wellawa	63	1	20	84
2. Pitiyakande	41	0	45	86
3. Ambakelle Tall	55	0	31	86
4. Moorock	36	0	48	84
5. Namalwatta	19	0	65	84
6. Debarayaya	56	0	24	80
7. Clovis	77	0	8	85
8. Palugaswewa	68	0	12	80
9. Ambakelle Special	76	0	2	78
10. Akuressa	73	0	13	86

Table 8: Current status of the Local gene-bank (LGB) (BE) (1984) and the San Ramon conservation block(BE) (1986)

Accession	Bearing Palms	Vacancies	Total
Bodiri	35	45	80
Kamandala	04	02	06
Dikiri	01	02	03
Gonthambili	53	16	69
Pora-pol	28	29	57
Ranthambili	30	08	38
Nawasi	30	06	36
San Ramon			162

Table 9: Status of the dwarf palm conservation blocks (BE) (1987)

Accession	Bearing palms	Seedlings	Vacancies	Total
Green Dwarf	0	45	13	58
Yellow Dwarf	3	10	05	18
Red Dwarf	33	18	4	55

Table 10: Current status of the Margaret Estate (Field 07) gene-bank ( )

Accession	Young palms	Bearing palms	Vacancies
Thelandiriya	11	32	10
Kalawewa	14	43	03
Sidurupitiya	19	4	5
Ambakelle special	20	38	2
Galenbidunuwewa	19	26	15
Vijithapura	06	46	09
Hangiligama	11	48	1
Mahawalatenna	22	21	11
Lanlib	23	33	4
Wanathawilluwa	40	14	6
Ihalakagama	35	22	3
Blackstone	35	12	10
Total	**255**	**339**	**79**

Table 11: Current status of the Margaret Estate (Field 10) gene-bank (2006)

Accession	Young palms	Vacancies
Ranthembili	52	33
Gonthembili	15	14
Bodiri	22	46
Kamandala	1	3
Porapol	1	7
Cameroon red dwarf	2	28
Red dwarf	41	0
Murusi	1	26
Spikata	6	5
Muthiyangana	35	47
Total	**176**	**209**

L Perera, S A C N Perera, H D M A C Dissanayake, M K Meegahakumbura, G K Ekanayake, H M N B Herath and R B Attanayake

Collection, conservation and evaluation of coconut biodiversity in the Southern Province

Collection and compilation of data related to stem, leaf, inflorescence and fruit morphology of the newly identified Southern coconut phenotypes Bothal thembili, Juwan pol, Ran pol and Murusi were completed. Comparative data for 6 already known coconut forms, namely, Sri

Lanka Tall, Sri Lanka Green Dwarf, San Ramon, King coconut, Bodiri and Sri Lanka Brown Dwarf have also been collected simultaneously for determining the inter-phenotypic diversity of different coconut forms. Accordingly, stem morphology (7 palms), leaf morphology (5 leaves from each of 7 palms), inflorescence morphology (9 inflorescences from each of 7 palms) and fruit and nut morphology (30 fruits from each of 7 palms) have been recorded to complete the morphological data collection.

Molecular data collection was started after extracting genomic DNA from selected palms used for the collection of morphological data. So far, 40 individuals belonging to the above phenotypes have been genotyped with 10 SSR markers. Both morphological and molecular data will be statistically analysed in the due course.

Eleven hand pollinated seed nuts belonging to a profusely bearing palm, Brown murusi and Juwan and 83 seednuts belonging to the phenotypes Juwan, Ran pol, Bothal thembili, Green murusi have been nursery laid.

G K Ekanayake (Full time M.Phil study), S A C N Perera and J M D T Everard [Deputy Director (Research)]

CHARACTERIZATION OF COCONUT GERMPLASM

Characterization and evaluation of indigenous Thembili germplasm (1996)

The trials at Margaret Estate and Raddegoda Estate are progressing satisfactorily.

S A C N Perera and R B Attanayake

PROJECT: MOLECULAR PATHOGEN DIAGNOSIS

The pathogen diagnosis work on tapering disorders was extended this year to test the phytoplasma hypothesis for the Weligama Coconut Wilt disease and Leaf Rot disease which showed symptoms similar to Kerala Wilt in India. DNA extracted from trunk shaving, mid ribs of leaflets and roots from ten healthy and 10 disease palms were PCR amplified with universal Phytoplasma primers. Nested PCR approach was used. DNA extracted from leaf samples from two disease palms produced positive PCR products with R16F2n/R16R2 and rU3/fU5 primer combination and R16mF2/R16mR1 and rU3/fU5. PCR products were run in a low melting Agorose gel and PCR products were purified from the gel using Wizard SV Gel and PCR Clean-up system (Promega, USA). Purified samples were sent to Macrogen Inc., South Korea for sequencing and sequence homology of both sequences was obtained by blasting them in the NCBI internet sequence database. The sequences were became 98% homologues to Sugarcane grassy shoot phytoplasma partial 16S rRNA gene and 98% to Sugarcane white leaf phytoplasma gene for 16S ribosomal RNA gene confirming the causal agent of the Weligama wilt disease as Phytoplasma.

L Perera, M K Meegahakumbura, W B S Fernando

3. DEVELOP MENT PROJECTS

(A) Increase of CRIC65 seed nut production at the ISG

During the year green dwarf seedlings established at ISG last year was well maintained. The routine emasculation programme at ISG was slightly changed this year not to cut and remove any female flowers in order to retain maximum number of female flowers to increase hybrid seed production.

A sprinkler irrigation system was designed for the nursery at ISG and necessary items were purchased. Establishment of the irrigation system will be done in 2008.

L Perera and S A S Chandrasiri

(D) Establishment of Pallama Seed Garden (PSG)

During the year 439 san ramon seedlings were planted in the seed garden as seed palms and as guard rows. The pollination programme done at Andigama NLDB farm terminated this year and harvesting of nuts continued. The pollination programme at PRS continued this year too. Altogether 211 selfed SR seed nuts were harvested and nursery laid. The tall x tall hand pollination programme at Field 4, PSG was also terminated this year. Harvesting of hand pollinated nuts continued. 726 hand pollinated tall x tall seed nuts were harvested this year and nursery laid. 200 green dwarf seedlings were established within the PSG as a mini seed garden for production of Kapruwana seeds in limited numbers. Production of CRISL 98 by hand pollination of tall palms at the seed garden was continued. More palms will be hand pollinated to increase the CRISL98 seed nut production

M K Meegahakumbura, L Perera and M H L Padmasiri

(D) Establishment of Maduru-Oya seed garden (MOSG)

The programme to field establish seedling at field number 07 of MOSG continued. The field was planted as half-sib family structure from nuts obtained from selected mother palms at ISG. Another 257 seedlings of the same half-sib nature were field planted this year too. Open pollinated nuts collected from selected mother palms at ISG were labeled and transported to MOSG and nursery laid there for future planting.

L Perera and M K Meegahakumbura

(E) Establishment of a seed garden for Kapruwana

A suitable land did not find for establishment of the seed garden for "Kapruwana" coconut hybrid this year.

L Perera and S A C N Perera

(F) Establishment of Seed Certification Unit

During the year 6 new estates (Lenawa Model Garden in Melsiripura, Miris Watta estate in Banduragoda, Delmukalana estate in Narangalla, Wayagolla estate in Attanagalla, Kohombe estste in Medagama, Kohombana farm in Gonagolla) were identified as plus palm estates.

Total of 6538 palms comprising 1726 from Lenawa, 375 from Miris Watta, 1162 from Delmukalana, 1264 from Wayagolla, 801 from Kohombe and 1210 from Kohombana were selected. During the year 833,295 CRIC60 seed nuts from ISG and 309,246 CRIC60 from MOSG and 92230 CRIC65 seed nuts from ISG were supplied to CCB, registered private nurseries and CRI estate nurseries during the year under the supervision of Seed and Seedling Certification Officer of the Seed Certification Unit. Seedling certification was restricted to CRIC60 and CRIC65 polybagged coconut seedlings this years and total of 157,146 coconut seedlings were certified this year. Seedling certification will be extended to cultivar Moorock next year.

During the year registration was given 8 private coconut nurseries making the total private nurseries in operating in Sri Lanka 14.

R Jayathilake and L Perera

4. EXTENSION ACTIVITIES

The division staff involved in organizing and conducting the "Coconut Day Exhibition" organized jointly by CRI, CCB and CDA at the CRI premises, 26-29 January 2007

The division staff involved in organizing and conducting the first programme of the One day training programme series of year 2007 of the CRI on "Replanting of coconut" at the Isolated Seed garden, Ambakelle, 25 May 2007

The division staff conducted two days training programme on "seed production and nursery management" for Nursery Officers of the CCB

Dr. L Perera, Dr. (Miss) S A C N Perera and L M S R Jayathilake delivered lectures on 'Basics of Coconut Breeding and nursery management' in an awareness programme conducted by the Coconut Cultivation Board for their officers on 02 February 2007. CCB Training Centre, Lunuwila.

The division staff delivered lectures to many groups of students, farmers, and growers who visited CRI and Isolated Seed Garden.

A substantial number of school children, students of technical colleges, undergraduates and graduates visited the division, molecular biology laboratory and the Isolated Seed Garden at Ambakelle.

REPORT OF THE SOILS AND PLANT NUTRITION DIVISION
Head – N.A. Tennakoon, Ph D

1. GENERAL

The Research programme of the Division was aimed at refining technology on nutrient management particularly with inorganic fertilizer and locally available organic sources, maintain soil quality by application of organic manures, evaluating nutrient levels of different types of coconut growing soils and developing irrigation/fertigation techniques for coconut.

During the year, the Division maintained 17 ongoing field experiments under 8 projects. Two experiments were terminated and three new field experiments were also commenced during the year. The Division has also conducted few miscellaneous studies which were supported to ongoing major experiments. The total research expenditure as consolidated funds for research was Rs. 6,747,000/-.

To assess the depletion of soil quality in coconut lands due to long-term cultivation of coconut and how to improve the soil quality in coconut lands, an experiment was established in the Agro Ecological Regions (AER) of Dry Zone, Intermediate Zone and Wet Zone in two land suitability classes S_2 and S_4. The results confirmed that in all sites and both land suitability classes, continuous cultivation of coconut for a long period even with the recommended management practices caused substantial reduction of soil quality compared with adjoining forest soils. The pH, electrical conductivity and field capacity were reduced (5-15%, 17-47% and 10-40% respectively). Gradually the bulk density of soil was increased at the range of 11-40%. Where as nutrient levels of major nutrients were reduced drastically in coconut soils compared to forest soils. The essential nutrients such as N, P, K and Mg were reduced in the range of 9-70%, 25-58%, 23-67% and 30-90% respectively while organic carbon was reduced by 10-66%. The order of the nutrient requirement for bearing coconut is K>Mg>N>P. These results confirmed that soil quality has drastically reduced due to long-term cultivation of coconut and supply of nutrients is essential for yield improvement of coconut.

The experiment on different sources of phosphate i.e. Triple Super Phosphate, Imported Rock Phosphate and Eppawela Rock Phosphate revealed that no significant difference in nut yield i.e. 16 years after the establishment of the experiment at Ratmalagara Estate (IL_1). Phosphorus nutrient in leaf was also not shown significant differences among different sources of P application. Therefore the recommendation of Eppawela Rock Phosphate as a source of P specially for Wet and Intermediate zones can be continued and this will lead to a substantial savings of foreign exchange.

The experiment on site specific fertilizer recommendation was established at five locations i.e. Mangalaeliya (DL_3 - Borupan soil series - S_2), Sirigampola (IL_{1a} - Madampe soil series - S_2), Kobeigane (IL_{1b} - Wariyapola soil series - S_3), Naiwala (WL_3 - Boralu soil series - S_4) and Wellawa (IL_{1a} - Kurunegala soil series - S_2). The sites at Mangalaeliya, Sirigampola, Kobeigane and Wellawa showed significant increase in nut yield as 82% ($P \leq 0.001$), 53% ($P \leq 0.05$), 37% ($P \leq 0.05$) and 49% ($P \leq 0.05$) respectively from the palms receiving 1400 g Urea, 1070 g Imported Rock Phosphate (at Mangalaeliya site in Dry zone), 1570 g Eppawala Rock Phosphate (at Sirigampola, Wariyapola and Kobeigane in Intermediate zone), 2800 g Muriate of Potash and 1750 g Dolomite (T_4) over control (no fertilizer). Nut yield increased as 28%, 38%, 16% and 14% respectively from the palm receiving recommended fertilizer

(800 g Urea, 600 g Imported Rock Phosphate or 900 g Eppawala Rock Phosphate, 1600 g Muriate of Potash and 1000 g Dolomite (T_2) over the control (no fertilizer). Increase of Urea by 600 g, Imported Rock Phosphate by 470 g (at Mangalaeliya site) Eppawala Rock Phosphate by 670 g (at Sirigampola, Kobeigane and Wellawa sites) Muriate of Potash by 1200 g and Dolomite by 750 g have shown the highest nut yield 42%, 10%, 18% and 14% respectively. The site at Naiwala showed nut yield increase as 81% from the palms receiving 1700 g Urea, 1225 g Eppawala Rock Phosphate, 3400 g Muriate of Potash and 2125 g Dolomite (T_5) over the control (no fertilizer) and 15% nut yield increase in the recommended fertilizer (T_2 - 800 g Urea, 900g Eppawala Rock Phosphate, 1600 g Muriate of Potash and 1000 g Dolomite) treated palms over the control (no fertilizer).

Experiment on comparison of the efficiency of organic and green manure against inorganic fertilizer Adult Palm Mixture (APM-W) showed 48% increase in the nut yield of the palms receiving poultry manure compared to the control (no fertilizer). The yield increase by inorganic fertilizer over the control (no fertilizer) was 23%. Nut yield of poultry manure treated palms increased by 20% over inorganic fertilizer treated palms. The nut yield increase in other organic sources such as cattle manure, goat manure and green manure - gliricidia was 25%, 25% and 6% over the control respectively. Results indicated that the application of organic manures such as poultry manure, cattle manure, goat manure etc. were more economically beneficial than inorganic fertilizers as in the previous years.

As service functions, the Division provided Differential Fertilizer Recommendation (DFR) to 130 growers covering 920 ha during the year. For quality testing, 210 inorganic fertilizer, 139 organic manure and 856 coir pith samples were analyzed. In addition, soil survey and land suitability tests were completed for 37 growers covering a total extent of 1370 ha.

2. RESEARCH PROJECTS

PROJECT 6.0: SUBSTITUTION OF LOW COST PHOSPHATE (ERP) IN PLACE OF IMPORTED ROCK PHOSPHATE FOR YOUNG COCONUT PALMS IN DIFFERENT AGRO ECOLOGICAL REGIONS

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

This experiment was a Randomized Block Design with 3 replicates and 6 palms per plot. Experiment was established in 1991, T x T seedlings were planted on Andigama series soils (Red Yellow Podzolic) at Ratmalagara Estate in IL_1 agro ecological region. The site falls into land suitability class S_4.

Treatments are given in Table 1.

Table 1: ***The sources of P and the rates of application***

Treatments	Rate of application g/palm/yr
T_1 - TSP (46% P_2O_5)	350
T_2 - IRP (27.5% P_2O_5)	600
T_3 - ERP (30% P_2O_5)	600
T_4 -Control (No P source)	0

Basal application -	Urea	800 g/palm/yr
	Muriate of potash	1600 g/palm/yr
	Dolomite	1000 g/palm/yr

The leaf samples from 14th frond of each treated palm were taken in June 2007. Fertilizer application was carried out in October. Nut yield data from October 2006 to September 2007 has not shown significant differences among the treatments (Table 2).

Table 2: ***Nut yield of the experiment***

Treatment levels	Nut yield	
	2002 October to 2006 September Cumulative (nuts/palm)	2006 October to 2007 September (palm/year)
T_1 - TSP	201	55
T_2 - IRP	195	54
T_3 - ERP	191	54
T_4- Control (No P sources)	165	47
Level of significance	* Only in 2005 October - 2006 September	ns
LSD ($p \leq 0.05$)	16.650 in 2005 October - 2006 September	-

Table 3 shows that the leaf P levels have shown significant differences ($p \leq 0.05$) between P sources and the control. Even though N and K levels were not significant, the levels of N and K nutrients were above the critical levels (N > 1.9% and K > 1.2%). Leaf magnesium levels of the treated palms were below the critical levels (Mg > 0.25%) except TSP treated palms. The magnesium levels of the palms have increased in this year compared to the last year (Table 3)

Table 3: ***Nutrient concentration in the 14th frond***

Treatment levels	N%	P%	K%	Mg%
T_1 - TSP	2.04	0.17	1.53	0.25
T_2 - IRP	2.02	0.16	1.44	0.24
T_3 - ERP	1.91	0.16	1.41	0.23
T_4 - Control (No P source)	1.90	0.13	1.34	0.23
Level of significance	ns	-	ns	ns
LSD ($p \leq 0.05$)	-	0.009	-	-

Therefore, it was clearly proven that there was no significant difference in P content of the leaves among IRP and ERP treated palms as well as nut yield. Therefore application of ERP is sufficient to supplement phosphate requirement in the Wet and Intermediate zone coconut soils and this will lead to a substantial savings of foreign exchange.

N A Tennakoon, C P A Kurundukumbura, W Gunasena and K J S Perera

Experiment 6.0.2: Effect of different phosphate sources on the performance of coconut seedlings in Southern soils - 2005

The experiment on a Randomized Block Design with 3 replicates and 6 palms per plot was established in December 2005 by planting T x SR seedlings in Katuwana soil series (Reddish Brown Latosols) at Middeniya sub station in IL_1 Agro Ecological Region. The site falls into land suitability class S_2 (Potential nut yields is 12,500 - 15,000 nuts/ha/yr). Treatments are given in Table 4.

Table 4: Treatments of the experiment

Treatment Levels	6 m	1 yr	1 1/2 yrs	2 yrs	2 1/2 yrs	3 yrs	3 1/2 yrs	4 yrs up to bearing	After bearing
T_1 - No P source (Control)	-	-	-	-	-	-	-	-	-
T_2 - ERP	340	407	407	540	540	675	675	810	900
T_3 - IRP	225	270	270	360	360	450	450	540	600
T_4 - HERP	170	200	200	275	275	340	340	407	450
T_5 - TSP	145	175	175	235	235	290	290	350	390

Basal Dose - Urea, Muriate of Potash and Dolomite as per recommendation
Rates up to bearing - g/palm/6 months

The quantities of urea and muriate of potash in the basal mixture application were increased by 25% as T x SR is a high yielding variety and which prevented the N and K nutritional deficiency symptoms observed in some seedlings.

The 1st, 2nd and 3rd (i.e. at the age of 6 months, 1 year and 1 _ year) treatment applications were completed in October 2006, March 2007 and October 2007. Preliminary soil and leaf samples were collected before the application of treatments. Leaf samples were also collected before the 2nd and 3rd treatment application in this year. The vegetative growth measurements i.e. girth of the stem, number of fronds, height of seedlings and leaf area were also recorded twice a year before the application of treatments. The vegetative growth measurements i.e. Leaf area, girth of the stem and number of fronds have shown significant differences among the treatments, 6 months and 1 year after fertilizer application (Table 5).

Table 5: Vegetative growth measurements (Mean value of 18 palms)

Treatments	Leaf area (cm^2)		Girth (cm)		Height (cm)		No of fronds	
	6 m	1 yr	6 m	1 yr	6 m	1 yr	6 m	1 yr
T1 - No P source	13012	27866	25	36	201	252	4	6
T2 - ERP	32046	32449	34	44	269	270	4	6
T3 - IRP	20835	38869	34	49	223	274	5	5
T4 - HERP	27216	33950	40	42	258	271	5	6
T5 - TSP	27699	43966	41	51	257	299	5	6
Level of significance	**	ns	***	***	ns	ns	*	*

N A Tennakoon, K P A Pahtirana and K L Ranasinghe

PROJECT 7.0: DEVELOPMENT OF FERTILIZER MIXTURES FOR YOUNG PALMS, TAPPING PALMS AND KING COCONUT PALMS

Experiment 7.0.2: Formulation of an effective fertilizer mixture for young coconut palms (2007)

The objectives of the experiment were

- To formulate an effective inorganic fertilizer mixture for young coconut palms.
- To formulate an effective package of organic manure for young coconut palms.
- To formulate the best inorganic/organic combination for young coconut palms.

Treatments combinations of the experiment have given in Table 6.

Two sites were selected during the year in dry zone at Mangala-eliya and intermediate zone at Melsiripura. A site in wet zone has to be selected in next year.

A mapping of the above experimental sites have been completed and lining at Mangala-eliya site was completed

N A Tennakoon, L R M C Liyanage, N H R M de Silva, C P A Kurundukumbura, E M A T Banda and K L Ranasinghe

Table 6: ***Treatment combinations of he experiment***

		6 months	1 year	1 _ years	2 years	2 _ years	3 years	3 _ years	4 yrs up to bearing
YPM - L_1	Urea (g)	150	180	180	240	240	300	300	360
	ERP (g)	340	405	405	540	540	675	675	810
	MOP (g)	150	180	180	240	240	300	300	360
	Dolomite (g)	500	500	500	500	500	500	500	500
YPM - L_2	Urea (g)	225	270	270	360	360	450	450	540
	ERP (g)	510	608	608	810	810	1013	1013	1215
	MOP (g)	225	270	270	360	360	450	450	540
	Dolomite (g)	750	750	750	750	750	750	750	750
YPM - L_3	Urea (g)	300	360	360	480	480	600	600	720
	ERP (g)	680	810	810	1080	1080	1350	1350	1620
	MOP (g)	300	360	360	480	480	600	600	720
	Dolomite (g)	1000	1000	1000	1000	1000	1000	1000	1000
Goat manure + Inorganic - L_1	GM (g)	3	7	-	9	-	11	-	13
	ERP (g)	200	450	-	600	-	750	-	1000
	MOP (g)	50	120	-	150	-	190	-	225
	Dolomite (g)	250	250	-	250	-	250	-	250
Goat manure + Inorganic - L_2	GM (g)	4.5	10.5	-	13.5	-	16.5	-	19.5
	ERP (g)	300	675	-	900	-	1125	-	1500
	MOP (g)	75	180	-	225	-	285	-	337
	Dolomite (g)	375	375	-	375	-	375	-	375
Goat manure + Inorganic - L_3	GM (g)	6	14	-	18	-	22	-	26
	ERP (g)	400	900	-	1200	-	1500	-	2000
	MOP (g)	100	240	-	300	-	380	-	450
	Dolomite (g)	500	500	-	500	-	500	-	500
Goat manure + Organic - L_1	GM (g)	3	7	-	9	-	11	-	13
	ERP (g)	200	450	-	600	-	750	-	1000
	Dolomite (g)	250	250	-	250	-	250	-	250
	Husk	8	18	-	22	-	30	-	40

		6 months	1 year	1 _ years	2 years	2 _ years	3 years	3 _ years	4 yrs up to bearing
Goat manure + Organic - L_2	GM (g)	4.5	10.5	-	13.5	-	16.5	-	19.5
	ERP (g)	300	675	-	900	-	1125	-	1500
	Dolomite (g)	375	375	-	375	-	375	-	375
	Husk	12	27	-	33	-	45	-	60
Goat manure + Organic - L_3	GM (g)	6	14	-	18	-	22	-	26
	ERP (g)	400	900	-	1200	-	1500	-	2000
	Dolomite (g)	500	500	-	500	-	500	-	500
	Husk	16	36	-	44	-	60	-	80
Gliricidia + Inorganic - L_1	Gliricidia (kg)	5	12	-	16	-	20	-	23
	ERP (g)	275	650	-	825	-	1100	-	1350
	MOP (g)	60	150	-	200	-	250	-	300
	Dolomite (g)	250	250	-	250	-	250	-	250
Gliricidia + Inorganic - L_2	Gliricidia (kg)	7.5	18	-	24	-	30	-	35
	ERP (g)	413	975	-	1238	-	1650	-	2025
	MOP (g)	90	225	-	300	-	325	-	450
	Dolomite (g)	375	375	-	375	-	375	-	375
Gliricidia + Inorganic - L_3	Gliricidia (kg)	10	24	-	32	-	40	-	46
	ERP (g)	550	1300	-	1650	-	2200	-	2700
	MOP (g)	120	300	-	400	-	400	-	600
	Dolomite (g)	500	500	-	500	-	500	-	500
Gliricidia + Organic - L_1	Gliricidia (kg)	5	12	-	16	-	20	-	23
	ERP (g)	275	650	-	825	-	1100	-	1350
	Husk	8	18	-	22	-	30	-	40
	Dolomite (g)	250	250	-	250	-	250	-	250
Gliricidia + Organic - L_2	Gliricidia (kg)	7.5	18	-	24	-	30	-	35
	ERP (g)	413	975	-	1238	-	1650	-	2025
	Husk	12	27	-	33	-	45	-	60
	Dolomite (g)	375	375	-	375	-	375	-	375
Gliricidia + Organic - L_3	Gliricidia (kg)	10	24	-	32	-	40	-	46
	ERP (g)	550	1300	-	1650	-	2200	-	2700
	Husk	16	36	-	44	-	60	-	80
	Dolomite (g)	500	500	-	500	-	500	-	500

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

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)

The objectives of this experiment were to test the response of coconut palms in different suitability classes to fertilizer doses that are higher than the generally recommended dose and in relation to data on soil, plant and fertilizer rates to develop recommendation criteria for coconut palms in high potential lands.

This experiment was a Randomized Block Design with 3 replicates and six palms per plot. It was established at the following locations.

Expt. No	Location	Agro ecological Region	Soil series	Year of commencement	Land suitability Class
7.1.2.1	Mangala-eliya	DL_1	Borupan series	2000	S_2
7.1.2.2	Naiwala	WL_3	Boralu series	2002	S_4
7.1.2.3	Kobeigana	IL_1	Wariyapola series	2002	S_3
7.1.2.4	Sirigampola	IL_1	Madampe series	2002	S_1
7.1.2.5	Wellawa	IL_1	Kurunegala series	2003	S_2

The treatments for the all sites are given in Table 7.

Table 7: Treatment combinations of the experiment (g/palm/yr)

Treatments	Urea	IRP/ERP	MOP	Dolomite
T_1	0	0	0	0
T_2	800	600 / 900	1600	1000
T_3	1100	825/1235	2200	1375
T_4	1400	1070/1570	2800	1750
T_5	1700	1225/1907	3400	2125

7.1.2.1: Mangala-eliya site

The nut yield of the experiments are given in Table 8.

Table 8: The nut yield of Mangala-eliya site

Treatment	Cumulative nut yield (nuts/palm) 2001 Sept. to 2006 Aug.	Nut yield (palm/year) 2006 Sept. to 2007 Oct.
T_1	431	
T_2	533	
T_3	545	
T_4	569	1(
T_5	525	
Level of Significance	* in (2003/ 2004) ** in (2005/ 2006)	***
LSD ($P \leq 0.050$)	13 (2003/ 2004) 15 (2005/ 2006)	11

A significant increase ($p \leq 0.001$) in nut yield (82%) was observed from those palms receiving 1400 g urea, 1070 g Imported Rock Phosphate, 2800 g Muriate of Potash and 1750 g Dolomite (T_4) over control (no fertilizer) and 28% nut yield increase was observed in the recommended fertilizer treated palms (T_2) - 800 g Urea, 600 g Imported Rock Phosphate, 1600 g Muriate of Potash and 1000 g Dolomite over control.

Increase of urea by 600 g, Imported Rock Phosphate by 450 g, Muriate of Potash by 1200 g and Dolomite by 750 g have shown the highest nut yield by 42% compared to the recommended dosage (T_2). This year i.e. 7 years after fertilizer application, this nut yield increase was shown particularly by Borupan soil series.(S_2) in the Dry zone where the site is located. It is clearly showed that coconut plantation at high fertile soils i.e. S_2, the supply of nutrients have to be increased by 1.5 to 2 times compared with general recommendation, due to high removal of nutrients and high yield.

The leaf sampling was completed in August 2007. All the leaf nutrients were in the sufficiency range ($N \geq 1.9\%$, $P \geq 0.11\%$, $Mg \geq 0.25\%$) except K. The K levels were increased in this year compared to the last year even though the K levels are little low than the critical levels i.e. $K \geq 1.2\%$ (Table 9).

Table 9: Leaf nutrient levels of the 14th leaf at Mangala eliya site

Treatments	N%	P%	K%	Mg%
T_1	1.96	0.15	0.98	0.28
T_2	2.03	0.16	1.14	0.29
T_3	2.03	0.16	1.16	0.29
T_4	2.04	0.16	1.15	0.29
T_5	2.13	0.16	1.18	0.29
Level of Significance	ns	ns	ns	ns

Soil samples were collected in July 2007. The soil nutrient values of the treatment applied soils were given in Table 10.

The nutrients of P, K, Ca, Na and pH of the soils have shown significant difference ($p \leq 0.05$) at the depth of 0 - 20 cm among the treatments. The treatment application was completed in November 2007.

Table 10: ***Soil nutrient levels at Mangala-eliya site (Soil depth at 0 - 20 cm)***

Treatment	pH (1:5)	EC (µs/cm)	N (mg/kg)	P (mg/kg)	K(meq/100g)	Mg(meq/100g)	Ca(meq/100g)	Na(meq/100g)
T_1	6.16	29.25	121	95	0.18	0.68	1.42	0.02
T_2	6.42	39.83	157	247	0.18	0.87	1.76	0.03
T_3	6.44	36.30	153	279	0.24	0.88	2.86	0.04
T_4	6.54	34.20	191	330	0.25	0.89	2.91	0.04
T_5	6.43	33.15	195	335	0.28	0.84	2.30	0.04
Level of Significance	*	ns	ns	***	*	ns	**	*
LSD ($p \leq 0.05$)	0.194	-	-	53.107	0.072	-	0.828	0.013

Experiment 7.1.2.2 - Naiwala

A significant increase ($p \leq 0.001$) in nut yield (81%) was observed from the palm receiving 1700 g Urea, 1907 g Eppawela Rock Phosphate, 3400 g Muriate of Potash and 2125 g Dolomite (Treatment 5) over control (no fertilizer) and 10% increase in nut yield was observed over recommended fertilizer applied palms (T_2 - Urea 800 g, Eppawela Rock Phosphate 900 g, Muriate of Potash 1600 g and Dolomite 1000 g) 4 years after imposement of fertilizer treatment (Table 11).

Table 11: The nut yield of the Naiwala site

Treatment	Cumulative Nut Yield (nuts/palm) 2003 November to 2006 October	Nut Yield (palm/year) 2006 November to 2007 October
T_1	102	44
T_2	144	69
T_3	136	76
T_4	150	78
T_5	154	80
Level of significant	** in 2004/ 2005 *** in 2005/ 2006	***
LSD ($p \leq 0.05$)	8 in 2004/ 2005 8 in 2005/ 2006	10

The leaf samples were collected in October 2007. Leaf nutrient only P has shown significant differences among the treatments (Table 12). In general leaf nutrient levels (N, K and Mg) were below the critical levels except P and N & K of T_4 and T_5.

Table 12: Leaf nutrient levels of the Naiwala Site

Treatment	N %	P %	K %	Mg
T_1	1.87	0.12	0.97	0.13
T_2	1.89	0.13	1.05	0.14
T_3	1.97	0.14	1.08	0.16
T_4	1.97	0.13	1.23	0.16
T_5	2.03	0.13	1.23	0.16
Level of significance	ns	*	ns	ns
LSD ($p \leq 0.050$)	-	0.010	-	-

The soil samples were collected in November 2007 and the nutrient levels are given in Table 13. Treatments were applied in November 2007, 4th year after establishment of the experiment. The nutrients such as N, P, K, Mg & Ca and the soil pH have shown significant differences among the treatments.

Table 13: ***Soil nutrient levels at Naiwala site (Soil depth 0 - 20 cm)***

Treatment	pH (1: 5 v/v)	EC(µs/cm)	N (mg/kg)	P (mg/kg)	K (meq/100g)	Mg (meq/100g)	Ca (meq/100g)
T_1	5.97	80.70	724	238	0.10	1.16	1.94
T_2	6.25	68.07	1149	360	0.14	1.21	2.69
T_3	6.32	69.60	1164	543	0.36	1.44	3.24
T_4	6.45	67.73	1178	572	0.44	1.45	4.39
T_5	5.98	83.75	1240	843	0.46	1.82	6.49
Level of Significance	*	ns	**	***	***	**	***
LSD ($p \leq 0.05$)	0.297	-	194.794	133.554	0.073	0.316	1.014

Experiment 7.1.2.3 - Kobeigane

The site at Kobeigane has shown 37% increase in nut yield ($p \leq 0.01$) from the palms receiving 1400 g Urea, 1570 g Eppawela Rock Phosphate, 2800 g Muriate of Potash and 1750 g Dolomite (Treatment 4) over the control (no fertilizer) and 16% nut yield increase in the treatment receiving recommended dosage of fertilizer (T_2) over the control. This year i.e. five years after fertilizer application, significant nut yield increase has shown particularly in Wariyapola series soil in the Intermediate zone (Table 14).

Table 14: Nut yield of the Kobeigane experimental site

Treatment	Cumulative nut yield (nuts/palm) 2003 November - 2006 October	Nut yield (palm/year) 2006 November - 2007 October
T_1	198	57
T_2	219	66
T_3	244	76
T_4	300	78
T_5	283	71
Level of significant	** in 2004/ 2005 and * in 2005/ 2006	**
LSD ($p \leq 0.05$)	16 in 2004/ 2005 and 14 in 2005/ 2006	11

The leaf samples were collected in October 2007 and results are given in Table 15. Leaf nutrients such as N, P and Mg have shown above the critical units expect K. However the K levels in increasing in this year compound to the last year. The leaf nutrient levels were not significant except N.

Table 15: Leaf nutrient levels at Kobeigane site

Treatments	N %	P %	K %	Mg %
T_1	1.90	0.13	0.99	0.29
T_2	1.94	0.13	1.06	0.29
T_3	2.06	0.13	1.08	0.31
T_4	2.17	0.13	1.02	0.31
T_5	2.03	0.14	1.10	0.35
Level of significant	*	ns	ns	ns
LSD ($p \leq 0.05$)	0.228	-	-	-

Soil samples were collected in December 2006 was analyzed and the results are given in Table 16. The pH, EC, P, K, Mg have shown significant differences among the treatments. The 4th year treatment application was completed in November 2007.

Table 16: ***Soil nutrient levels at Kobeigane site (Soil depth 0 - 20 cm)***

Treatment	pH (1: 5 v/v)	EC(μs/cm)	P (mg/kg)	K (meq/100g)	Mg (meq/100g)	Ca (meq/100g)	Na (meq/100g)
T_1	6.99	57.30	190	0.28	1.30	6.10	0.02
T_2	6.71	79.07	206	0.96	1.34	7.31	0.03
T_3	7.03	62.67	214	1.00	2.16	8.14	0.03
T_4	7.12	90.77	265	1.16	1.61	8.02	0.08
T_5	7.16	79.90	292	1.24	1.70	8.17	0.09
Level of Significance	*	***	***	*	*	ns	ns
LSD ($p \leq 0.05$)	0.269	8.773	72.126	0.540	0.485	-	-

Experiment 7.1.2.4 - Sirigampola

The site at Sirigampola has shown 53% significant increase ($p \leq 0.05$) in nut yield from the palms receiving 1400 g Urea, 1570 g Eppawela Rock Phosphate, 2800 g Muriate of Potash and 1750 g Dolomite (Treatment 4) over control (no fertilizer) and 38% nut yield increase in the treatment received recommended fertilizer (Treatment 2) over the control (Table 17).

Table 17: Nut yield of the Sirigampola Site

Treatment	Cumulative nut yield (nuts/palm) 2003 November - 2006 October	Nut yield (palm/year) 2006 November - 2007 October
T_1	186	70
T_2	210	97
T_3	227	99
T_4	236	107
T_5	270	102
Level of significant	** in 2004/2005 and *** in 2005/2006	*
LSD ($p \leq 0.05$)	14 in 2004/2005 and 13 in 2005/2006	22

The leaf samples were collected in August. Leaf nutrient analysis showed the leaf K & Mg have been significantly increased with high K & Mg treatments (significance at $p \leq 0.001$) in this year (Table 18).

Soil samples were collected in October 2006 was analyzed and results are given in Table 19. Soil nutrients such as P, K, Mg, Ca, Na and EC have shown the significant differences among the treatments. Treatment application was completed in November 2007.

Table 18: Nutrient level of the 14th frond at Sirigampola site

Treatment	N %	P %	K %	Mg %
T_1	2.16	0.14	0.90	0.23
T_2	2.17	0.15	1.20	0.24
T_3	2.23	0.14	1.27	0.27
T_4	2.27	0.14	1.33	0.28
T_5	2.28	0.14	1.34	0.28
Level of significant	ns	ns	**	***
LSD ($p \leq 0.05$)	-	-	0.187	0.037

Table 19: Soil nutrient levels at Sirigampola site (Soil depth 0 -20 cm)

Treatment	pH (1:5 v/v)	EC(µs/cm)	N (mg/kg)	P (mg/kg)	K (meq/100g)	Mg (meq/100g)	Ca (meq/100g)	Na (meq/100g)
T_1	5.33	26.63	795	116	0.10	0.34	0.84	0.03
T_2	5.38	38.80	727	210	0.26	0.38	0.96	0.03
T_3	5.50	49.60	780	327	0.38	0.78	2.23	0.03
T_4	5.79	75.43	802	420	0.79	0.79	2.17	0.05
T_5	6.09	83.13	840	445	1.11	0.75	5.68	0.06
Level of Significance	ns	**	ns	***	*	***	***	**
LSD ($p \leq 0.05$)	-	24.183	-	73.575	0.521	0.107	0.860	0.013

Experiment 7.1.2.5 - Wellawa

The 4th fertilizer application was carried out in September 2007. The nut yield has shown significant difference among the treatments in this year (Table 20). The results clearly showed that nut yield was increased as 49% from palms received 1400 g Urea, 1570 g ERP, 2800 g MOP and 1750 g Dolomite (T_4)over the control (no fertilizer). Only 14% nut yield was increased between T_4 and T_2 (Recommended fertilizer mixture).

Table 20: Nut yield of the experiment at Wellawa Site

Treatment	Cumulative nut yield (nuts/palm) 2003 November - 2006 October	Nut yield per (palm/year) 2006 November - 2007October
T_1	162	39
T_2	167	51
T_3	168	55
T_4	168	58
T_5	173	53
Level of significant	ns	*
LSD ($p \leq 0.05$)	-	8

Leaf nutrient levels have given in Table 21 and the nutrients have not shown significant differences among the treatments in this year. In general all nutrients are in the range of critical level.

Table 21: Nutrient levels of the Wellawa site

Treatment	N %	P %	K %	Mg %	Ca %
T_1	1.91	0.13	1.07	0.25	0.37
T_2	1.97	0.13	1.18	0.29	0.40
T_3	1.99	0.14	1.27	0.29	0.42
T_4	1.99	0.14	1.25	0.31	0.44
T_5	2.06	0.14	1.35	0.30	0.46

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

Experiment 7.2.2: Quantification of the removal of some nutrients by the coconut palm (2005)

The aim of this experiment was to quantify the removal of some micronutrients from coconut palms growing in moderately suitable (S_4) and highly suitable (S_1) land classes.

The experiment on land suitability class S_4 was commenced in 2005 in a field containing Boralu series soil at Bandirippuwa Estate. Ten T x T palms, which were 20 years old, were randomly selected as replicates for further experiments. The number and the weight of each component harvested and removed from the palm were determined at monthly intervals. The components were analyzed for N, P, K, Ca, Mg, S, Cl, B, Fe, Cu, Zn, and Mn. The full year data (October 2006 to September 2007) are given in Tables 22, 23 & 24. The data can be used in determining the pattern and the level of micronutrient as well as macronutrient removed by the coconut palm which is belongs to S_4 land suitability class.

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Table 22: ***Nutrients removed by each component of the palm in one year period (October 2006 to September 2007)***

	N	P	K	Ca	Mg	Na	Cl	S	B	Cu	Fe	Mn	Zn
	◄						(g)						►
Frond													
Ekel	10.448	3.095	20.415	14.220	8.394	4.566	4.589	0.792	0.043	0.010	0.988	0.524	0.083
Leaflet	92.152	7.830	66.583	88.354	35.633	12.683	94.808	17.795	0.224	0.048	2.685	3.925	0.528
Rachis	23.496	20.869	242.380	233.911	82.102	128.217	119.392	10.126	0.323	0.072	1.436	1.036	0.607
Sub Total	*126.095*	*31.794*	*329.378*	*336.485*	*126.130*	*145.466*	*218.790*	*28.712*	*0.590*	*0.120*	*5.109*	*5.484*	*1.217*
Nut													
Shell	7.452	2.079	42.413	1.263	1.333	2.700	6.648	0.215	0.040	0.070	1.580	0.019	0.018
Kernel	103.220	19.453	58.874	2.317	11.079	1.475	6.609	2.807	0.077	0.116	0.572	0.230	0.158
Nut water	0.730	0.972	20.823	2.104	0.908	0.576	0.037	0.000	87.162	4.564	40.345	36.615	3.704
Husk	61.767	14.361	615.891	17.343	16.279	21.919	257.370	0.684	0.396	1096.661	12972.350	1292.785	1241.450
Sub Total	*173.169*	*36.845*	*738.001*	*23.027*	*29.589*	*26.669*	*270.665*	*3.707*	*87.655*	*1101.410*	*13014.847*	*1329.649*	*1245.330*
Inflorescence													
Spadix	4.692	2.314	73.168	2.309	5.384	7.851	36.395	0.321	0.248	0.013	0.149	0.017	0.016
Spiklets	10.553	3.696	74.803	7.948	7.987	4.799	38.990	0.248	0.042	0.018	0.162	0.035	0.033
Matalu	4.165	0.764	1.393	3.076	0.794	0.253	0.520	0.012	0.084	0.010	0.588	0.019	0.022
Spath	6.302	0.472	6.174	7.311	2.794	0.533	0.790	0.016	0.019	0.016	0.096	0.014	0.011
Bract	10.539	0.981	8.425	9.389	3.827	0.712	0.854	0.026	0.039	0.022	0.209	0.076	0.030
Scar	1.377	0.576	9.077	0.379	0.507	0.714	4.459	0.023	1.416	0.001	0.036	0.007	0.004
Immature nuts	0.887	0.244	4.660	0.160	0.154	0.317	0.662	0.026	0.007	0.007	0.173	0.002	0.002
Sub Total	*38.516*	*9.047*	*177.679*	*30.553*	*21.446*	*15.178*	*82.670*	*0.672*	*1.854*	*0.087*	*1.413*	*0.167*	*0.118*
Grand Total	**337.780**	**77.687**	**1245.079**	**390.075**	**177.175**	**187.313**	**572.125**	**33.090**	**90.099**	**1101.618**	**13021.369**	**1335.300**	**1246.665**

Table 23: Average fronds and nuts removal of 10 palms from October 2006 to September 2007

	Oct/06	Nov/06	Dec/06	Jan/07	Feb/07	March/07	April/07	May/07	June/07	July/07	Aug/07	Sept/07
Fronds	0.2	0.2	0.0	1.0	1.2	6.0	1.0	0.4	0.1	0.2	1.1	2.0
Nuts	7.7	6.7	5.5	8.8	5.5	4.4	5.2	2.9	3.8	11.3	5.7	5.1

Table 24: Mean nutrient levels of the 14th frond of 10 experimental palms

Palm No.	N	P	K	Mg	Ca	Na	Fe	Mn	Cu	Zn	B	Cl
	◄		%			►	◄		mg/kg			►
1	1.74	0.13	1.20	0.18	0.30	0.09	91.25	114.40	7.59	21.75	9.11	0.42
2	1.68	0.14	1.16	0.22	0.27	0.11	103.90	113.30	7.41	22.04	10.27	0.43
3	1.96	0.15	1.36	0.23	0.28	0.06	100.30	89.66	8.07	23.35	13.62	0.58
4	1.81	0.15	1.21	0.24	0.31	0.08	94.02	109.60	6.80	20.02	12.62	0.48
5	2.41	0.15	1.24	0.19	0.25	0.05	93.26	117.70	8.26	27.37	12.47	0.36
6	1.43	0.13	1.18	0.19	0.24	0.13	99.07	59.48	6.94	23.11	13.62	0.47
7	2.16	0.16	1.30	0.20	0.23	0.04	116.50	94.92	7.85	26.57	13.75	0.40
8	1.97	0.16	1.32	0.27	0.30	0.10	104.20	154.20	7.78	28.83	17.29	0.55
9	1.88	0.16	1.45	0.17	0.29	0.10	103.60	132.10	7.86	28.71	14.04	0.53
10	1.92	0.15	1.10	0.25	0.31	0.05	94.86	112.50	8.43	29.87	16.24	0.30
Total	19.0	1.47	12.52	2.14	2.78	0.76	990.46	1097.56	76.99	251.62	133.65	4.52
$\overline{X}$	1.90	0.15	1.25	0.21	0.28	0.076	99.05	109.76	7.70	25.16	13.31	0.45

Experiment 7.2.3: Determination of heavy metals in nut water and kernel after long-term application of organic manure (2007)

The objective of the experiment is to assess the accumulation of heavy metals in nut water, kernel and leaf of the coconut palm and coconut soil after long-term application of organic manure.

The samples were taken from the on-going experiment on comparison of organic manure and inorganic fertilizer on coconut palm at Rathmalagara. This was established in 1997.

Ash content of nut water and kernel are given in Table 25.

Table 25: Ash content of the nut water and kernel

Treatment	Nut water mg/150ml	Kernel (%)
T_1 - Na - Fertilizer	820 ± 34	1.33 ± 0.03
T_2 - 3 kg APM + 1 kg of dolomite/ palm	710 ± 126	1.39 ± 0.04
T_3 - 35 kg cattle manure + 1200g MOP/ palm	796 ± 40	1.38 ± 0.01
T_4 - 25 kg goat manure + 800g MOP/ palm	839 ± 42	1.28 ± 0.09
T_5 - 30 kg poultry manure + 750g MOP/ palm	787 ± 23	1.37 ± 0.05
T_6 - 30 kg gliricidia + 750 IRP + 1500g MOP+ 1000 dolomite/ palm	822 ± 82	1.35 ± 0.04

Heavy metals analyses are in progress.

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Experiment 7.2.4: Studies on Zn & Cu chelates on micronutrient sources for coconut (2007).

The objective of the experiment was to determine Zn and Cu nutrient levels in coconut seedlings due to application of Zn and Cu chelates to the soil and effect of Zn and Cu on the growth of coconut.

A poly tunnel has been constructed specially for this experiment at Bandirippuwa Estate.

Twenty one large buckets (pots) were selected for this experiment and the design of experiment was Randomized Block Design with 3 replicates. Soils were selected from Madampe soil series and 80 kg of soils were filled to each bucket. Planting of coconut seedlings has been completed and treatment application will be carried out in next year.

Treatment combinations are given in Table 26.

Table 26: Treatments of the experiment

Treatments	Rate of chelate application (g)
T_1	0
T_2	30/ Cu_2 EDTA
T_3	60/ Cu_2 EDTA
T_4	30/ Zn_2 EDTA
T_5	60/ Zn_2 EDTA
T_6	30/ Cu_2 EDTA and 30/ Zn_2 EDTA
T_7	60/ Cu_2 EDTA and 60/ Zn_2 EDTA

YPM has been applied as the basal application according to the recommendation for young palms.

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PROJECT 9.0: DEVELOPMENT OF IMPROVED FERTILIZER APPLICATION TECHNIQUES FOR COCONUT TO IMPROVE EFFICIENCY OF UPTAKE AND TO MINIMIZE COST

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, was a Randomized Block (Complete) Design with single palm replicate with four treatments, four palms per block, 3 replicates per group with six groups was established in 2002 at Bandirippuwa Estate.

Location	Agro-ecological Region	Soil type	Land suitability class
Bandirippuwa Estate	IL_1	Gravel (Boralu series)	S_4

Treatment combinations are given in Table 27.

Table 27: Treatment combinations of the experiment

	Application rate (palm/year)
T_1	3 kg APM (MOP 1600 g + Urea 800 g + ERP 600 g)
T_2	3 kg APM + 1 kg Kieserite
T_3	3 kg APM + 1 kg Kieserite (6 months later)
T_4	Urea 800 g + ERP 600 g + MOP 1600 g - _ circle MOP Kieserite 1 kg - _ circle Kieserite

Nut yield as well as female flowers of this experiment during the period of October 2006 to September 2007 have not shown significant difference among the treatments. (Table 23). The palms having treatments 3 and 4 have shown higher nut yield compared to treatments 1 and 2.

Table 28: Nut and female flower production of the treatment palms

Treatment	Nut yield (palm/yr) (Oct. 2006 to Sept. 2007)	Female Flowers (palm/yr) (Oct. 2006 to Sept. 2007)
T_1	39	107
T_2	45	122
T_3	56	126
T_4	53	127
Level of Significance	ns	ns
LSD ($p \leq 0.05$)	-	-

Leaf samples were collected in June 2007 and the leaf nutrient levels of 14th leaf are given Table 29. The nutrients have not shown significant differences among the treatments except Ca in this year. However the major nutrients such as N, P, K & Mg are in the sufficiency range.

Table 29: Leaf nutrient levels of the experiment

Treatment	N %	P %	K %	Mg %	Ca %
T_1	1.90	0.13	1.37	0.25	0.38
T_2	1.91	0.13	1.55	0.25	0.40
T_3	1.92	0.13	2.12	0.24	0.45
T_4	1.92	0.13	1.43	0.25	0.45
Level of Significance	ns	ns	ns	ns	*
LSD ($p \leq 0.05$)	-	-	-	-	0.053

Soil sampling was done in July 2007 and the soil nutrient values are given in Table 30. The K & Mg nutrients of the top soil (0-20 cm) as well as sub soil (20 - 40 cm), Na of top soil and pH of sub soil have shown significant a differences among the treatments.

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Table 30: Soil nutrient levels of the experiment

Treatment	pH (1:5)		EC(µs/cm)		N (mg/kg)		P (mg/kg)		K(meq/100g)		Na(meq/100g)		Ca(meq/100g)		Mg(meq/100g)	
	(I)	(II)	(I)	(II)	(I)	(II)	(I)	(II)	(I)	(II)	(I)	(II)	(I)	(II)	(I)	(II)
T_1	6.19	5.99	93.80	74.57	1041.17	802.68	410.22	138.21	0.89	0.73	0.09	0.07	4.43	2.50	1.84	1.33
T_2	6.27	5.89	84.98	76.02	1317.14	772.12	427.67	122.69	0.82	0.71	0.07	0.06	4.10	2.23	3.02	1.64
T_3	6.36	5.91	103.31	98.36	992.63	698.62	434.29	127.81	0.77	0.69	0.04	0.04	4.39	2.46	2.41	1.33
T_4 (MOP)	6.41	6.11	92.97	82.94	1134.98	820.88	398.72	168.40	1.32	1.06	0.07	0.06	3.67	2.23	1.78	1.25
T_4 (Kieserite)	6.25	5.77	81.63	71.78	1160.96	781.48	302.44	168.72	0.47	0.43	0.04	0.05	3.26	2.48	3.11	2.17
Level of Significance	ns	**	ns	ns	ns	ns	ns	ns	**	***	**	ns	ns	ns	***	***
LSD (p ≤0.05)	-	0.213	-	-	-	-	-	-	0.323	0.218	0.027	-	-	-	0.555	0.436

(I) Soil depth at 0 - 20 cm

(II) Soil depth at 20 - 40 cm

Experiment 9.0.3: Behavior of urea and dolomite in dry zone high pH soil. (2007)

A field experiment was designed to study the availability of nitrogen from urea and availability of magnesium from dolomite in high pH dry zone soils based on the results obtained from a green house experiment conducted in the last year.

Details of two locations are given in Table 31.

Table 31: Details of the locations.

Location	AER	Soil Type	Land suitability class	pH of the soil
Anuradhapura	DL_1	Reddish Brawn Earth and Law Humic Gley	S3	6.70
Maduru Oya	DL_2	Reddish Brawn Earth	S3 - S4	6.50

The plot demarcation was completed and preliminary soil and leaf samples were collected and the analyses are in progress. The preliminary nut yield recording are continuing in 45 days intervals.

The design of the experiment was Randomized Block Design with 3 replicates. Each plot has six effective palms.

Treatment combinations are given in Table 32.

Table 32: Treatment combinations of the experiment.

T_1	Control (only basal application)
T_2	Dolomite 1000 g palm/ yr
T_3	Urea 800 g palm/ yr
T_4	Ammonium sulphate 1750 g palm/ yr
T_5	Dolomite + Urea (Combination of $T_2 + T_3$)
T_6	Dolomite + Ammonium sulphate (Combination of $T_2 + T_4$)

Basal dose - IRP 600 g + MOP 1600 g palm/ yr

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Experiment 9.0.4: Alternative sources capable of supplying potassium for coconut: Green House Experiment (2007)

Potassium is the most important nutrient is coconut and conventionally used chemical potassium fertilizers are not accepted in organic coconut cultivation. Therefore, a pot experiment was conducted to evaluate some locally available materials as a source of potassium for coconut.

An experiment was established in 2007, in the green house at Bandirippuwa Estate.

Pots were filled with 5 kg of soil (Madampe series) and just after filling soils were analyzed for chemical parameters. The materials used as treatments were analyzed for their total K level based on K_2O content and then were applied to provide recommended K Level (L_1). Double the rates were also applied as (L_2). Amounts added were given in Table 33.

Table 33: Treatments and amount Potassium source added in each treatment

Treatment	Material	Amount (g)/ 5kg soil of pot
T_1	Control - No natural source	-
T_2	Mica (powder)	26 g
T_3	Feldspar (powder)	24 g
T_4	Coconut husk ash	12 g
T_5	Tithonia (wild sun flower)	70 g
T_6	Locally produced fertilizer	20 g
T_7	Muriate of Potash (MOP)	04 g

A same set of treatments were (L_1 and L_2) planted with an indicator plant *(panicum maximum)* in a separate set of pots to study the pattern of uptake. Soil sampling was done in 3 weeks intervals initially pots were watered up to the field capacity. (Pots were not allowed to drain out).

Results shows that exchangeable K levels of locally produced K fertilizer and coconut husk ash treatments are significantly higher than other treatments in level 1 and level 2 (Figs 1 and 4). Tithonia levels added treatment also has a higher K content than other treatments in level 1. Significantly lower K content was given in control, mica and feldspar treated soils a both the levels.

Exchangeable Mg content was significantly higher in locally produced K fertilizer, coconut husk ash and Tithonia treatments than control, mica and feldspar in level 1 and level 2 (Figs 2 and 5).

When soil pH is considered, locally produced K fertilizer coconut husk ash and Tithonia applied treatments at recommended rates has increased pH to neutral level which is significant increment compare to control (4.7) but double dosage applied treatment of coconut husk ash and locally K fertilizer has brought pH to alkaline level (above 8). It indicates that level 2 of above treatments seems to be not suitable, even though K availability is high (Figs 3 and 6).

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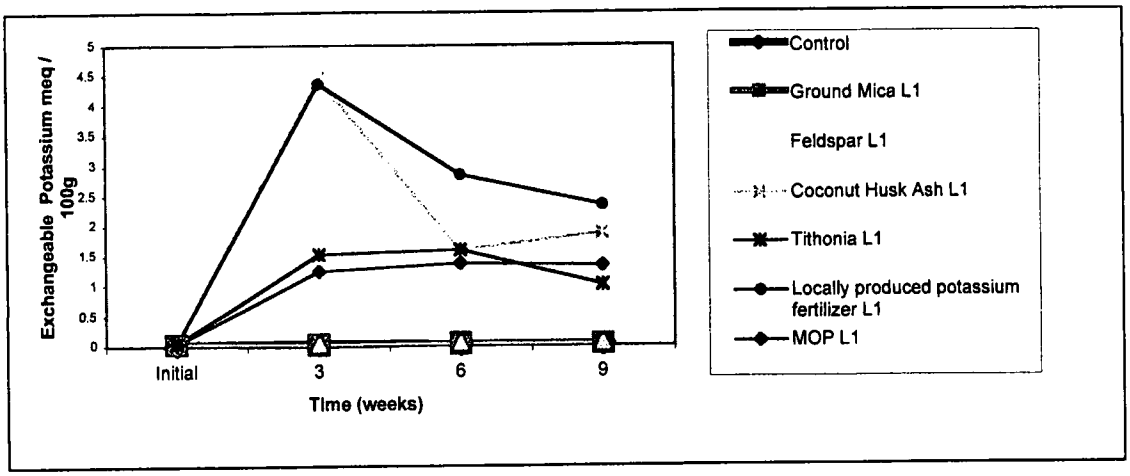

Figure 1: Variation of Soil Exchageable K in different treatments(recommended rate-L1) with time

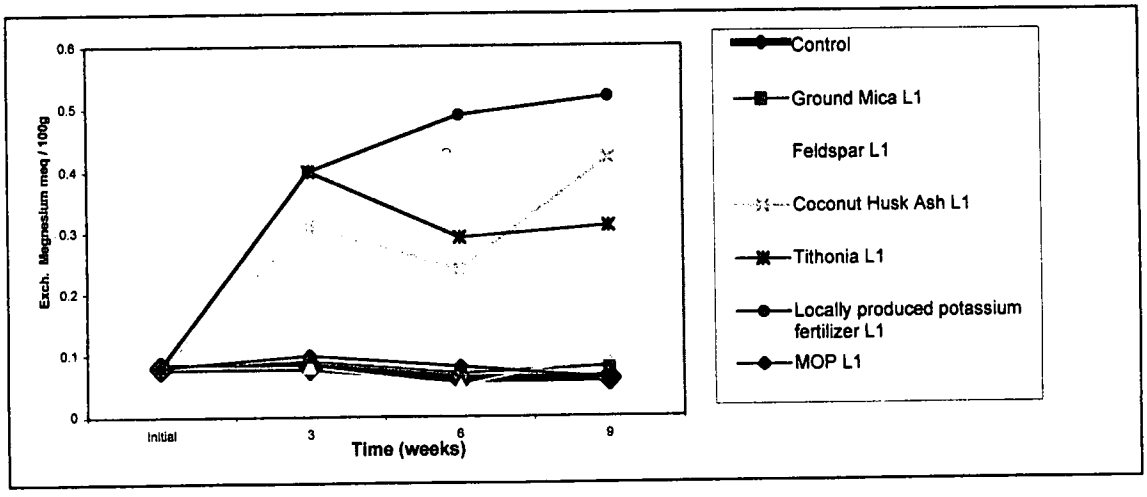

Figure 2 : Variation of Soil Exchageable Mg in different treatments(recommended rate-L1) with time

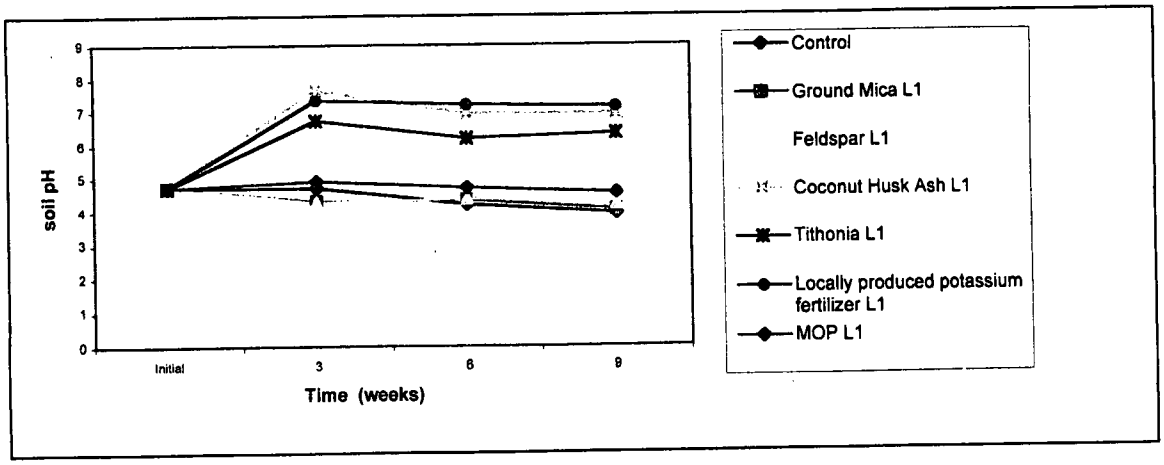

Figure 3: Variation of Soil pH in different treatments(recommended rate-L1) with time

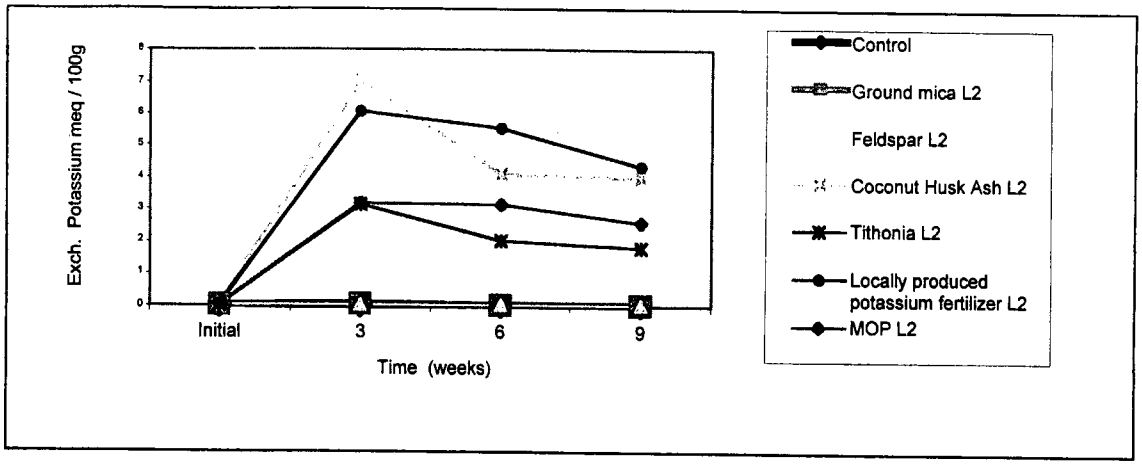

Figure 4 : Variation of Soil Exchageable K in different treatments(Level 2) with time

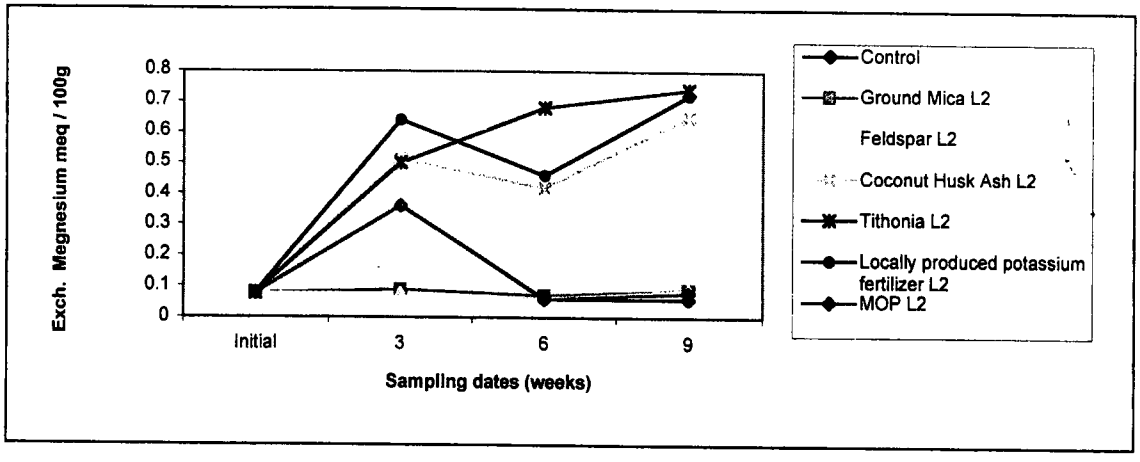

Figure 5 : Variation of Soil Exchageable Mg in different treatments(Level 2) with time

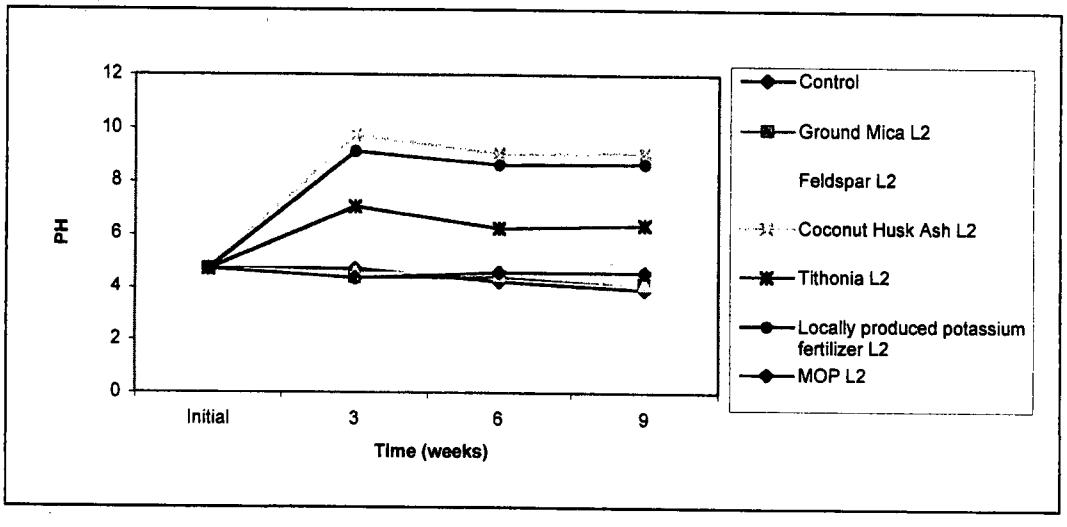

Figure 6: Variation of Soil pH in different treatments(Level 2) with time

Experiment 10.0.2: Evaluating the effect of fertigation on coconut (2004)

The experiment was established in 2004 at Ratmalagara Estate (IL_1). It was located in a shallow sandy clay loam soil (Andigama series) falling into land suitability class S_5. This experiment was Randomized Complete Block Design with 3 replicates and 6 palms (15 years also) per plot. Treatment combinations were given in Table 34.

Table 34: Treatment combinations of the experiment

T_1	Control - no Fertilizer, No Irrigation (No Fertigation)
T_2	Fertilizer (3 kg APM + 1 kg Dolomite applied on the entire manure circle) + No Irrigation
T_3	No Fertilizer + Drip Irrigation (40 l/day)
T_4	Fertilizer (3 kg APM + 1 Dolomite – applied on the entire manure circle) + Drip Irrigation (40 l/day)
T_5	Fertilizer (67 g urea + 133 g MOP through drippers/palm/month) + (Fertilizer 75g ERP + 83 g Dolomite applied at the point of 4 drippers) + Drip Irrigation (40 l/day)
T_6	Fertilizer (67 g urea + 133 g MOP + 75 g ERP + 83 g Dolomite/palm/month with Hose Irrigation (40 l /day)

Nut yield records for two year period are given in Table 35. Treatments were imposed in November 2007 and leaf samples were collected in August 2007. It is too early to examine yield response among the treatments.

Table 35: Nut yield and female flowers data of the experiment

Treatment	Cumulative nut yield (nuts/palm) November 2004 to October 2006	Nut yield (palm/year) November 2006 to October 2007	Female flowers (palm/year) November 2006 to October 2007
T_1	146	84	241
T_2	121	98	304
T_3	134	86	300
T_4	132	86	288
T_5	158	101	295
T_6	160	105	302
Level of Significance	ns	ns	ns

The leaf nutrient values are given in Table 36 showed that there is no significant differences among the treatments. All the nutrients are in the sufficiency ranges except Mg. ($N \geq 1.9$ %, $P \geq 0.11$ %, $K \geq 1.2$ %, $Mg \geq 0.25$ %). Kernel thickness of the nuts have also not shown significant differences among the treatment i.e. 3 years after treatment application.

Table 36: Leaf nutrient values of the 14th leaf

Treatment	N %	P %	K %	Mg %
T_1	1.97	0.14	1.59	0.26
T_2	2.08	0.15	1.74	0.23
T_3	2.00	0.15	1.54	0.26
T_4	2.16	0.15	1.62	0.25
T_5	2.17	0.15	1.76	0.24
T_6	2.17	0.16	1.74	0.24
Level of Significance	ns	ns	ns	ns

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Experiment 10.0.3: A study on the potential of girdle sprinkler system for fertigation of coconut through rain water harvesting (2006)

The experiment was established in 2006 at Pallama Genetic Resource Center.

The objectives of the experiment were to

(i) Assess the yield increase through sub surface irrigation
(ii) Study the use of harvested rain water for fertigation
(iii)Study the salinity development in soil

A water harvesting pond has been completed and water collection to the pond was monitored for a period of 1 _ years (up to end of 2007).

The total catchment area of the pond is 1 ac which supposed to irrigate for same 1 ac coconut land during the dry spell using the collected water during the raining period.

Following data were collected during last 1 _ years.

- Total rainfall received was 1625 mm and the fan evaporation was 1418 mm during the stabilization period.
- The amount of water received by the pond was around $20m^3$.
- Water requirement for 1 ac coconut plantation is 12800 l per one irrigation practice with 5 days intervals.
- Two pumping tests were carried out to study the pond behavior.

These results have shown that the harvested amount of rainwater by 1 ac catchment area which has 3% slope and Ambakele shallow series soils would not be sufficient to irrigate the same area of land during the dry spell of the year. The surface run-off was also very less due to sand layer on the top of the profile on this soil series. High amount of subsurface runoff was observed. The collected rain water can be used only for 2 irrigation cycles.

Therefore this experiment was terminated at the end of 2007.

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PROJECT 27: STUDIES ON CHEMCIAL 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 coconut growing soils. Soil samples were collected to represent the top layer (0-25 cm depth) and the sub layer (25-50 cm) of soil series. 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^{th} frond) from coconut palms were also taken from the same location.

The soil series Kuliyapitiya, Kurunegala, Boralu and Pallama were sampled and analyzed for soil and leaf nutrient levels. The results were published in the past Annual Reports.

Soil and leaf sampling for another major soil series of Kurunegala 1 inch sheet namely Wariyapola (50,073 ha) and Maho (16,533 ha) were commenced from January 2005. It was planned to complete sampling of 250 sites from Wariyapola series and 50 sites from Maho series. At the end of the year, the soil and leaf sampling were completed in both soil types and from each site soil samples were collected from 4 locations to prepare composite samples separately from top soil (0-25 cm) and sub soil (25-50 cm). The available soil nutrient data are given in Table 37.

When soil nutrient levels are considered both Wariyapola and Maho series are having almost similar pattern of variation.

Table 37: ***Studies on chemical properties of Wariyapola and Maho series***

Soil series	Position in the coconut land	Depth	N (mg/kg)	P (mg/kg)	K	Ca (meq/100g)	Mg	Zn	Cu (mg/kg)	Fe	Mn
Wariyapola Series	Center of square	Top soil	54	29	0.09	1.21	0.46	2.10	1.35	48.42	14.37
		Sub soil	102	17	0.07	1.34	0.32	1.17	1.21	38.67	21.44
	Manure circle	Top soil	150	32	0.06	0.96	0.51	0.82	0.93	68.41	8.65
		Sub soil	108	12	0.05	1.78	0.55	0.67	1.11	23.45	13.42
Maho Series	Center of square	Top soil	220	31	0.12	2.30	0.86	3.21	1.27	21.21	28.61
		Sub soil	158	31	0.09	1.71	0.71	1.41	1.11	11.95	31.44
	Manure circle	Top soil	204	24	0.14	1.45	1.21	2.11	2.10	18.67	47.21
		Sub soil	196	18	0.06	1.21	0.97	2.04	2.01	21.19	33.34
Wariyapola Series	Center of square	Top soil	184	10	0.14	4.36	1.10	0.91	0.93	25.69	35.68
		Sub soil	134	10	0.05	3.11	0.84	0.48	0.86	20.22	29.21
	Manure circle	Top soil	216	3	0.09	5.11	0.85	1.12	1.13	78.57	47.43
		Sub soil	152	5	0.11	1.63	0.64	1.30	0.97	57.23	36.81
Maho Series	Center of square	Top soil	196	14	0.21	0.28	0.95	0.79	1.24	29.61	8.67
		Sub soil	184	9	0.14	0.64	0.89	0.48	0.96	22.24	11.21
	Manure circle	Top soil	213	8	0.09	1.59	0.73	2.12	0.86	30.11	14.37
		Sub soil	198	10	0.06	1.66	0.56	1.11	0.72	23.56	12.57

The macro nutrients such as nitrogen and potassium levels were very much below the tropical soil nutrient levels (K - 0.4 meq/100g and N - > 1000 mg/kg). Most of the locations, Ca & Mg levels were just below tropical soil nutrient levels except few locations. The all micronutrients analyzed Zn, Cu, Fe & Mn were above the general tropical soil micronutrient levels.

For nutrient analysis, leaflets from 14th frond of four coconut palms were collected to prepare a composite sample from each site. The leaf nutrient data are given in Table 38.

Table 38: Leaf nutrient levels of the palms in Wariyapola and Maho series soils.

Soil series	N	P	K	Ca	Mg	Zn	Cu	Fe	Mn
	◄		%		►	◄		mg/kg	►
Wariyapola Series	1.91	0.14	0.56	0.34	0.39	30.1	3.52	103.30	212.20
Maho Series	1.97	0.15	0.97	0.41	0.43	28.4	3.88	165.20	111.10
Wariyapola Series	2.13	0.13	1.30	0.52	0.51	20.2	3.49	105.54	79.80
Maho Series	2.11	0.15	0.51	0.48	0.36	24.6	2.79	130.20	259.60

From the analytical data it was evident that N and P are above the critical leaf nutrient levels, but K levels are below the critical level. Ca and Mg are just within the range except few locations which compared with critical values for coconut (N ≥ 1.9%, P ≥ 0.01%, K ≥ 1.2%, Mg ≥ 0.25%, Ca ≥ 0.35%).

Among the micronutrients Cu levels were below the critical nutrient level in almost all the locations. Zn levels have just research critical levels while Fe and Mn were well above the critical levels. (Critical levels of Cu, Zn, Fe and Mn for coconut are 5-, 30-, 40 and 60 respectively).

Results of this experiment highlights production of coconut in these soil series are limited by lower level of potassium and some micronutrients such as Cu and Zn.

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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) - 1997

The experiment, is a Randomized Block Design with 3 replicates and 6 palms (45 years old) per plot, was established in 1997 at Ratmalagara Estate.

The annual treatment combinations are given in Table 39.

Table 39: Treatment combinations of the experiment

T_1	Control (no fertilizer)
T_2	3 kg APM (Adult Palm Mixture) + 1 kg dolomite per palm
T_3	35 kg cattle manure + 1200 g MOP per palm
T_4	25 kg goat dung + 800 g MOP per palm
T_5	30 kg poultry manure + 750 g MOP per palm
T_6	30 kg Gliricidia + 750 g SP + 1500 g MOP + 1000 g dolomite per palm

Leaf samples collected at Ratmalagara Estate site on October 2007 were analyzed and results are given in Table 40. Leaf N, P & K have shown significant difference ($p \leq 0.05$) among the treatments. This difference was clearly shown between fertilized palms and control palms. Essential nutrients such as N, P, K and Mg were in the above critical level ($N \geq 1.9\%$, $P \geq 0.11\%$, $K \geq 1.2\%$ & $Mg \geq 0.25$)

Table 40: *Leaf nutrient levels in the 14th frond*

Treatment	N %	P %	K %	Mg %
T_1	1.94	0.13	0.80	0.29
T_2	1.97	0.13	1.30	0.31
T_3	2.23	0.14	1.34	0.31
T_4	2.14	0.14	1.26	0.30
T_5	2.30	0.15	1.27	0.33
T_6	2.14	0.15	1.30	0.32
Level of significant	*	*	*	ns
LSD ($p \leq 0.05$)	0.211	0.011	0.334	-

Forty eight percent increase in nut yield of the palms receiving poultry manure was observed compared to that of the control (no fertilizer). This was significant at $p \leq 0.05$, the yield increases due to application of inorganic fertilizer over the control (no fertilizer) was 23% (Table 41). Among other organic sources such as cattle manure, goat manure and gliricidia, the yield increase was 25%, 25% and 6% over the control (no fertilizer) respectively. Twenty percent yield increase was observed in palms receiving poultry manure over inorganic fertilizer (APM-W). Results indicated that the application of organic manure such as poultry manure, cattle manure, goat manure etc were more economical and beneficial than that of inorganic fertilizer.

Table 41: Nut yield data at the Ratmalagara Experimental Site

Treatment	Cumulative nut yield (nuts/palm) June 1997 to August 2006	Nut yield (palm/year) June 2006 to August 2007
T_1	504	52
T_2	609	64
T_3	670	65
T_4	650	65
T_5	717	77
T_6	605	55
Level of Significance	* in 2002/2003 & 2005./2006	ns
LSD ($p \leq 0.05$)	20 (2002/2003) & 19 (2005/2006)	-

Soil samples were taken in August 2007 and analysis are in progress. The available data are given in Table 42.

The organic carbon and CEC has increased by 53% and 62% respectively due to application of organic manure than no organic manure application.

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Table 42: Available Soil nutrient data of the experiment (Soil depth 0 - 20 cm)

Treatment	pH (1:5)	EC (µs/cm)	N	P	K	Mg	Na	Ca	CEC meq/100g	OC %
			← mg/kg →		← meq/100 g →					
T_1	5.89	36.50	55.50	207	0.14	0.95	0.07	2.10	2.28	0.45
T_2	6.45	32.37	71.25	261	0.18	0.87	0.04	2.64	2.58	0.47
T_3	6.62	43.33	75.75	280	0.24	1.57	0.04	4.16	3.50	0.69
T_4	6.76	56.90	49.25	356	0.23	1.49	0.07	6.59	3.47	0.67
T_5	6.87	79.73	65.25	405	0.21	1.82	0.07	10.11	3.70	0.69
T_6	7.07	41.23	48.25	327	0.25	1.61	0.07	5.90	3.50	0.59
Level of Significance	***	***	*	***	**	**	*	***	*	**
LSD ($p \leq 0.050$)	0.160	16.709	18.399	87.65	0.045	0.464	0.016	1.909	4.181	0.380

Experiment 30.1.2: Amelioration of Boralu and Sudu series soil by adding organic manure for improvement of the soil (2005)

The objective of the experiment was to study the rate of increase in soil organic matter with application of different levels of organic manure. Two sites were selected for this experiment.

Badalgama Site

The experiment is a Randomized Block Design with 3 replicates and 6 palms per plot was established in 2005 at Boralu soil series (potential nut yield is 5,000 - 10,000 nuts/ha/yr) at Badalgama in WL_3 Agro Ecological Region. The site falls into land suitability class S_4.

Treatments are given in Table 43.

Table 43: Treatments of the Badalgama site

T_1	Control - only APM-W
T_2	Goat manure 35 kg per palm/yr
T_3	Goat manure 50 kg per palm/yr
T_4	Goat manure 75 kg per palm/yr
T_5	Goat manure 100 kg per palm/yr

Basal dosage (g/palm/y)	-	Eppawela Rock Phosphate	900
		Muriate of Potash	1600
		Dolomite	1000

Nut yields of the experiment are given in Table 44. It is too early to predict the differences of nut yield as well as female flower production among the treatments. i.e. 1st year after treatment application.

Table 44: Nut yield and female flowers of the experiment (March 2006 to December 2007)

Treatment	Nut yield per palm	Female flowers per palm
T_1	76	157
T_2	81	204
T_3	77	172
T_4	80	210
T_5	86	181
Significance	ns	ns

Soil and leaf samples were collected in April and December 2007 respectively. The results are given in Tables 45 & 46 respectively.

Table 45: Soil nutrient data of the experiment

Treatment	Parameters																	
	pH (1:5)		EC (µs/cm)		N (mg/kg)		P (mg/kg)		K (mg/kg)		Mg (meq/100g)		Ca (meq/100g)		Na (meq/100g)		OC %	
	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II
T_1	6.65	5.97	59.53	39.30	1462	712	224	40	0.55	0.34	1.49	0.51	10.72	5.37	0.04	0.03	1.72	1.92
T_2	6.68	6.05	66.83	48.38	1250	1076	312	84	0.81	0.41	1.89	0.65	13.12	2.35	0.04	0.04	2.09	1.37
T_3	6.89	6.18	68.40	40.13	1286	645	188	18	0.59	0.49	1.60	0.59	13.64	2.79	0.03	0.03	2.07	1.34
T_4	6.29	5.43	50.35	32.30	1560	952	108	10	0.46	0.45	1.38	0.58	3.53	1.29	0.03	0.04	1.84	1.31
T_5	6.40	5.64	54.53	36.47	1283	836	169	24	0.71	0.52	1.69	0.52	5.16	3.23	0.04	0.03	2.11	1.66
Level of Significance	ns	ns	**	ns	ns	*	*	*	ns	ns	ns	ns	***		*	ns	ns	ns
LSD ($p \leq 0.050$)	-	-	10.118	-	-	289.040	104.950	44.039	-	-	-	-	4.348		0.011	-	-	-

Table 46: Leaf nutrient levels of treatment palms

Treatment	Parameters					
	N %	P %	K %	Mg %	Ca %	Na %
T_1	2.35	0.19	1.57	0.23	0.46	0.07
T_2	2.35	0.18	1.59	0.25	0.47	0.07
T_3	2.33	0.17	1.67	0.23	0.17	0.08
T_4	2.28	0.18	1.66	0.20	0.44	0.06
T_5	2.15	0.18	1.48	0.24	0.47	0.04
Level of Significance	**	ns	ns	ns	ns	ns
LSD ($p \leq 0.050$)	0.141	-	-	-	-	-

Madampe site

The site for Sudu soil series has been selected at Madampe in this year. The site is in IL_3 Agro Ecological Region. The site falls into land suitability class S_4 (5,000 - 10,000 nuts/ha/yr).

The treatments of the site at Madampe are given in Table 47.

Table 47: Treatments of the Madampe site

T_1	Control - only APM-W
T_2	Cattle manure 50 kg per palm/yr
T_3	Cattle manure 75 kg per palm/yr
T_4	Cattle manure 100 kg per palm/yr
T_5	Gliricidia 50 kg per palm/yr
T_6	Gliricidia 75 kg per palm/yr
T_7	Gliricidia 100 kg per palm/yr

Basal dosage (g/palm/y)	-	Eppawela Rock Phosphate	900
		Muriate of Potash	1600
		Dolomite	1000

Plot demarcation was completed and preliminary nut yield recording is in progress.

N A Tennakoon, P Liyanage & F H A J R Silva

Experiment 30.1.3: Assessment of soil quality depletion in coconut lands in order to develop improvement resources (2005)

The objectives of the experiment were

i) To assess the depletion of soil quality in coconut lands after introduction of coconut
ii) To improve the soil quality in coconut lands

The experiment was established at 3 locations namely at Rathmalagara, Pallama and Walpita estates.

The Agro Ecological Region, land suitability classes and soil types of these locations are given in Table 48.

Table 48: Agro Ecological Regions, land suitability class and the soil types of the experimental sites

Location	AER	Land Suitability Class	Soil Series
Rathmalagara	IL_1	S_2 & S_4	Wilattawa (S_2) and Andigama (S_4)
Pallama	IL_3	S_2 & S_4	Wilattawa (S_2) and Andigama (S_4)
Walpita	WL_3	S_2 & S_4	Pallama (S_2) and Boralu (S_4)

Soil samples were collected from center squares of the coconut land and adjoining forest land which consist of S_2 and S_4 land suitability classes. Six sampling points were selected in each land suitability class in coconut lands as well as forest lands at two depths (0-20 cm and 20-40 cm). All together 72 soil samples were collected from coconut lands and forest lands at 3 locations.

Soil samples were analyzed for chemical, physical and biological parameters. Chemical and physical data at RE and Pallama sites were reported in Annual Report for 2006.

The chemical and physical data of Walpita site and bulk density values of 3 sites are given in Tables 49 and 50 respectively.

Table 49: ***Chemical and physical parameters at Walpita site***

			pH (1:5)	EC (µs/cm)	N	P	Na	K	Ca	Mg	Zn	Cu	Fe	Mn	Cl	OC %	CEC (meq/100g)
					◄(mg/kg)►		◄	(meq/100 g)		►	◄		(mg/kg)		►		
S_2	Forest	Top soil	5.35	41	413	15	0.024	0.17	0.55	0.21	1.15	0.28	39.22	15.31	15.60	0.63	3.50
		Sub soil	5.33	27	320	11	0.026	0.12	0.29	0.04	0.75	0.24	42.56	4.85	23.45	0.41	2.25
	Coconut	Top soil	5.16	20	261	12	0.025	0.13	0.31	0.08	0.72	0.29	36.35	5.97	14.40	0.42	2.30
		Sub soil	5.12	19	173	08	0.028	0.11	0.15	0.06	0.95	0.36	33.25	4.24	13.60	0.29	1.60
S_4	Forest	Top soil	5.45	78	2378	20	0.04	0.33	1.31	0.48	3.82	0.76	145.12	57.86	38.10	2.28	12.35
		Sub soil	5.30	39	1114	13	0.06	0.15	4.39	1.42	3.86	0.68	11.74	20.36	31.00	1.42	9.08
	Coconut	Top soil	5.30	45	758	12	0.04	0.26	0.57	0.29	1.00	0.46	67.33	21.89	16.56	1.05	3.87
		Sub soil	5.13	25	525	10	0.04	0.19	0.36	0.11	0.79	0.48	72.14	26.28	10.41	0.70	2.60

From the analytical data, it was evident that soil nutrient levels in the coconut growing area at Walpita estate were lower than forest soil. These values were lower than the tropical soil values, indicating that nutrient levels have depleted as a result of long term cultivation of coconut.

Table 50: Bulk density values (g/cm^3) of 3 sites (Mean values of 6 samples)

Site	Land suitability class S_2		Land suitability class S_4	
	Forest Land	Coconut Land	Forest Land	Coconut Land
Rathmalagara Estate	1.29	1.52	1.09	1.54
Pallama	1.26	1.58	1.20	1.60
Walpita	1.20	1.31	1.22	1.30

The bulk density of the soils is high in coconut lands compared with forest lands in 3 locations. High bulk density affects the penetration of coconut roots due to hardness of coconut soils.

MISCELLANEOUS STUDIES

I. ALTERNATIVE SOURCES CAPABLE OF SUPPLYING POTASSIUM FOR COCONUT

The demand for organic agricultural products is generally increase. Conventionally used commercial chemical fertilizers are not accepted by organic certification bodies. Most of the organic manures used in coconut cultivation are low in potassium. Therefore, a pot experiment was conducted to evaluate some locally available K sources to be used as K fertilizers.

Potassium sources used as treatments were coconut husk ash, feldspar, ground mica, wild sunflower; locally produced potassium fertilizer and muriate of potash (MOP). They were applied at recommended (L_1) and double the recommended K dosage (L_2). After establishment of treatments soil samples were analyzed for exchangeable K, Mg, Ca and Na.

Results of exchangeable K showed significant difference among the treatments up to three samplings. Highest exchangeable K was observed in locally produced K fertilizer followed by coconut husk ash and *Tithonia*. The values were 2.3, 1.9, and 1.0 in Meq/100 g respectively in three samplings at recommended rate. MOP did not show significant increase, compared to coconut husk ash and *Tithonia*. Ca levels were significantly higher in *Thithonia* applied treatment than all the other treatments at recommended rate of application.

When exchangeable Mg is considered, it did not showed clear pattern among treatments up to 9^{th} week eventhough it was significantly different among the treatments.

pH values were also showed significant differences among treatments. As a result of applied of *Tithonia,* locally produced K fertilizer and coconut husk, pH of the soil increased from 4 to the range of 6.5 - 7.5.

The applicant of Mica and feldspar treatments shows a trend of slowly increasing available nutrient which did not show significant increase compare to control in considered nutrient levels up to 9th week.

Considering overall results, it shows that *Tithonia,* coconut hush ash and locally produced K fertilizer show great potential to be used as fertilizer for coconut. Among them *Thithonia* has advantage with its possibility of direct application without undergoing any process of preparation and its multinational value.

However, it indicates that releasing pattern of slowly releasing materials need longer period of time for show its real fertilizer value.

W T U Perera, H M I K Herath & N A Tennakoon

II. EVALUATION OF GIRDLE SPRINKLER IRRIGATION SYSTEM FOR COCONUT PLANTATION

Irrigation has become an essential and important practice for coconut cultivation especially in Intermediate and Dry zones of Sri Lanka. Even through several methods have been recommended, none of those methods are been successfully practiced yet. The girdle sprinkler system is a new approach to solve the problems occurred in this area. The objective of this study was to develop a sustainable irrigation system for small scale coconut cultivation and to find out the best model through the study of field uniformity. The water distribution uniformity is the key parameters which was used to evaluate the system. Water distribution uniformity model [DU + (average low quarter flow rate/ overall average flow rate) x 100%)] was selected to calculate the uniformity value in the experiment.

The girdle sprinkler irrigation system was installed to one acre (64 palms) block at Ratmalagara Estate (RE), Madampe, a sub station of the Coconut Research Institute, Sri Lanka. The experiment was conducted during the period from August 2007 to December 2007. Half acre was installed with 16mm conduit pipe laterals and other half acre was installed with 20 mm PVC pipe laterals. Several modifications such as leveling, looping, testing with different pump capacities, shifting sub-main to the middle, testing with same girdle sprinkler were carried out in order to achieve to maximum distribution uniformity. Flow rate and pressure were measure to calculate the uniformity. A comparison was also carried out with drip irrigation system to evaluate the system.

The girdle sprinkler system with comprise with one horsepower, one inch water pump with sub-mainline in middle modification having 20mm PVC laterals girdle sprinkler irrigation system has 94.78% of distribution uniformity and the same system with 16mm conduit laterals girdle sprinkler irrigation system has 91.64% of distribution uniformity which shows an excellent distribution uniformity. Therefore this irrigation system is the best method for small scale coconut cultivation. Raw materials required to install the system are available in the local market. Therefore this system is economically viable and feasible to the coconut grower. This method requires very less amount of technical support to install and maintain the system.

Further more the distribution uniformity can be further increase by constructing girdle sprinklers with maintain accurate officers' diameter as 1mm.

Y Purusothaman, D P Panditharathana, L R M C Liyanage & N A Tennakoon

3. SERVICE FUNCTIONS

Differential Fertilizer Recommendation	-	130 growers (920 ha)
Land suitability tests for coconut cultivation/surveys	-	37 growers
Inorganic fertilizer analysis	-	210 samples
Organic fertilizer analysis	-	139 samples
Analysis of coir pith samples	-	856 samples
Soil analysis	-	1746 samples
Leaf analysis	-	1780 samples
Water analysis	-	15 samples

4. EXTENSION ACTIVITIES

Dr. N.A. Tennakoon participated as a resource person in 2 programmes on Usage of Eppawela Rock Phosphate for coconut held in Anamaduwa and Kobeigane organized by Phosphate Lanka (Pvt) Ltd, Colombo.

Dr. N.A. Tennakoon participated as a resource person on Fertilizer for coconut held in Gampaha organized by Lanka Fertilizer Corporation.

Dr. N.A. Tennakoon participated as a resource person in 3 of one day training programme on Fertilizer for coconut, Irrigation for coconut and Rehabilitation of coconut lands conducted by Coconut Research Institute.

Miss. M.K. Fathima Nadheesha and Mrs. H.M.I.K. Herath participated as resource persons in one day training programme on fertilizer for coconut conducted by Coconut Research Institute.

Mr. L.R.M.C. Liyanage participated as a resource person in one day training programme on Irrigation on coconut conducted by Coconut Research Institute.

5. ACKNOWLEDGEMENT

I sincerely thank the staff members of the Division for their support in carrying out the experiments smoothly and the Head and the staff of the Biometry Division for the assistance in designing field experiments and statistical analysis of data.

REPORT OF THE CROP PROTECTION DIVISION FOR 2007

Head – L.C.P. Fernando, PhD

1. GENERAL

Two recommendations; introduction of an electronic device to detect red weevil infested palms and application of 2% palm or vegetable oil and 0.5% sulphur mixture for the management of coconut mite were made (interim recommendation). A new disease outbreak, 'Weligama coconut leaf wilt disease' (WCLWD) was reported from all areas of Matara District and Habaraduwa AGA Division of Galle District.

The research programme of the Division was mainly focused on investigations on coconut mite, red weevil, black beetle, leaf rot disease and Leaf Scorch Decline disorder. The research on coconut mite involved studies on ecology of the pest and its natural enemies, identifying tolerant coconut cultivars and developing management strategies using biological and chemical methods. The study on population dynamics of coconut mite and the predatory mite, *Neoseiulus baraki* was modified to include determining fluctuation pattern of the other local predatory mite, *N. paspalivorus* in the previous study sites and new sites at Gampaha, Kurunegala and Lunuwila. Pest reached peak populations during June-August in Kalpitiya, Madurankuliya, Rajanganaya and Lunuwila, while it peaked in February at Gampaha and Kurunegala. Irrespective of the season, the highest number of 1103 mites/nut and the lowest of 545 mites/ nut were recorded from Kurunegala and Gampaha areas respectively. *N. baraki* was reported in all sites, but *N. paspalivorus* was predominantly and only reported from Gampaha area.

Development of most efficient method for field releases of *N. baraki* was continued. The pest population was not considerably reduced by releasing *N. baraki* at 2-, 4- and 6-monthly intervals at a rate of 5000 mites/ palm. However, the fraction of infested nuts and the fraction of half-priced nuts in 4 consecutive picks were lowest in the plot where predators were released at 2-monthly intervals. The fraction of infested button nuts was also lower in the same plot.

The collaborative project with the Industrial Technology Institute, Colombo to develop and test mycoacaricide formulations of the entomopathogenic fungus, *Hirsutella thompsonii* of coconut mite was continued. Two formulations, an alginate and corn starch-based powder compared with the rice medium at three sites showed no conclusive results. All three formulations did not have a considerable effect on coconut mite numbers and their infection rates were very low.

Field-testing of different doses of neem granules (Azadirachtin 1500ppm) and spraying of NeemAzal 1% (Azadirachtin 1%) were completed. The mean percentage of undamaged nuts in treated palms was significantly higher than the untreated palms at Wallawa. The highest percentage of undamaged nuts of 80.6% was present in palms treated with the highest dose of neem granules (120g) compared to 45% in the untreated control. The evaluation of the effect of root feeding of 10 ml of Neemraj supreme (Azadirachtin 10,000ppm) was completed. The pattern of damage levels in the three estates differed, but it showed that application of neemraj reduced the damage on harvested nuts at different degrees in different estates. The pilot trials on application of a mixture of 20% palm/ vegetable oil and 0.05% wettable sulphur indicated that the damage on young nuts was considerably reduced after the treatment. An experiment was initiated to determine the suitable frequency of application of this mixture.

Evaluation of four crosses; DY x SR, DG x SR, DY x T and DG x T at Ratmalagara estate was continued using the mite index. All crosses recorded higher tolerance levels compared to ordinary tall.

Financial support for coconut mite research was provided by coconut CESS, consolidated fund and CFC/DFID/FAO/APCC projects.

The CARP funded collaborative research project with Rinzen Laboratories (Pvt) Ltd. to develop an electronic device to detect red weevil infested palms was completed. The device consists of a sensor that could be easily mounted on the palm trunk, high quality signal processing unit, a play back sound clip of the real crunching sound and a set of earphones to hear the output noise. It is compact, light weight, convenient to use and powered by a single 9V battery. Field-testing proved that it could detect infested palms with an accuracy of 97%. The device was recommended to the coconut growers and manufacturing was commenced by the Rinzen Laboratories (Pvt) Ltd. A patent has being applied for the invention.

Evaluation of integrated pest management methods of *Oryctes* beetle viz. *Oryctes* pheromone, Green muscardine fungus (GMF), *Oryctes* virus (*Or*V), *Or*V+GMF and integration of all methods conducted under the CFC/DFID/FAO/APCC project was completed. There was no significant difference in the damage levels between different treatments, but it was lowest in the blocks installed with pheromone traps. Seventy five farmers and 30 Coconut Development Officers were trained on the technologies developed for on-farm production of green muscardine fungus, 75. The trainees were supplied with a basic tool kit and the inoculum for commencing production of green muscardine fungus.

A Preliminary survey conducted to collect natural enemies of *Plesispa reichei* did not reveal any.

An experiment was commenced to study the effect of palm nutrition on leaf rot affected palms at 3 sites in Matara District by applying 50 kg of compost per palm in addition to the normal fertilizer dose. No considerable improvement in the treated palms was observed.

Using Polymerase chain reaction (PCR) with phytoplasma specific primers it was confirmed that the causal agent for Weligama leaf wilt disease (WLWD) is a phytoplasma. A study on the effect of oxy-tetracycline on remission of symptoms in WLWD-affected palms was commenced.

The repeat study using gas liquid chromatography method to determine the presence of acids produced by *Fusarium* spp. in the cell sap of Leaf Scorch Decline-affected palms and healthy palms indicated that LSD-affected palms had higher levels of Zearalenone and Fusaric acid compared to healthy palms. The study initiated to determine the effect of root pruning at different intervals on the remission of symptoms continued.

The Division continued to serve the coconut growers during the year. Advice on management of pests and diseases were given while field inspections were made in instances where specialized advice was required. A leaf blight epidemic of coconut seedlings were successfully managed using fungicides.

2. RESEARCH PROJECTS

PROJECT 27: CONTROL OF COCONUT MITE, *ACERIA GUERRERONIS* (1999)

Experiment 27.11: Studies on population fluctuations of coconut mite, *Aceria guerreronis* and the predatory mite, *Neoseiulus baraki* (1999)

The study conducted to determine the annual and seasonal population fluctuation pattern of coconut mite and its predatory mite, *Neoseiulus baraki* was modified to include determining the seasonal population pattern of the other local predatory mite, *N. paspalivorus*. The experiment was conducted in Kalpitiya, Madurankuliya, Rajanganaya, Gampaha, Kurunegala and Lunuwila. In each area, nuts were collected from 3 coconut mite infested sites (10 nuts from 10 palms in each site) in February, June, August and November, which are correspondent to the dry, wet but less intense rainfall, dry and wet with intense rainfall periods respectively.

Populations of both pest and predator fluctuated over time in all sites. Pest reached peak populations during June-August in Kalpitiya, Madurankuliya, Rajanganaya and Lunuwila while it peaked in February in Gampaha and Kurunegala (Fig. 1). Irrespective of the season, annual mean number of coconut mites was highest in Kurunegala (1103 mites/nut) and lowest in Gampaha (545 mites/nut). *N. baraki* was reported in all sites, but *N. paspalivorus* was predominantly and only reported from Gampaha area (Table 1). Fluctuations of *N. baraki* or *N. paspalivorus* did not follow the fluctuation pattern of the coconut mite.

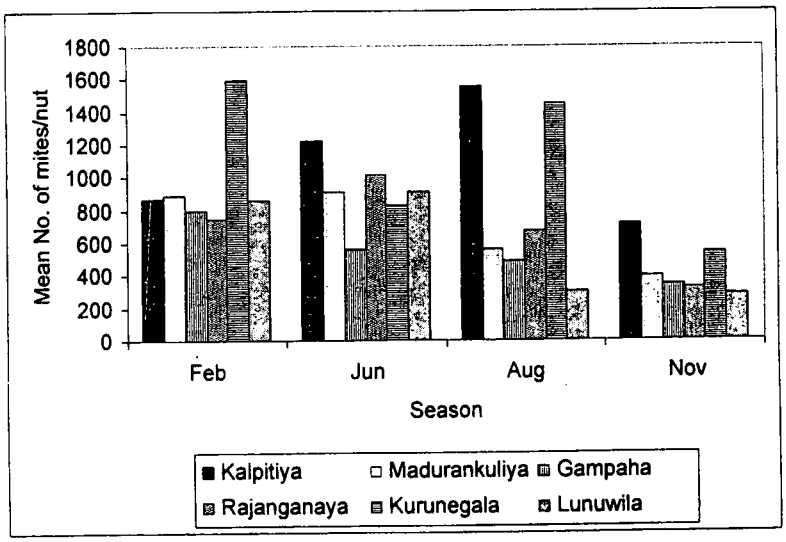

Figure 1: Seasonal population fluctuation of coconut mite in 2007

Table 1: ***Mean number of N. baraki and N. paspalivorus per nut in February, June, August and November, 2007***

Site	*N. baraki*				*N. paspalivorus*			
	Feb	June	Aug	Nov	Feb	June	Aug	Nov
Kapitiya	8	6	6	4	0	0	0	0
Madurankuliya	7	15	12	3	0	0	0	0
Gampaha	0.4	0	0	0	9	6	7	5
Rajanganaya	10	7	11	7	0	0	0	0
Kurunegala	18	11	6	10	0	0	0	0
Lunuwila	11	6	8	14	0	0	0	0

N. S. Aratchige, K. F. G. Perera & P. H. P. R. de Silva

Experiment 27.70: Determination of frequency of release of *N. baraki* in the field (2006)

A study that was conducted in Weragoda Estate, Pallama to determine a suitable frequency for releasing *N. baraki* in the field to control the coconut mite was replicated in another estate at Mangalaeliya. Four 1 ac. plots (at least 6 rows away from each other) were selected in each estate. Ten coconut mite infested-palms from each plot received 5000 predatory mites/palm and the releases were repeated either at 2-monthly or 4-monthly or 6 monthly intervals in each plot. Control plot was maintained without release of *N. baraki*. Before releasing the predatory mites, one pre-release sample was collected (one week before the first release), 1 nut from the 4 or 5-month old bunch of each of the released palms, 5 adjoining palms and control palms in Weragoda estate. After releasing predatory mites, 1 nut from 4 or 5-month old bunch of palms was sampled at 2 weeks after release and thereafter once in 2 months until 8 months after the first release in Weragoda estate. Total number of eggs and other stages of predatory mites and the total pest population were assessed.

However, it was found that the effect of release of predatory mites at different frequencies was not reflected considerably by mite census (Fig. 2). Hence, mite census was not collected from the Mangalaeliya estate. Four months after the 1st release matured nuts were harvested at 2 monthly intervals and total number of infested nuts, un-infested nuts, full-priced nuts, half-priced nuts and barren nuts were counted from each palm.

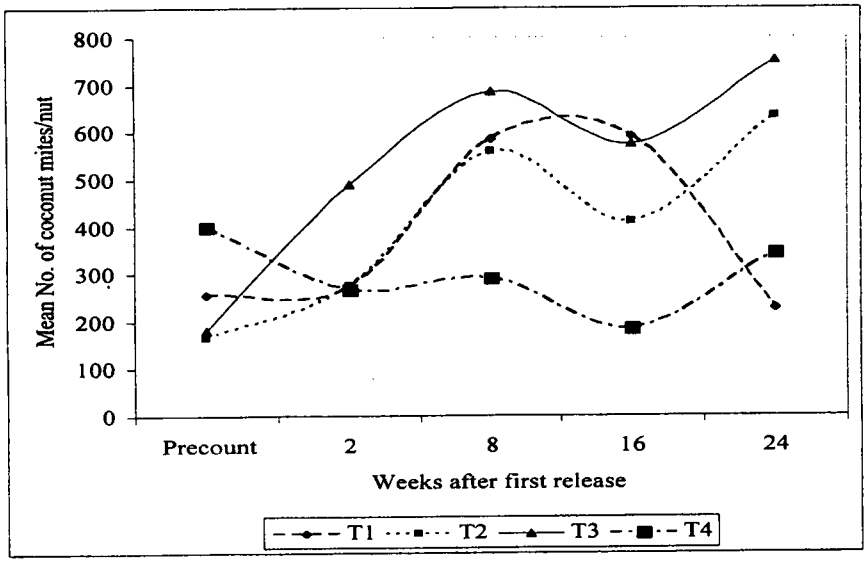

Figure 2: Fluctuation of coconut mites in plots that received predatory mites at 2-monthly (T1), 4-monthly (T2), 6-monthly (T3) and control (T4) in Weragoda estate, Pallama (n=10 palms)

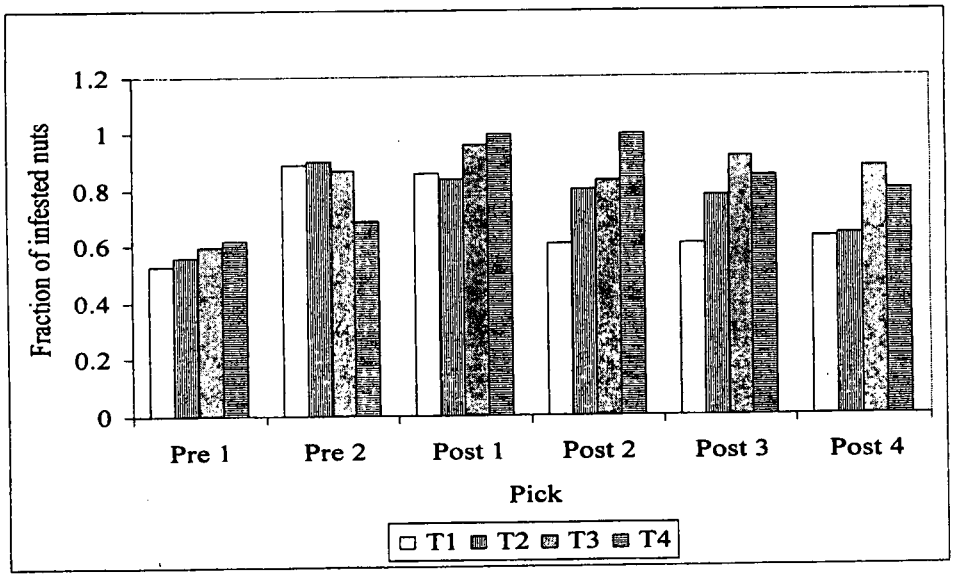

Figure 3: Fraction of infested nuts in the harvest in plots that were released with predatory mites at 2-monthly (T1), 4-monthly (T2), 6-monthly (T3) and control (T4) in Weragoda estate, Pallama (n=10 palms)

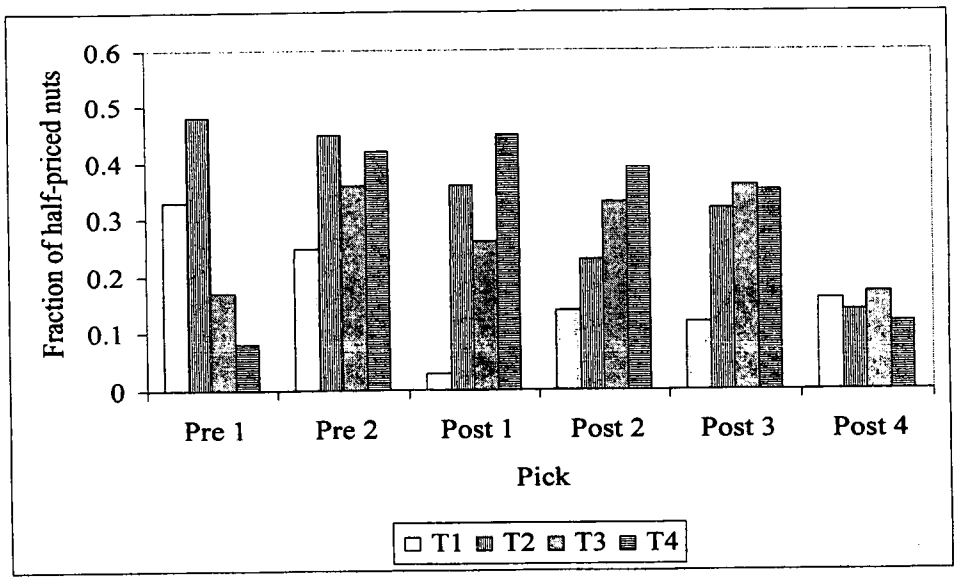

Figure 4: Fraction of half-priced nuts in the harvest in plots that were released with predatory mites at 2-monthly (T1), 4-monthly (T2), 6-monthly (T3) and control (T4) in Weragoda estate, Pallama (n=10 palms)

In Weragoda estate the fraction of nuts without damage by mites (on 3 or 4 or 5-month old bunch) was not different among treatments. However, the fraction of infested nuts (Fig. 3) and the fraction of half-priced nuts (Fig. 4) in 4 consecutive picks were lowest in the plot where predators were released at 2- monthly intervals. The study is in progress.

N. S. Aratchige, A. D. N. T. Kumara, K. F. G. Perera, C. Wijesinghe, & C. Hettiarachchi

Experiment 27.81: Determination of rate of release (number of palms/ac) of *N. baraki* in the field (2007)

A study was commenced in Katana estate at Mundel to determine the suitable number of palms per acre for the release of *N. baraki* in the field to control coconut mite. Four 1 ac. plots (at least 8 rows away from each other) were selected. In each plot of 1 ac. either 16 or 11 or 6 palms were selected for the releases. On each palm, approximately 5000 predatory mites were released at 2-monthly intervals. Before releasing the predators, one pre-release nut sample was collected, 1 nut from the 5 month old bunch of each palm to evaluate the total number of coconut mites and the total number of predatory mites. Furthermore, before releasing predatory mites and at monthly intervals thereafter, the total numbers of infested nuts, un-infested nuts, full-priced nuts, half-priced nuts and barren nuts in the harvest were counted from every palm in each plot. Total numbers of nuts, infested nuts and damaged-discontinued button nuts (on 3-, 4- and 5-month old bunches) were counted before releasing the predatory mites and at 3-monthly intervals after releasing the mites. At the end of October, 2007 only the pre-release parameters were taken and the experiment is in progress.

N. S. Aratchige, A. D. N. T. Kumara, K. F. G. Perera, C. Wijesinghe, & C. Hettiarachchi

Experiment 27.63: Determination of frequency of application of *H. thompsonii* in the field (2005)

The study conducted to determine the suitable frequency of application of the isolate H/2 was completed in 2 sites at Ariyagama (intermediate zone) and Manchadi estate (dry zone).

With respect to the effect of the treatments on damage levels, the two estates did not show a consistent pattern. At Ariyagama, the percentage of undamaged nuts was significantly higher on the treated palms than that on the untreated palms, irrespective of the application interval. The percentage of nuts with discontinued damage was significantly higher on treated palms than on untreated palms while the percentage of nuts with continued damage was significantly lower on the treated palms than on the untreated palms, which indicate the positive effect of the treatments. Also, the percentages of damaged-smaller nuts (half-priced) were almost half and significantly lower in the treatments than in the control (Table 2). The two application intervals were not significantly different with respect to the above damage categories. At Madurankuliya, the percentage of damaged-smaller sized nuts was significantly lower in the two treatments than in the untreated control (Table 3). The study suggested that application of *H. thompsonii* at either 2- or 3-monthly intervals reduce the damage level at harvest. However, the cost-benefits of the applications need to be determined.

Table 2: ***Percentage of fruits (S.E) in different damage categories at harvest, after application of H. thompsonii at 2- and, 3-monthly intervals and in untreated control at Ariyagama.***

Damage category	2-monthly	3-monthly	control
Undamaged (A)	0.23±0.01A	0.23±0.01A	0.12±0.02B
Damaged-discontinued (B1)	0.34±0.03A	0.37±0.03A	0.16±0.9B
Damaged-continued (B2)	0.19±0.03A	0.22±0.03A	0.41±0.04B
Damaged-small size (C1)	0.15±0.12A	0.12±0.18A	0.24±0.03B
Damaged-deformed (C2)	0.06±0.01	0.03±0.01	0.05±0.01

Table 3: ***Percentage of fruits (S.E) in different damage categories at harvest after application of H. thompsonii at 2- and, 3-monthly intervals and in untreated control at Madurankuliya.***

Damage category	2-monthly	3-monthly	control
Undamaged (A)	0.14±0.01	0.18±0.01	0.16±0.01
Damaged-discontinued (B1)	0.22±0.03	0.20±0.03	0.19±0.03
Damaged-continued (B2)	0.50±0.03	0.46±0.03	0.48±0.03
Damaged-small size (C1)	0.07±0.01A	0.07±0.01A	0.11±0.01B
Damaged-deformed (C2)	0.03±0.01	0.04±0.01	0.03±0.01

L.C.P. Fernando, D. C. L. Hapuarachchi & P. Damayanthi

Experiment 27.82: Pilot study to confirm the effectiveness of application of *H. thompsonii* at 3-monthly intervals (2007)

Based on the results of the above study, a pilot trial was commenced in an estate at Ududaddawa to confirm that 3-monthly application of *H. thompsonii* reduce the damage levels of developing nuts and harvested nuts. Two plots, each of 80 coconut mite infested palms were selected. In one plot, the palms are being sprayed with *H. thompsonii,* grown on rice medium at 3-monthly intervals. The other plot was kept as untreated control. In each plot, 20 palms were randomly marked and the 3-5 month old bunches were tagged and the total number of nuts and the number of damaged nuts on each was recorded. Subsequently, at 3-monthly intervals, bunches up to the 3-month old bunch was tagged and the total number of nuts and the number of damaged nuts were recorded. Also, the same data were recorded on the previously tagged bunches on the same palm. The study is in progress.

L.C.P. Fernando, D. C. L. Hapuarachchi, P. Manoj & P. Damayanthi

Experiment 27.83: Preliminary studies to determine effectiveness of *H. thompsonii* formulations (2007)

For large scale application of *H. thompsonii* it is required to develop a mycoacaricide formulation that could be stored and used conveniently by the growers. A collaborative research project was initiated with the Industrial Technology Institute, Colombo in this respect. Several formulations developed by the ITI were field tested.

In the first experiment, one formulation (filtrate of the fungus) and fungus grown on rice supplied by ITI were tested along with the fungus grown on the liquid medium and on rice at CRI. Twenty five palms were selected at Bandirippuwa estate and each treatment was applied on 3-5 month old bunches of randomly selected 5 palms. From each fungus preparation 10^6-10^7 ml^{-1} spore suspensions were sprayed. Another 5 palms were kept as untreated control. Prior to application of treatments, one 4-month old nut from each palm was picked and the number of live mites was assessed. Also, 20 dead mites were incubated and the number of mites with mycosis due to the fungus was recorded. After the treatment, at every 2 weeks up to 8 weeks, the same observations were taken on one nut from 3, 4 and 5 bunches of each palm. The results were not encouraging. In the nuts treated with rice formulations, the sharp drop in the mean number of live mites were observed one week after the treatment, but in other formulations no considerable reductions were observed (Fig. 5). The infection by the fungus was recorded on treated nuts, but it was below 30% always.

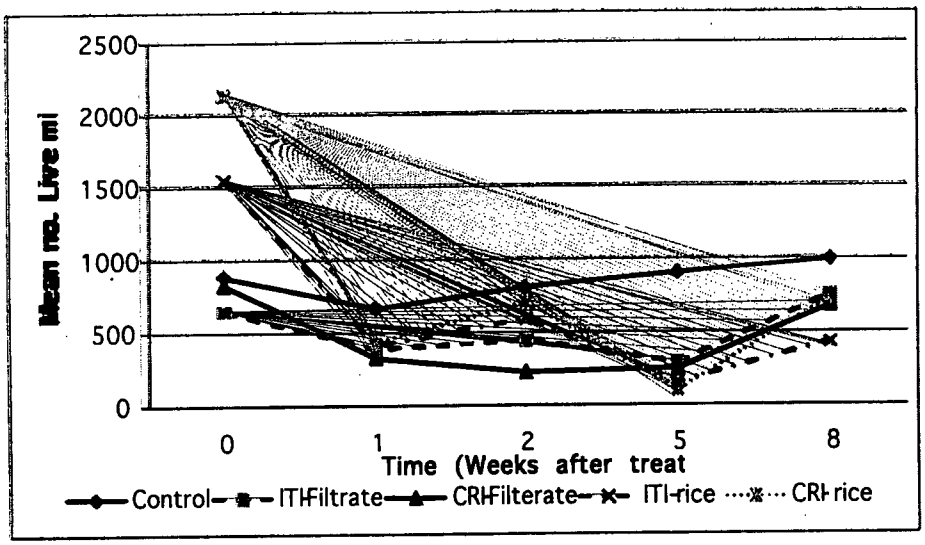

Figure 5: Mean number of live mites present on nuts treated with four preparations of H. thompsonii over time at Bandirippuwa estate.

The second experiment was conducted at Rathmalagara estate. Three formulations (dust, alginate and emulsion) supplied by ITI and the fungus grown on rice were compared. Spore suspensions of 10^6-10^7 ml^{-1} were prepared from each medium and sprayed on 3-5 month old bunches of 5 palms, from each suspension. The method described in the previous experiment was followed in collecting nuts and assessing the total number of live mites and the infection due to the fungus. There was no considerable difference among the treatments were observed. The nuts treated with the alginate showed reduction in the mite population up to 4 weeks after the treatment as well as the nuts treated with the rice medium (Fig. 6).

The third experiment was conducted at an estate in Kuliyapitiya. In there, the alginate and the rice medium were compared with the untreated control. Also, the dust formulation was compared with the control in the same location. In the experiment, 2-4 month old bunches of 10 palms were sprayed with the spore suspensions of each preparation. The data was collected as above, up to 8 weeks from the treatment. There was no considerable difference in the mean number of live coconut mites between treatments of alginate, rice and control (Fig. 7). Compared to the control, nuts treated with the dust formulation showed a decline in the mite population over time (Fig. 8).

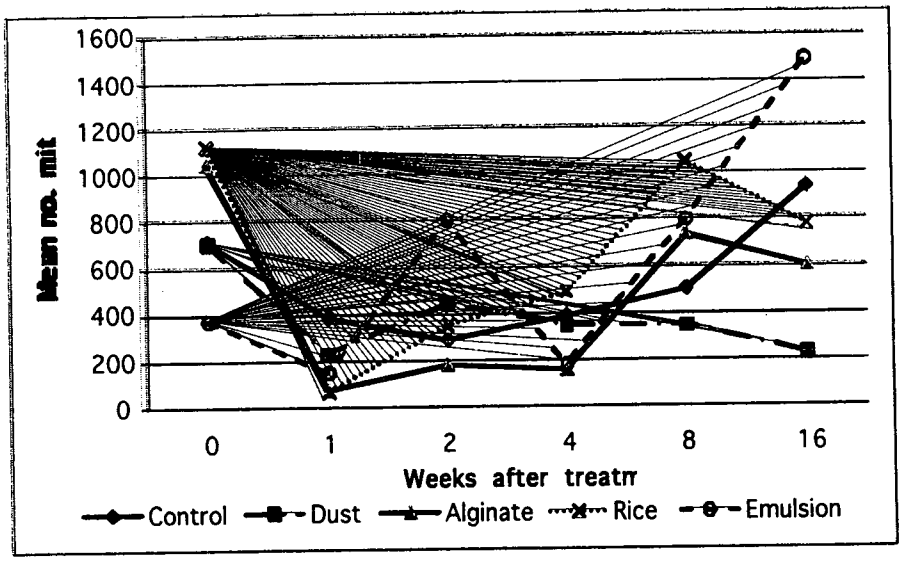

Figure 6: Mean number of live mites present on nuts treated with four preparations of H. thompsonii over time at Bandirippuwa estate.

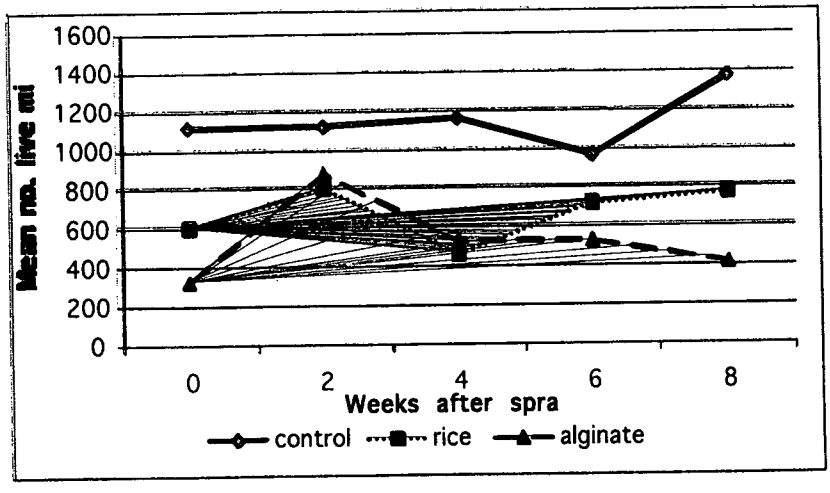

Figure 7: Mean number of live mites present on nuts treated with alginate formulation, rice preparation of H. thompsonii and on untreated nuts over time at Kuliyapitiya.

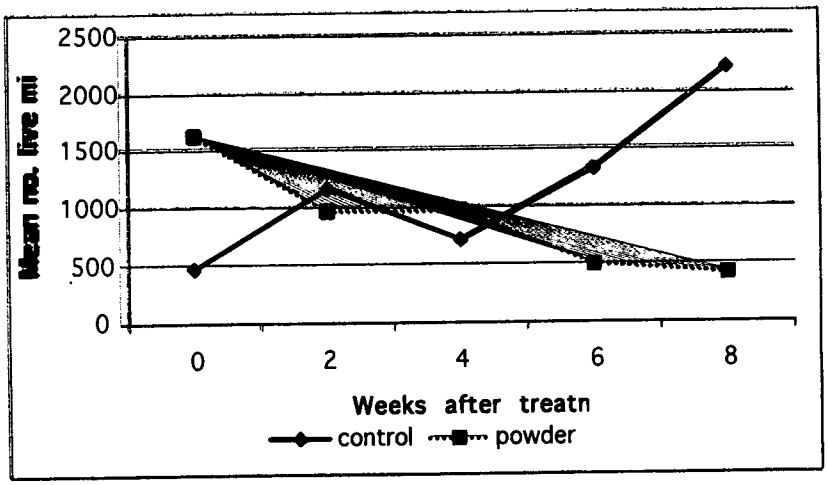

Figure 8: Mean number of live mites present on nuts treated with powder formulation of H. thompsonii and on untreated nuts over time at Kuliyapitiya.

The results are being statistically analysed. Since, the results of these trials are not conclusive the experiments will be repeated.

L.C.P Fernando, D.C.L. Hapuarachchi, P.Damayanthi & Dr. R. Samarasekara (ITI)

Experiment 27.84: Determination of frequency of application of palm oil and sulphur mixture (2007)

It has been confirmed that 20% palm oil and 0.5% wettable sulphur mixture is effective in managing the coconut mite. Hence, a study was commenced at FNF estate, Madurankuliya and Isolated Seed Garden, Ambekelle to determine the frequency of application of this mixture. In each estate 3 application frequencies; 2 (March and August), 3 (March, June and August) and 4 (March, June, August and January) times a year were tested. For each treatment at FNF estate, 27 coconut mite infested palms in 3 blocks of nine palms were selected. Similarly at ISG, 30 palms were selected in 3 blocks. A similar number of palms were used for the untreated control. From each block, 3 palms were randomly selected and marked for collection of damage assessment data. On the marked palms, 3- and 4- month old bunches were labeled before commencement of treatments. On these bunches the total number of nuts and the number of damaged nuts were recorded. Thereafter, at every 3 months the same data were collected on the marked bunches, until bunches are about 9 months old, on which data collection is impossible. Also, at the same time, bunches from the last labeled bunch up to the 3-month old bunch was labeled and above data was collected. The study is in progress.

L.C.P. Fernando & K.A.S. Chandrasiri

Experiment 27.65: Effect of spraying a mixture of palm oil and sulphur for the management of coconut mite (2005)

The pilot trial to confirm the effectiveness of spraying a mixture of palm oil and sulphur in the management of coconut mite by quantifying the reduction in damage on developing nuts and harvested nuts was continued in 4 estates. At Nikadalupotha and Nattandiya, each of 30 palms were treated at 3-monthly and 6-monthly intervals, while the blocks at Hettipola and Kobeigane were treated at 6-monthly intervals. From each block, 20 palms were selected and damage assessment on 3 and 4-month old bunches taken at 3-monthly intervals was completed. The assessment of damage on harvested nuts was commenced.

The results indicated that spraying with palm/vegetable oil mixture reduced the damage on developing nuts, either applied at 3- or 6-monthly intervals (Figs. 9 &10). On treated palms generally, the damage declined over time (with some exception at 6 months), whereas on untreated palms no such reduction was observed. The sites at Kobeigane and Hettipola also showed the same trend in damage levels. The results are being analysed.

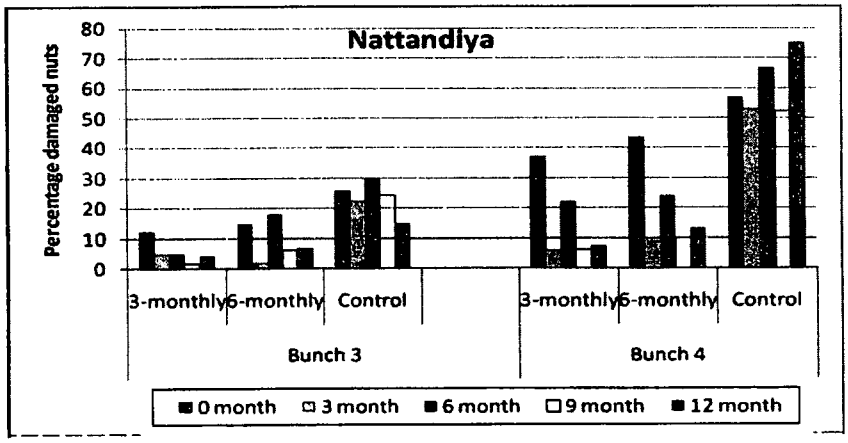

Figure 9: Percentage damaged nuts on 3- and 4-month old bunches in treated and untreated palms at 3- and 6-monthly intervals up to 12 months of treatment at Nattandiya

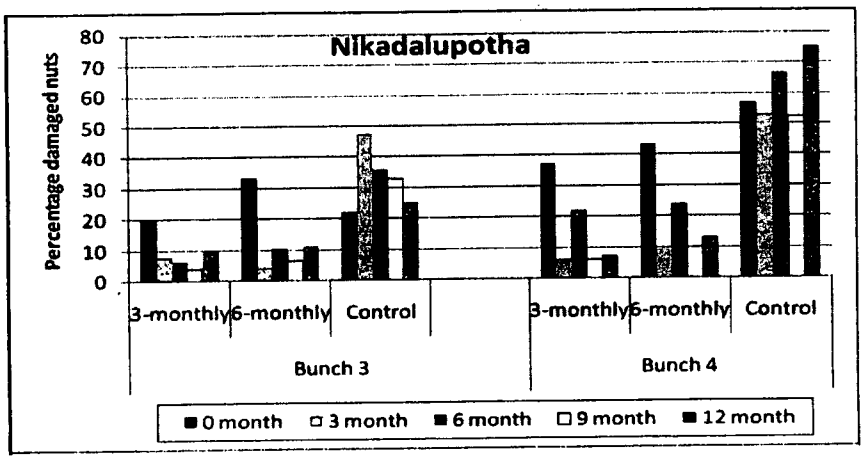

Figure 10: Percentage damaged nuts on 3- and 4-month old bunches in treated and untreated palms at 3- and 6-monthly intervals up to 12 months of treatment at Nikadalupotha

L.C.P. Fernando & K.A.S. Chandrasiri

Experiment 26.75: Screening of Neem granule and NeemAzal 1% against coconut mite (2006)

Evaluation of the effect of different doses of neem based granules (Azadirachtin 1500ppm) and NeemAzal 1% (Azadirachtin 1%) on 15-20 years old palms in two estates at Wallawe and Heraliyawala in the Kurunegala District was completed. In each estate, 5 treatments were done on each of 6 randomly selected palms at three-monthly intervals. The treatments were soil application of neem granules (1500ppm) at doses of 80g, 100g and 120g per palm, spraying of NeemAzal 1% (5ml/palm) and untreated control.

In the analysis, mean number of mites at pre treatment was taken as the covariate and post treatment data were adjusted accordingly. Consistent results were not obtained in the 2 estates. The total numbers of coconut mites fluctuated over time in all the treatments. There was no significant difference among the treatments at Wallawe for mean number of total mites while at Heraliyawala it was significantly different ($p<0.001$). In both estates, mean number of total mites in the untreated control was higher than other treatments (Table 4). The mean percentage live mites were significant among the treatments at Wallawe ($p<0.001$), but at Heraliyawala it was not so. In both estates, percentage live mites were higher in the untreated control palms (Table 4).

The percentage of undamaged nuts in the new developing bunches of each palm in the treatments after 9 months (after 3 rounds of treatments) significantly differed in Wallawe (Table 5), but not in Heraliyawala estate. In Wallawe, the highest percentage of undamaged nuts was present in palms treated with neem granule (120g) and there were no differences with other neem granule treatments. At Heraliyawala estate the same results did not hold due to the high variation of the results. The highest percentage of undamaged nuts was recorded in the NeemAzal treatment followed by neem granule treatments. The percentage of undamaged nuts in the neem granule

120 g treatment at 9 months was less than that of 6 months due to an experimental error. However, the percentage of undamaged nuts was higher in the treatments than in the untreated control.

Table 4: ***Adjusted mean number of total mites and mean percentage of live mites in different treatments at Wallawe and Heraliyawala***

Treatment	Total mites		Percentage live mites	
	Wallawe	Heraliyawala	Wallawe	Heraliyawala
Neem granules 80g	115.5	18.2A	54.4A	42.9
Neem granules 100g	221.3	230.2B	52.3A	65.5
Neem granules 120g	99.4	9.2A	46.4A	50.5
Neemazal	89.9	3.2A	39.2A	44.9
Control	734.6	367.0B	87.3B	72.5
Significance	NS	P<0.001	P<0.001	NS

Table 5: ***Mean percentage of undamaged nuts in different treatments at Wallawe and Heraliyawala***

Treatment	Mean % healthy nuts / palm ± standard deviation		
	3 month after treatment	6 month after treatment	9 month after treatment
Wallawa estate			
Neem granule (80 g)	26.06±7.33^{A}	46.77±10.93^{A}	58.31±9.23^{A}
Neem granule (100 g)	40.20±7.33^{A}	48.83±10.94^{A}	68.84±9.23^{B}
Neem granule (120 g)	24.31±9.12^{A}	59.44±10.98^{A}	80.59±9.27^{B}
NeemAzal (5ml/ l)	38.091±7.35^{A}	52.21±10.96^{A}	46.33±9.24^{A}
Control	28.87±7.36^{A}	34.16±10.97^{A}	44.95±9.25^{A}
Significance	NS	NS	**
Heraliyawala Estate			
Neem granule (80 g)	37.60±09.94^{A}	69.12±10.00^{A}	48.80±10.03
Neem granule (100 g)	27.46±07.33^{A}	47.65±10.23^{A}	67.64±19.53
Neem granule (120 g)	26.77 ±10.04^{A}	56.75±10.10^{A}	48.10±07.82
NeemAzal (5ml/ l)	28.99±10.07^{A}	58.01±10.13^{A}	67.89±12.91
Control	28.04±10.09^{A}	40.77±10.15^{A}	34.99±10.20
Significance	NS	NS	NS

The results suggested that application of neem granule 120g is more effective in reducing the damage and pilot trial would be necessary to confirm this.

A. D. N. T. Kumara, L. C. P. Fernando, N. A. A. M. Nissanka, W. A. C. Wanigasekara & N. G. Premasiri

Experiment 26.76: Evaluation of the efficacy of Neem granule against coconut mite (2007)

In a previous study, it was suggested that applying 120g of neem granules effectively reduces the damage nuts on treated palms. Therefore, a pilot trial was commenced to confirm this finding. Half-acre blocks (app. 34 palms) were selected at Mundel and one block was treated at 3-monthly intervals, and another one at 6-monthly intervals, while the rest was kept as the untreated control. From each block, 15 palms were selected and damage assessments in 3-, 4- and 5-month old bunches were taken at 3-monthly intervals. Pick records were taken to assess the impact of the treatment. The study is in progress.

A. D. N. T. Kumara, L. C. P. Fernando, and N. G. Premasiri

Experiment 26.77: Screening of Neemraj Supreme against coconut mite (2006)

Evaluation of the effect of root feeding of Neemraj supreme (Azadirachtin 10000ppm) at the dose of 10ml Neemraj + 10 ml at 3-monthly intervals against coconut mite at Mundel, Mangalaeliya, and Rajakadaluwa in the Puttlam District was completed.

The results of covariate analysis showed that in both estates the total mite population and percentage live mite percentage in the treated palms were not significantly different with compare to the control palms (Table 6). However, with time percentage of undamaged nuts in the developing bunches of treated palms were significantly higher than the untreated palms at Mangalaeliya and Rajakadaluwa but not at Mundel (Table 7).

Table 6: ***Adjusted mean number of total mites and mean percentage of live mites in different treatments at Mundel and Rajakadaluwa.***

Treatment	Total mites		Percentage live mites	
	Mundel	Rajakadaluwa	Mundel	Rajakadaluwa
	170.71	104.58	54.51	62.43
Control	219.20	145.47	57.17	62.15
CV	53.43	63.63	55.97	53.21
Significance	NS	NS	NS	NS

Table 7: ***Adjusted mean percentage of damage nuts in new developing bunches in different treatments at Mundel, Rajakadaluwa and Mangalaeliya.***

Treatment	Mundel	Rajakadaluwa	Mangalaeliya
Neem Raj 10ml	53.30	54.37	49.04
Control	55.60	63.13	67.75
CV	20.23	28.45	25.77
Significance (P<0.001)	NS	**	**

The percentage of damaged nuts at harvest in the treated palms was lower than the control palms in three estates (Fig. 11). However, it was significantly different only at Mundel (p= 0.03). The percentage of full-priced nuts at harvest was increased with time and always it was higher than the control, but was not statistically significant in all three estates (Fig. 12). In considering the percentage of nuts rejected due to mite damage, there was a reducing trend compared to the control and with time (Fig. 13). However, this effect is not comparable with that of the current recommendation.

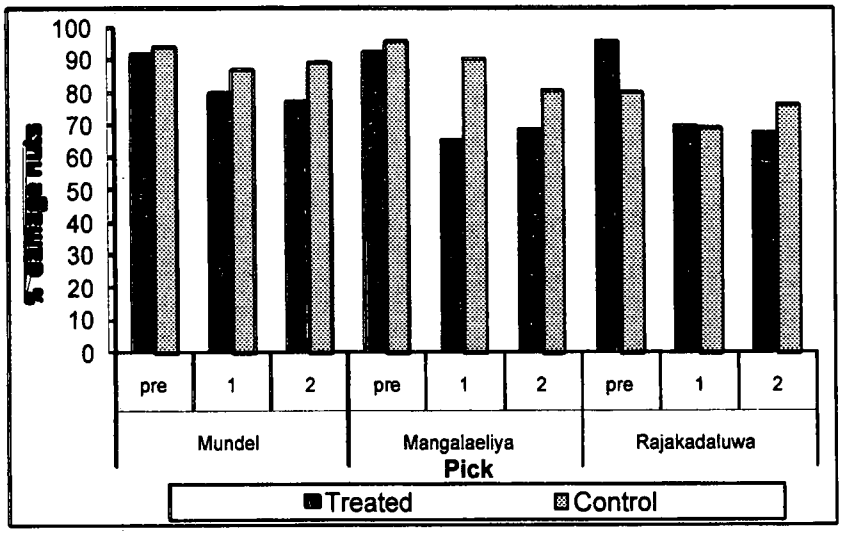

Figure 11: Percentage of damaged nuts at harvest in three estates

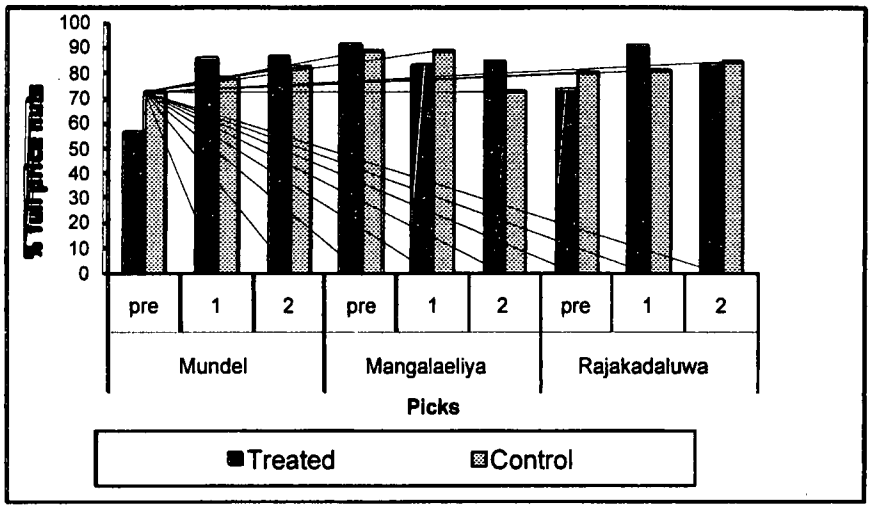

Figure 12: Percentage of full-priced nuts at harvest in three estates

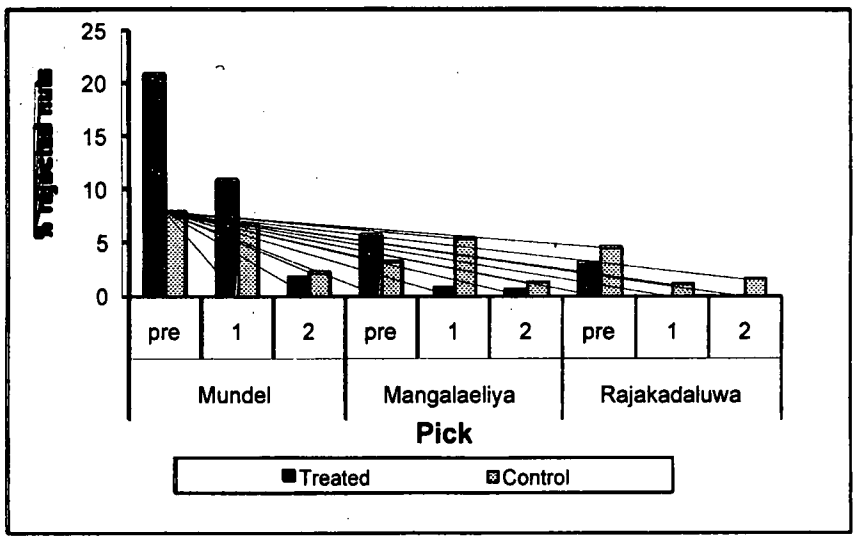

Figure 13: Percentage of nuts rejected at harvest in three estates

A. D. N. T. Kumara, L. C. P. Fernando, N. A. A. M. Nissanka, W. A. C. Wanigasekara & N. G. Premasiri

Experiment 27.77: Evaluation of the resistance/tolerance level of parental material at Ambakelle Seed Garden for coconut mite (2005)

In the previous year it was shown that the dwarf yellow (DY) coconut variety, which is a mother parent for producing hybrid CRISL 65, was more tolerant to coconut mite damage than green dwarf (DG) and tall varieties. Since, it had been observed that morphological differences occur within DY form, based on morphology of the palm, the entire dwarf yellow population has been classified in to three groups. In order to find out whether there would be a difference in mite incidence among these three groups, an assessment was conducted using the index developed for assessing the mite incidence in palms.

Results indicated that the palms did not vary among the three groups (Fig. 15). It indicated that the morphological differences that have been observed, therefore do not contribute towards a difference in the mite incidence on the nuts. Hence, with regard to the tolerance for mite damage, any palm within the block may be used as a mother parent in producing the hybrid seeds.

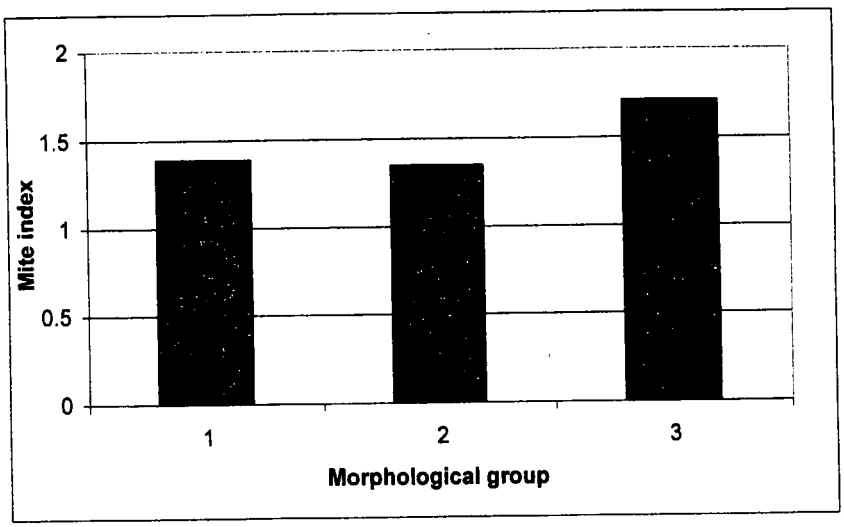

Figure 15: Mite index of three morphological groups within DY form

I. R. Wickramananda, A. F. L. K. Perera (GPB) & W. Mangala Nissanka

Experiment 26.78: Screening of three coconut varieties for coconut mite tolerance in Bandirippuwa Estate (2005)

Preliminary observations at Bandirippuwa Estate indicated that the Gon Thembili had a lower incidence of initiation and subsequent expression of symptoms on the fourth bunch and therefore, would be a potential tall form tolerant to mite damage. This observation was verified by making an assessment of the mite incidence on palms using the mite index that was developed in the previous year. The index of Gon Tembili was recorded in comparison with ordinary tall and San Ramon (SR).

Results showed that the color form Gon Tembili had the lowest index ($P<0.05$), which indicates a low level of mite damage on nuts. The index increased in the order of Gon Tembili (GT), San Ramon (SR) and Tall (T) (Fig. 16) showing a decreasing order of tolerance in the three varieties.

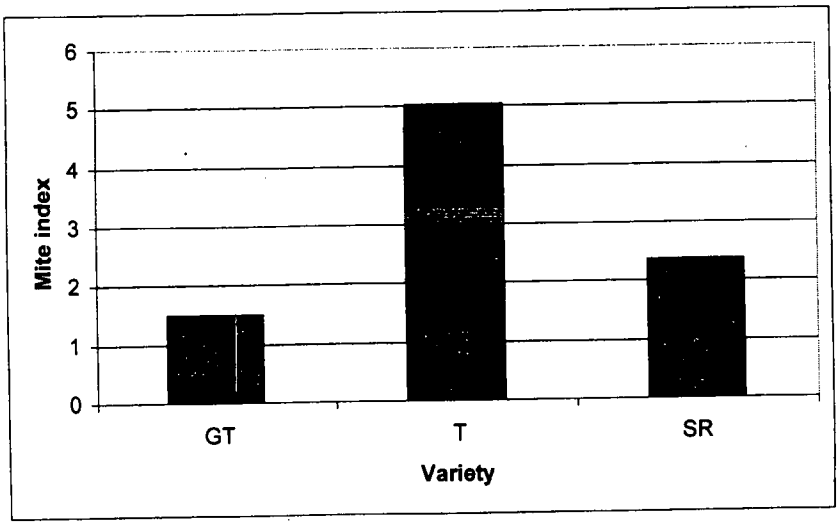

Figure 16: Mite index of three tall forms at Bandirippuwa Estate

I. R. Wickramananda, A. F. L. K. Perera (GPB) & Mangala Nissanaka

Experiment 26.79: Screening of four coconut cultivars for tolerance against coconut mite Ratmalagara Estate (2006)

Four crosses that have been established as observational plots at Ratmalagara Estate, Madampe were in the mite infested fields within the estate, but the incidence has been low. The crosses under consideration are Dwarf Yellow X San Ramon (DYSR), Dwarf Green X San Ramon (DGSR), Dwarf Green X Tall (DGT) and Dwarf Green X San Ramon (DGSR). A study was conducted to assess the mite incidence of these four cultivars in comparison with the ordinary tall plantation in an adjacent block by recording the mite index three times at four- monthly intervals.

Interestingly, both of the two hybrids DY X SR and DY X T of mother parent Dwarf Yellow, color form and DGSR had low indices mite damage in comparison to DG X T even though the differences were statistically not significant. Further, all four crosses had significantly low indices ($P< 0.05$) in comparison to Ordinary Tall (Fig. 17). The study will be continued.

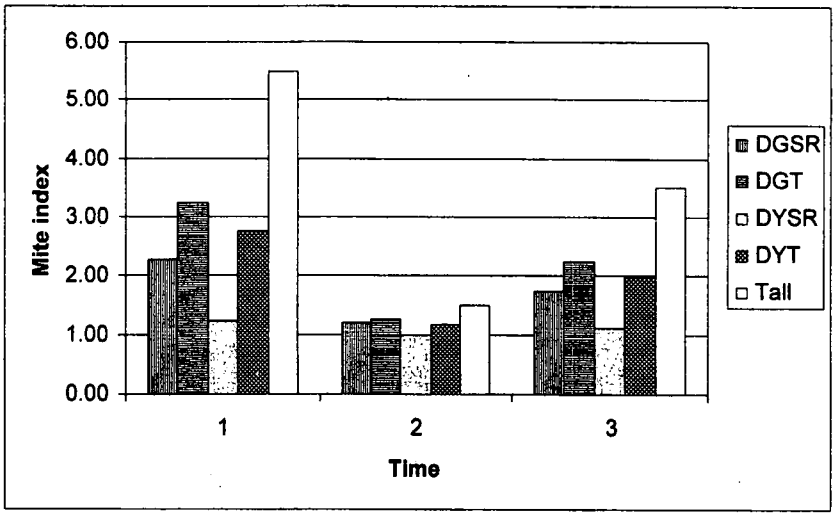

Figure 17: Mite index of four improved cultivars and Ordinary Tall

I. R. Wickramananda, A. F. L. K. Perera (GPB), W. M. Pushpakumara & N. G. Ruwantha

PROJECT 26: IMPROVEMENT OF THE ELECTRONIC DEVICE TO DETECT RED WEEVIL INFESTED PALMS (1998)

Experiment 26.2: Improvement of the electronic device to detect red weevil infested palms (2005)

The improved final device was tested at Nagahawatte, Wilpotha (Puttalum District) and Pimburettawa (Polonnaruwa District). In the selected blocks heavily infested sections of the blocks were examined. Each palm was checked as described in the previous year. Symptoms present on the palms were recorded as clearly visible or hardly visible to the grower.

Out of the 159 palms checked, 103 palms showed symptoms of infestation. Out of 103 palms showed symptoms, 97.1% palms were accurately detected as infested, while 2.9% such palms was not detected accurately. Also, out of 56 palms that showed no symptoms, 7.1% palms were wrongly detected as infested, while other palms were correctly detected as un-infested (Table 8). The results confirmed that the finally developed device could detect the infested palms at a high reliability (97.1%) even at the first observation compared to the pilot device (93.1%). The study was completed.

The advantages of the device are that infested palms could be detected reliably and well in advance, no cleaning of palm is required and saves labor cost. The device was recommended to the coconut growers and manufacturing was commenced by the Rinzen Laboratories (Pvt) Ltd. A patent was applied for the invention.

Table 8: Two-way frequency table between the status of red weevil damage symptom and status of detection for red weevil by the advanced device

Symptoms	Status of the detection		
	Detected	Not detected	Total
Present	100 (97.1%)	3 (2.9%)	103 (100%)
Absent	4 (7.1%)	52 (92.9%)	56 (100%)
Total	104	55	159

Parentheses represent row percentages

L. C. P. Fernando, K. F. G. Perera, A. D. N. T. Kumara & Dr. N. Nanayakkara (Rinzen Laboratories)

PROJECT B26.5: STUDIES ON THE CONTROL OF LEAF ROT DISEASE OF COCONUT (2000)

Experiment B26.5.6: Studies on the effect of nutritional condition on leaf rot affected palms (2006)

The experiment commenced to study the effect of palm nutrition on leaf rot affected palms at Batadolawatta, Pathegama, Medahena watta, Dandeniya and Abensuhena watta, Kamburugamuwa continued. Each of 6 affected palms in mild and moderate stages and 6 healthy palms of similar age were selected to represent soil classes S2, S3 and S4. Forty kg. of compost were applied into a half circle trench around the palms in addition to the normal fertilizer dose. Disease condition (total number of affected fronds, onset tapering, number of nuts in bunches, extent of leaf rotting) of the palms was recorded at 3-monthly intervals. No improvement of palm health of experimental palms was observed. The experiment is in progress.

H. T. R. Wijesekara, A. Tennakoon , P.H.P.R. de Silva, C. Wanigasekara & N. G. Premasiri

PROJECT 26.6: STUDIES ON WELIGAMA LEAF WILT DISEASE (2007)

Experiment 26.6.1: Studies on the effect of oxytetracycline on symptom expression of Weligama Leaf Wilt affected palms (2007)

Each of 12, Weligama leaf wilt affected palms in mild and moderate stages of the disease were selected from Nugagahawatta and Rubberwatta in Kamburugamuwa. Eight palms from each land were injected with 5g of oxytetracycline (plant formula) in 5 ml of sterile distilled water in to the trunk of the palm. Another set of four palms from each land were injected with 5ml of sterile distilled water to serve as controls. Treatments were repeated at three-monthly interval. Total number of fronds, yellow coloured fronds, fronds with flaccidity and fronds with marginal necrosis were recorded. Further, the emerging bud leaf was marked for easy identification of new fronds and for future reference and the number of nuts in the palm also was recorded. Two rounds of treatments were applied. Oxytetracycline treated palms were greener than distilled water treated palms. The experiment is in progress.

H.T.R. Wijesekara, P.H.P.R. de Silva & N.G. Premasiri

PROJECT 28: DEVELOPMENT AND FIELD-TESTING OF INTEGRATED PEST MANAGEMENT STRATEGIES FOR *ORYCTES RHINOCEROS* (2006)

Experiment 28.1: Field testing of Integrated Pest Management Strategies for *Oryctes rhinoceros* (2006)

Field testing of six treatments viz. integration of *Oryctes* virus (*Or*V) + Green Muscardine Fungus (GMF) + Attractant baited traps (pheromone), GMF + *Or*V, GMF, *Or*V, Pheromone traps and untreated control were completed. Each treatment was replicated thrice in one ha blocks in three different estates. In the center of each block, 15 palms were randomly selected and recorded the fresh bud damage. Post treatment assessments were continued at 3-monthly intervals on the same palms.

The analysis of data on damage in different treatments over time was done by adjusting the mean percentage damage using pre treatment count as covariate. There was no significant difference among the treatments over the 3 assessment periods (Table 9). The percentage damage was lowest in the blocks installed with pheromone traps. The damage was highest in blocks of GMF and *OrV* treatments. In the OrV treatment, virus infected adults were released and they may have also caused damaged to the palms before death. Similarly, the beetles that were attracted to the GMF pits may also damage the palms before being dead. In summary it could be stated that installation of pheromone traps along would be the best treatment to reduce the damage of *Oryctes* beetle. Pilot trials in larger areas are required to confirm the results.

Table 8: ***Percentage and mean (adjusted) of palms damaged by Oryctes rhinoceros in experimental blocks in different treatments at each 3-month interval***

Treatment	Percentage damaged palms			
	0	1	2	Adjusted mean
Oryctes virus (*Or*V)+ GMF+Pheromone baited traps	55.7±15.7	51.0±11.0	55.7±16.2	56.7
GMF + *Or*V	53.3±3.8	46.7±15.3	49±11.7	56.3
GMF	62.0±5.8	57.3±15.5	75.3±2.3	67.6
*Or*V	80.0±11.5	82.0±11.0	80.0±16.6	66.9
Pheromone baited traps	76.0±2.0	60.0±0.0	57.7±2.3	50.0
Control	53.3±3.7	64.7±18.9	33.7±9.8	57.4
Significance				NS

H.T.R. Wijesekara, N.I. Suwandhrathne, M. Nissanka & C. Wanigasekara

PROJECT 28: STUDIES ON THE ASSOCIATION OF PARASITIC NEMATODES AND FUNGI WITH LEAF SCORCH DECLINE OF COCONUT (2001)

Experiment 28.4: Determination of whether toxins of *Fusarium* spp. are present in the tissues of LSD affected palms (2005)

The study initiated to determine whether the toxins, Fusaric acid, Zearalenone and T2 produced by *Fusarium* spp: are present in the leaf, stem and root tissues of affected palms was completed. Fusaric acid was absent in roots of affected palms and roots of affected palms. But it was present in stem and leaf tissues of the affected palms (Table 8). Zearalenone and T2 were present in all tissues of both healthy and affected palms. Although levels of Zearalenone were not statistically significant between healthy and affected tissues, its amounts were considerably higher in affected tissues than that of healthy tissues. T2 did not show any consistent pattern. The results suggested that tissues of LSD-affected palms have higher levels of Fusaric acid and Zearalenone, which may contribute to the symptoms expressed by the affected palms.

Table 9: ***The mean amount (µg/ml) of Fusaric acid (Fus.), Zearalenone (Zea.) and T2 present in leaf, stem and root tissues of healthy and LSD-affected palms obtained by GC analysis***

Status of	Leaf			Stem			Roots		
palm	Fus.	Zea.	T2	Fus.	Zea.	T2	Fus.	Zea.	T2
Healthy	0	532.0	97.1	0	1925.0	63.7	0	877.0	155.3
Affected	1057.0	1174.0	64.6	1064.0	4192.0	677.4	0	1592.0	67.6
Sig.		ns	ns		ns	ns		ns	ns

L. C. P. Fernando, P. H. A. P. Siriwardena & W.W.N. Fernando

Experiment 28.5: Determining effect of root pruning in remission of LSD symptoms (2006)

The study initiated to assess the effect of root pruning on remission of symptoms was continued at Bandirippuwa, Rathmalagara and Pottukulama estates. In each estate root pruning was carried out at 2-, 4- and 6-monthly intervals. At each interval, roots of 1/3 of the manure circle (up to a depth of 9") of 15 palms were pruned while in another 15 palms, _ of the circle was pruned. Fifteen palms were kept as the control. The total number of leaves and the number of newly affected fronds of all palms were recorded at 4 monthly intervals. The study is in progress.

L. C. P. Fernando, P. H. A. P. Siriwardena & W.W.N. Fernando

Miscellaneous experiments

Preliminary survey on identification of natural enemies of *Plesispa reichei*

Since the local natural enemies of *P. reichei* have not been determined, a survey was conducted in Walpita and Narammala area to collect parasitoids. Forty seedlings each in CCB nursery and in Miriswatta estate at Walpita area were observed. Also, in Narammala and Heilarawa estate, each of 40 seedlings was observed. Although 10-12 adult beetles per seedling were found no parasitoids were collected. The frequent usage of insecticides may have disturbed the establishment of natural enemies. The study is in progress.

N. I. Suwandhrathne, M. Nissanka and C. Wanigasekara

3. CROP PROTECTION SERVICES

Report of new pathogens causing diseases in coconut palms

Leaf blight epidemics in coconut seedlings and young palms were reported from Mannar and Wanathawilluwa. Samples from Mannar yielded *Ceratocystis paradoxa* and *Colletotrichum gloeosporioides* while Wanathawilluwa samples yielded only *Colletotrichum gloeosporioides*.

Colletotrichum gloeosporioides was isolated from the brown lesions on nuts from Pallebedda.

Collar rot disease caused by *Ceratocystis* sp. was reported from coconut seedling nursery of CCB at Ulhitiya.

Biological and chemical control

a. Coconut caterpillar: All infestations were successfully controlled by release of parasitoids. The number of parasitoids released is given in Table 10.
b. Synthesis and sale of red weevil pheromone: Pheromone synthesis in the CRI laboratory continued and a total of 3175 vials were sold to the growers and CCB Regional Offices.
c. Chemical control: A total of 127l of monocrotophos was issued mainly to CRI estates. The requirement of the growers was supplied to the Coconut Cultivation Board.

Table 10: Release of parasitoids in different provinces for the management of coconut caterpillar

Parasitoid	Western	North western	South -ern	Eastern	Sabaragamuwa	Northern	Total
Eriborus trochanteratus	1500	25750	3500	600	-	-	31350
Bracon hebetor	25000	125200	-	8500	-	-	158700
Goniozus nephantidis	8250	60600	400	750	-	-	70000
Brachymeria nephantidis	1000	16700	-	1300	-	-	19000
Total	35750	228250	3900	11150	-	-	279050

4. TRAINING AND EXTENSION ACTIVITIES

Training programmes on small scale production of green muscardine fungus

Based on the technologies developed for on farm production of green muscardine fungus, training programmes were completed. Seventy five farmers in Gampha and Marawila CDO ranges and 30 Coconut Development Officers in Kurunagala District were trained. A demonstration on application of green muscardine fungus was conducted. The trainees were supplied with the inoculum (starter material) and basic tool kit for commencing the production. Trainees were keen on learning the new technology, however, only few trainees requested the starter material for subsequent production.

N. I. Suwandhrathne, H.T.R.Wijesekara,P.Damayanthi, M. Nissanka and C. Wanigasekara

Other

Divisional staff participated as resource personnel in various training programmes arranged by the CRI and other Institutions. Students from universities, technical colleges, schools and growers visited the Division during the year.

Acknowledgements

I am grateful to the staff of Crop Protection Division for their dedication and valuable contribution to the research programmes of the Division. Their cooperation and assistance in research and other activities during the year is greatly acknowledged. I am grateful too to the contract staff for their hard work. Sincere thanks are extended to the Head and staff of the Biometry Division for the assistance given in designing experiments and analysis of data. I thank Dr. T. Nanayakkara of Rinzen Laboratories and Dr. R. Samarasekara for collaborating in research projects. I acknowledge the funds provided by the Coconut CESS, Council for Agricultural Research Policy, Department for International Development, UK and Asian Pacific Coconut Community for conducting several research projects.

REPORT OF THE BIOMETRY DIVISION
Acting Head – J M D T Everard, M Sc

1. GENERAL

Staff of the Biometry Division assisted research divisions in all aspects of statistical assistance, mainly designing field experiments, analyzing data and conducting surveys. The computer network system with 34 workstations was administrated efficiently and the institute's website (www.cri.lk) was updated throughout the year. Four agro-meteorological stations and three rainfall stations were maintained while collecting and collating meteorological data.

Island wide consumer survey on coconut and coconut oil in collaboration with the Divisional Secretaries and selected Grama Niladaries and data capturing survey on coconut yield in collaboration with the Regional Managers and Coconut Development Officers of Coconut Cultivation Board were successfully carried out during the year.

2. COMPUTER RELATED WORK

The divisional staff attended to following activities related networking and computer services.

The website (www.cri.lk) was maintained and updated routinely.

(J D J S Kularathna)

Climate database of the coconut growing areas and yield database of CRI estates were duly updated

(K P Waidyarathne & S S Rajapakse)

Continuously assisted to all research divisions on the use of Internet system and e-communications.

(K P Waidyarathne, S S Rajapakse, J D J S Kularatna & W S Wickramarachchi)

Co-ordinated in developing computer programs for analyzing databases related to personal management system and monthly transport system in the Establishment Division.

(W S Wicramarachchi)

Assisted in hardware and software maintenance of computers in the Institute.

(S S Rajapaksa, W S Wickrmarachchi & J D J S Kularatna)

Collecting and collating the weather variables records in seven meteorological stations of the CRI throughout the year.

(J D J S Kularatna, W B P Fernando & J H U Jayamaha)

Assistance provided for maintaining and processing MAS activities of the Institute.

(J D J S Kularatna)

3. STATISTICAL ASSISTANCE

Analyses of various long-term and short-term field experiments, lab experiments, and surveys of various divisions were carried out. Undergraduates and postgraduates from the different universities were also provided Services on statistical analysis of projects undertakes at the CRI.

(K P Waidyarathne, J D J S Kularatna, and W E R C Fernando)

Assisted research divisions in designing their field experiments commenced during the year.

(K P Waidyarathne & J D J S Kularathna)

4. RESEARCH PROJECTS

THRUST AREA: CROP PRODUCTION/IMPROVEMENT/PROCESSING

PROJECT 1: YIELD CAPTURING SURVEY

Objective: To identify yield variability between districts and seasons for providing information for policy makers in the coconut industry.

Methodology

Data capture survey was continued with assistance of Coconut Development Officers (CDOO) of the Coconut Cultivation Board (CCB). Five estates were identified from each CDO range covering all CCB regions excluding those in the Northern Province. In addition to those estates selected data were also collected from estates selected from Puttlam, Gampaha and Kurunegala CCB regions by the divisional staff.

Results

The highest annual per palm yield 69 was observed in at national level Amparai. Marawila followed next with 67 (Table 1). The lowest 45 was observed in Galle. The yield per bearing palm in the CCB regions of Galle, Gampaha, Kuliyapitiya, Kurunegla, Matale, Matara, Kegalle, Hambantota and Ratnapura were below the national average, 58 nuts per bearing palm. During the year highest yield per pick was observed during May/April and lowest during Nov/Dec. (Table 2). The pattern of bi-monthly yield varied from region to region, probably due to different pattern of bi-monthly rainfall in these regions during 2006.

The coconut yield of 2007 prediction in October 2007 was 2,935 million nuts. The actual was 2,798 million nuts only 4.7% less than predicted (Figure 2) of the CCB regions the highest percentage of the national yield (16.7%) was from the Kurunegala region (467.2 million nuts). Nearly 55% of the national yield was contributed from the four CCB regions, Kurunegala, Kuliyapitiya, Marawila and Gampaha.

Table 1: ***Observed bi-monthly coconut yields (nuts/bearing palm) in different CCB regions during the years 2007***

CCB Region	Jan /Feb	Mar/ Apr	May /Jun	Jul /Aug	Sep /Oct	Nov /Dec	Total (nuts/p/y)
Amparai	12.0	10.6	15.1	11.4	8.4	11.3	68.8
Annuradapura	9.1	8.4	10.8	10.1	9.4	8.8	56.6
Galle	5.7	6.8	11.8	10.2	6.2	4.3	45.0
Gampaha	8.6	9.0	13.0	10.7	7.8	5.5	54.6
Hambantota	8.9	9.4	11.0	8.0	6.7	6.9	50.9
Kalutara	8.9	9.3	13.7	12.8	6.7	7.6	59
Kegalle	7.9	9.5	10.6	9.8	7.7	5.1	50.6
Kuliyapitiya	9.0	8.3	10.4	8.8	6.2	5.4	48.1
Kurunegela	8.9	9.0	11.1	8.8	6.5	6.3	50.6
Marawila	13.1	12.1	13.8	12.2	7.8	7.9	66.9
Matale	7.7	5.9	9.5	10.1	10.2	6.7	50.1
Matara	6.9	7.9	10.7	8.9	6.7	5.3	46.4
Monaragala	11.3	7.5	12.2	10.0	9.6	8.6	59.2
Polonnaruwa	10.8	9.9	12.6	8.6	8.2	9.4	59.5
Ratnapura	9.2	8.7	12.0	9.7	7.4	7.3	54.3
Other areas	8.9	9.0	11.8	8.9	6.6	6.9	52.1
National	9.3	9.7	11.7	9.7	7.4	7.1	54.9

Table 2: Contribution of CCB regions to the national yield (million nuts) in 2007

CCBR	Jan/Feb	Mar/Apr	May Jun	Jul/Aug	Sep/Oct	Nov/Dec	Total
Amparai	9.4	7.2	10.2	7.7	4.7	7.5	46.7
Annuradapura	20.1	16.4	19.0	16.1	15.0	16.8	103.4
Galle	13.0	13.4	21.4	18.7	12.3	8.4	87.2
Gampaha	59.2	52.1	78.0	64.3	47.0	32.9	333.5
Hambantota	29.6	35.4	31.8	22.8	19.5	20.6	159.7
Kalutara	27.2	22.8	37.8	30.5	18.2	19.5	156
Kegalle	18.8	19.1	21.5	20.3	16.0	10.5	106.2
Kuliyapitiya	72.6	65.5	73.5	62.1	43.7	38.4	355.8
Kurunegela	93.2	78.5	99.4	79.6	59.1	57.5	467.3
Marawila	84.7	65.1	76.8	67.8	44.3	44.8	383.5
Matale	19.7	11.2	21.0	21.9	21.0	15.4	110.2
Matara	17.0	18.8	22.5	18.7	14.1	11.1	102.2
Monaragala	20.9	11.2	19.9	15.6	15.2	14.5	97.3
Polonnaruwa	10.9	9.1	11.4	7.9	7.4	8.5	55.2
Ratnapura	20.0	16.5	26.6	20.7	15.6	15.4	114.8
Other areas	21.3	20.2	26.5	20.0	14.9	15.7	118.6
National	538	462	597	495	368	338	2797.6

Comparison of observed and predicted bi-monthly national yield by regions for 2007 is given in Figure. 1. The percentage error varied from 9.65 during Jul/Aug to - 14.3 during Nov/Dec. with a percentage error for the annual yield, 4.7%. When compared to 2006, the yield of picks during Mar/Apr, Sep/Oct and Nov/Dec in 2007 are considerably low.

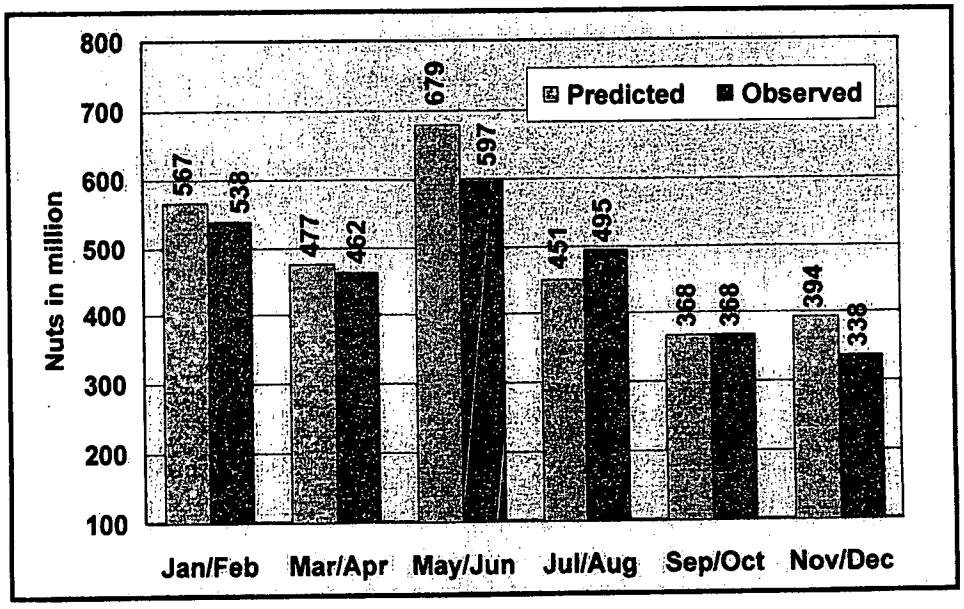

Figure 1: Predicted and observed bi-monthly national coconut production in the year 2007

(K P Waidyarathne, J D J S Kularatna and W K M K Herath)

THRUST AREA: **CROP PRODUCTION/IMPROVEMENT/PROCESSING**

PROJECT 2: **PREDICTION OF ANNUAL NATIONAL COCONUT PRODUCTION**

Objective: **Prediction of Annual and bi-monthly national yield for 2008**

Progress

Using the integrated crop forecasting model (CRI Annual Report, 2005), which incorporates climate effect and technology effect, the national coconut production for 2008 was predicted as 2,776 million nuts in October 2007. Prediction of national coconut production for 2008 by two monthly seasonal basis (Jan/Feb - Nov/Dec) was also done using a composite index based on bi-monthly national yield distribution in 2006 and 2007 and bi-monthly distribution of rainfall intensity in 2006 and 2007 in the main agro-ecological regions in coconut growing areas. (Figure.2)

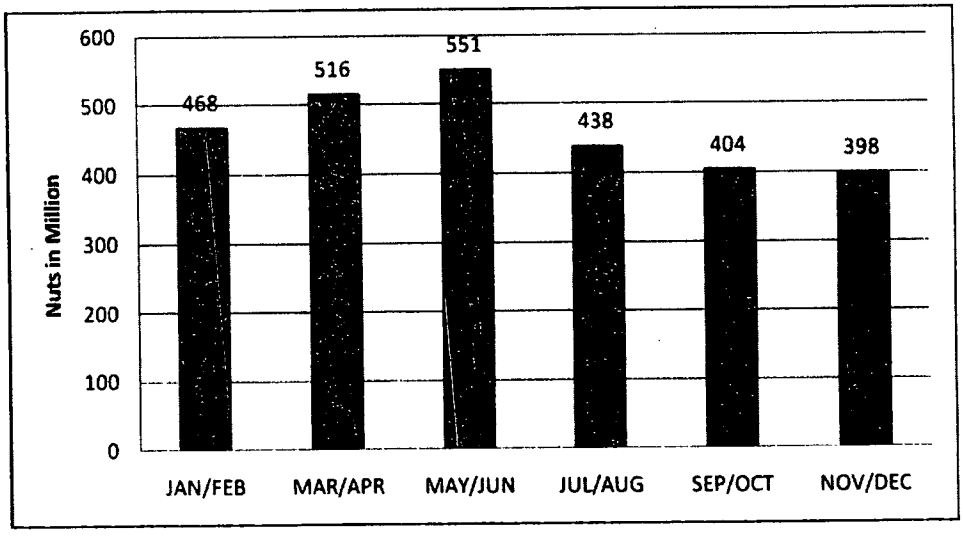

Figure 2: Predicted bi-monthly national yields of coconut for year 2008

(K P Waidyarathne)

THRUST AREA: **CROP PRODUCTION/IMPROVEMENT/PROCESSING**

PROJECT 3: **IDENTIFICATION OF CONSUMPTION PATTERN OF COCONUT NUTS AND COCONUT OIL**

Objective: **To identify the pattern of consumption rate of coconuts and oil by district**

This information would be useful to control imports of substitute oils, compute cost of living indices by districts and to identify the actual nut consumption locally.

Methodology

The consumer survey on the coconuts and coconut oil was conducted island-wide in selected DS divisions with the assistance from the Divisional Secretaries & Grama Niladaries from January 2007. The amount of coconut oil and fresh nuts consumed by a family was monitored for five weeks samples of ten families selected within a Grama Niladarie Division. Data were collected through post to Biometry Division. The Grama Niladaries assisted in the programme who provided data were honoured by issuing a certificate.

Results

Table 3: Consumption rate of coconuts and coconut oil during the year 2007 in 19 districts

District	Consumption rate/person/year	
	Number of nuts	Number of oil bottles
Anuradhapura	103.11	8.22
Badulla	57.25	9.71
Batticaloa	87.39	7.23
Colombo	75.82	7.93
Galle	99.85	6.74
Gampaha	102.14	6.72
Hambantota	128.51	5.07
Jaffna	104.43	8.32
Kalutara	99.49	6.72
Kandy	82.65	7.39
Kegalle	111.06	6.56
Kurunegala	143.59	6.11
Matale	101.45	7.71
Matara	105.32	5.74
Monaragala	96.55	8.22
Nuwara Eliya	66.64	9.35
Polonnaruwa	101.17	7.90
Puttlam	125.72	7.72
Ratnapura	112.87	7.44
Mean ± SE of	101.0	7.3
CV (%)	20.1	15.2

The average nut consumption in 2007 has decreased to 101 nuts from corresponding value of 105 nuts in 2006 (CRI Annual Report, 2006). The total number of nuts utilized for fresh nut consumption alone in 2007 is 2008 million nuts. The rate of oil consumption has increased from 7.2 bottles to 7.3. The study found that there is no significant correlation between consumption rate of coconut nut and oil. The variability of nut consumption between districts has reduced (cv from 21.6 to 20.1) but the variability of oil consumption was increased (CV from 11.5 to 15.2). The consumption rate of fresh nut was exceptionally high in Kurunegala district while it was exceptionally low in the districts of Badulla and Nuwara Eliya. Badulla and Nuwara Eliya were relatively higher coconut oil consuming districts in the country.

(K P Waidyaratne, J D J S Kularatna, S SRajapakse, S Wickramarachchi, W E R C Fernando, W B P Fernando, W K M K Herath, J H U Jayamaha & J H Premarathna)

THRUST AREA: **CROP PRODUCTION/IMPROVEMENT/PROCESSING**

PROJECT 4: **EFFECT OF MONTHLY PICKING AT FARM LEVEL.**

Objective: **To find the impact of monthly picking (1M) vs bi-monthly picking (2M) at farmer's land**

Methodology

Treatments: Monthly picking vs Bi-monthly picking

Experiment Design: Randomized block design with single palm plot (Number of blocks varied from location to location)

Locations: Three locations from each of four land suitability classes (LSC) of coconut: (S_1 - S_4) were selected.

Results:

Table 4: ***No of female flowers and nuts harvested after one month & two months harvesting frequency from January to October 2007***

LSC	Location	Total nuts			Female Flowers			Percentage setting	
		Harvesting Frequency 2007		% Increase in IM wrt 2M	Harvesting Frequency 2007		% increase in IM wrt 2M	Harvesting Frequency 2007	
		1M	2M		1M	2M		1M	2M
S1	Pambala	134.55	93.85	43.37	333.95	286.95	16.38	40.29	32.71
	Marawila	162.49	158.44	2.56	669.01	680.79	-1.73	24.29	23.27
	Sirigampola	100.98	82.26	22.76	273.19	268.31	1.82	36.96	30.66
	Mean	**132.67**	**111.52**	**18.97**	**425.38**	**412.02**	**3.24**	**31.19**	**27.07**
S2	Madurankuliya	-	-	-	-	-	-	-	-
	Kuliyapitiya	83.99	60.64	38.51	245.54	208.46	17.79	34.21	29.09
	Nattandiya	104.82	85.48	22.63	348.09	299.83	16.10	30.11	28.51
	Mean	**94.41**	**73.06**	**29.22**	**296.82**	**254.15**	**16.79**	**31.81**	**28.75**
S3	Mangalaeliya	96.92	98.54	-1.64	405.37	296.25	36.83	23.91	33.26
	Kobeigane	76.94	60.26	27.68	247.31	189.75	30.33	31.11	31.76
	Dunkannawa	113.70	94.70	20.06	339.65	215.54	57.58	33.48	43.94
	Mean	**95.85**	**84.50**	**13.44**	**330.78**	**233.85**	**41.45**	**28.98**	**36.13**
S4	Sembukattiya	104.20	79.72	30.71	222.70	204.99	8.64	46.79	38.89
	Dunkannawa	131.09	117.62	11.45	356.10	320.39	11.15	36.81	36.71
	Bingiriya	108.38	72.94	48.59	242.34	203.61	19.02	44.72	35.82
	Mean	**114.56**	**90.04**	**27.15**	**273.71**	**243.00**	**12.64**	**41.85**	**37.08**
	Grand Mean	**111.00**	**91.30**	**21.58**	**334.84**	**288.62**	**16.01**	**33.15**	**31.63**

The annual yield per palm obtained using 1M picking was significantly higher than that obtained using 2M picking in all farmer's fields (Table 4). The percentage increase varied from location to location. Of the four land suitability classes of coconut (S_1 – S_4) the highest percentage increase was observed in S_2 as all three estates in S_2 showed high percentage increase. The rates of increase were low during 2007 compared to 2006 (CRI Annual Report, 2006).

The female flower production was high in monthly harvesting palms, though statistically not significant. Since nut count of both harvested and fallen nuts is taken the increase is due in part to the high production of female flowers. When all LSC are pooled the percentage of nut setting is almost the same, 33% in monthly picking and 32% in bimonthly picking.

The results confirmed that the monthly picking is more beneficial with respect to nut increase and income gain at the farmers' lands irrespective of land suitability class and the highest beneficial effect were from S_2 lands. Similar results were observed in 2005 and 2006.

(K P Waidyaratne, W E R C Fernando, W B P Fernando & J H U Jayamaha)

TRUST AREA: CROP PROTECTION

PROJECT 5: TEMPORAL VARIABILITY OF MITE INFESTATION

Objective: To identify the intensity of mite damage over time

Methodology

A survey was carried out during the year in the three selected coconut mite infested zones (MIZ) namely Anuradhpaura, Puttalam and Kurunegala. The sampling method was two-stage stratified random sampling. The five mite infested estates were selected from each MIZ. The nuts were harvested at bi-monthly interval from the randomly selected ten mite infested palms in each estate. Harvested nuts were grouped into two categories based on (a) status of mite damage (Nuts having no mite scars – MF, and nuts having mite scars - MI), and (b) nut size (full priced nuts – S1 and half priced nuts – S2, barren & deformed - BD). The full price nuts were defined as the nuts which could be sold at the full price and half price nuts were referred as nuts which are generally sold at half of a full price nut. This was determined in consultation with the owner of the estate or the buyer of nuts. Nuts do not belong to full or half priced nuts were named as either barren or deformed. Those nuts can not be sold irrespective of MI or MF. Barren nuts are those of with no water inside the nut. Deformed nuts are those which do not belong to either normal shape or barren.

Results

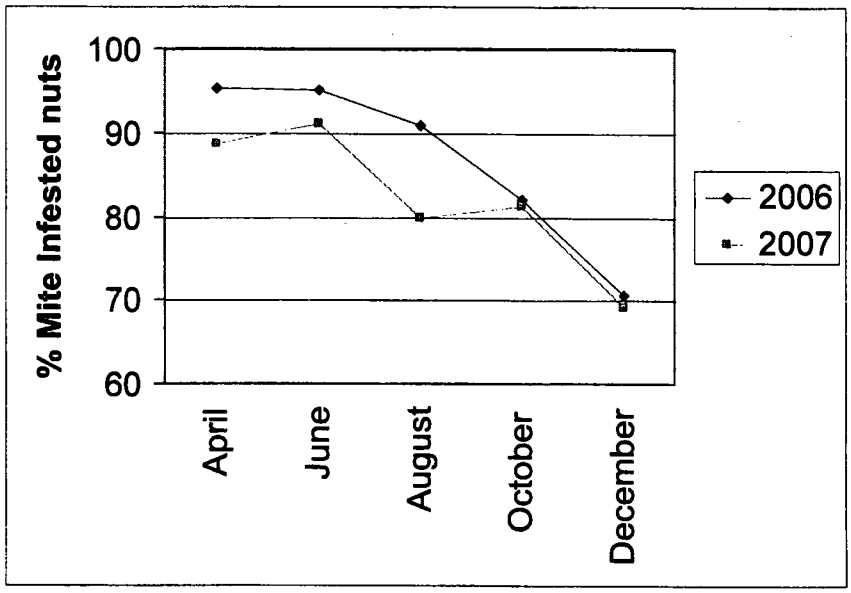

Figure 3: Distribution of percentage mite infested nuts during years 2006 & 2007

Table 5: Monthly distribution of mite free & infested nuts in three mite infested zones (MIZ) in the country.

MIZ	Period	Mite free			Mite infested		
		Full Sized (MF_S1)	Half Sized (MF_S2)	B & D (MF_BD)	Full Sized (MI_S1)	Half Sized (MI_S2)	B & D (MI_BD)
A	Feb	13.99	0.00	0.00	61.59	23.73	0.69
A	April	0.99	0.00	0.00	64.60	32.80	1.61
A	June	1.15	0.00	0.00	73.91	22.76	2.18
A	August	2.52	0.00	0.00	63.20	26.71	7.57
A	October	6.76	0.00	0.00	78.92	12.14	2.18
A	December	17.93	0.00	0.00	66.87	12.16	3.04
K	Feb	28.94	0.55	0.00	57.69	11.72	1.10
K	April	15.25	3.69	1.44	49.76	25.68	4.17
K	June	13.28	0.00	0.00	61.03	23.28	2.41
K	August	20.67	0.96	0.00	60.34	15.14	2.88
K	October	22.76	0.00	2.24	67.95	5.45	1.60
K	December	39.05	3.33	0.00	40.95	14.29	2.38
P	Feb	34.24	0.00	0.00	54.07	10.41	1.28
P	April	12.07	0.00	0.00	74.01	8.49	5.44
P	June	11.67	0.00	0.42	72.92	12.50	2.50
P	August	36.30.	0.00	0.28	50.85	7.91	4.66
P	October	24.12	0.00	0.00	71.19	1.17	3.51
P	December	31.86	0.00	0.00	66.67	0.88	0.59

A- Anuradhapura, **K** – Kurunegela & **P** - Puttalam

Table 5 clearly indicates that percentage of barren and deformed nuts are higher among mite infested nuts, which are almost negligible among mite free nuts.

Table 6: Percentage of mite infested nuts (MI_S1+MI_S2+MI_DB) in mite infested palms by MIZ

MIZ	% mite infested nuts
A	92.8
K	71.4
P	74.8

LSD at 5% level = 11.7

Results in Table 6 shows that percentage of mite infested nuts during the period from Feb. to December in Anuradhapura (92.8%) was significantly higher ($p < 0.005$) than Kurunegela (71.4%) or Puttalam (74.8%). There was no significant difference between percentage of mite infested nuts in Kurunegela and Puttalam. However, mite infested full priced nuts were significantly higher (67%) in Puttalam than Anurdhapura or Kurunegela. The mite infested half priced nuts were significantly lower (9%) in Puttalam than other two districts.

Table 7: Percentage of mite infested nuts (MI_S1+MI_S2+MI_DB) in mite infested palms by months

MIZ	% mite infested nuts
Feb	74.1
April	88.8
June	91.2
August	79.8
October	81.4
December	69.3

LSD at 5% level = 15.1

Results in Table 7 indicates that percentage mite infested nuts in a mite infested palm is significantly lower ($p < 0.005$) during December and February than months, June, April & October irrespective of the location. The percentages drop of mite infested nuts during December in Puttlam and Kurunegala were much higher than that in Anuradhapura.

Temporal variability of the percentage of mite infested full priced and half priced nuts are shown in Figures 3 and 4 respectively. Analysis revealed that there was not significant correlation ($p>0.005$) between mite infested half priced nuts and full priced nuts.

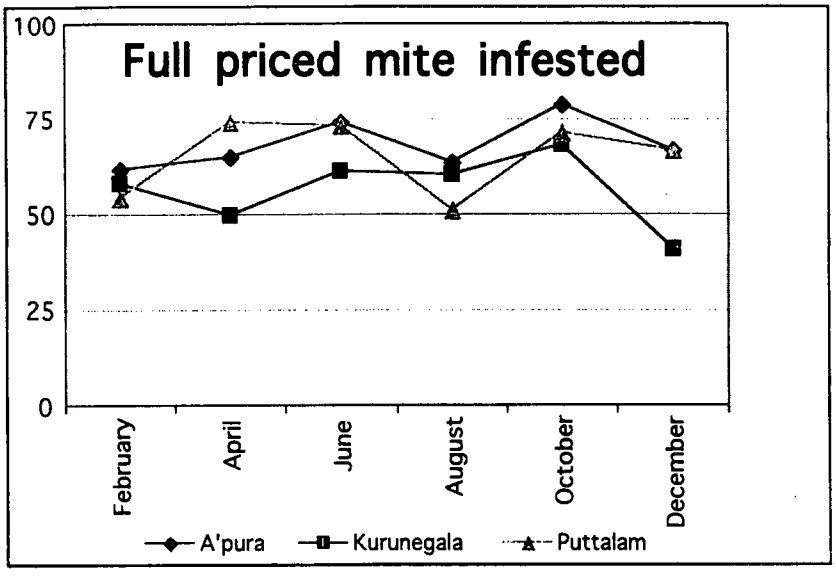

Figure 3: The temporal variability of mite infested full priced nuts

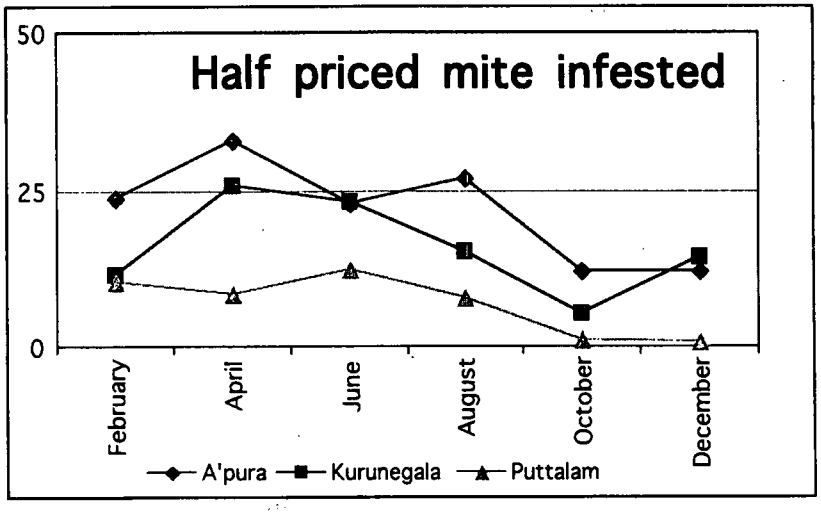

Figure 4: The temporal variability of mite infested half priced nuts

K P Waidyarathne, J D J S Kularathna & W E R C Fernando

5. CLIMATE IN CRI RESEARCH CENTERS

The four meteorological stations at Bandirippuwa Main Research Centre, Ratmalagara Research Centre, Ambakelle Genetic Resource Center and Maduru Oya Genetic Resource Center were maintained. Daily recordings were taken throughout the year on rainfall (mm), air temperature maximum and minimum (^{0}C), evaporation (mm), relative humidity morning and afternoon (%), sunshine duration (hrs/d) and soil temperature (morning and afternoon) at 5, 10, 20, 30, 60 and 120 cm depth. The rainfall, evaporation and sunshine duration were

measured using rain gauge, class A evaporation tank and Campbell stokes sunshine recorder respectively. The maximum and minimum air temperatures were recorded in Stevension Screen using mercury and alcohol-in-glass thermometers respectively. Relative humidity was obtained by transforming the current dry and wet bulb temperature recorded using ventilated mercury-in-glass psychrometer. Data were recorded at 8.30 hrs and 15.30 hrs daily.

5.1 Climate at Bandirippuwa Main Research Center (BRC) (Table 10)

Rainfall: The total rainfall for the year was 1383.8 mm. This rainfall is 36.5% lower than the last year rainfall (2180) and 21.7% lower than long-term (1997-2006) annual mean. The rainfall received during February, July & November 2007 is considerably lower than long term mean. The percentage contribution of rain fall for three monthly seasons namely January-March, April-June, July-September and October-December were 7.4, 36.4, 17.0 and 39.2 respectively.

Temperature: The monthly maximum temperature ranged from 30.1 ^{0}C during October to 33 .2^{0}C during March. The monthly minimum temperature ranged from 21.5 ^{0}C during January to 24.5 ^{0}C during May. During this year mean monthly maximum temperature has increased by 0.2^{0}C and no change in mean monthly minimum temperature.

Sunshine: Sunshine hours ranged from 3.9 hrs/day (October) to 8.1 hrs/day (March) with a mean 6.2 hrs/day. During the year showed reduced sunshine hours compared to long-term average of 7.2 hrs/day.

Evaporation: The lowest and highest evaporation was recorded in October and April with values 2.3 mm. and 4.9 mm. respectively. The average for the year was 3.4 mm which is 0.5 mm loss of long term mean.

Relative Humidity: The average relative humidity in the morning fluctuated between 81% during April to 86% during November/December. In the afternoon it varied around 68% during March to 85% during June.

5.2 Climate at Ratmalagara Research Center (RRC) (Table 11)

Rainfall: Total rainfall during 2007 (1450.7) has reduced by 17.4% compared to the last 10 year mean (1997-2006). Rainfall during first quarter in 2007 has decreased by 55.5% compared to long-term average of the first quarter, but rainfall during third quarter has increased by 42% compared to long-term mean during third quarter. The contribution from three monthly seasons to the total was 5.7%, 29.35%, 20.9% and 44% respectively.

Temperature: The monthly maximum temperature ranged from 30.9^{0}C during July to 34.2^{0}C during March. The monthly minimum temperature increased from January to May and then decreased from June to December.

Sunshine: Sunshine hours ranged from 4.4 hrs/day (December) to 7.8 hrs/day (March) with a mean 6.3 hrs/day. The mean daily sunshine duration was higher compared to long-term mean of 5.6 hrs/day.

Evaporation: The lowest and highest evaporation was recorded in October and February with values 1.9 mm and 3.5mm. respectively with a monthly mean of 3.2 mm.

Relative Humidity: The average relative humidity in the morning was 82% and that in the afternoon was 67%. Relative humidity in the after noon varied from 52% (February) to 74% (September). The corresponding values for relative humidity in the morning was 79% (May) to 86% (Jan-Feb).

5.3 Climate at Ambakelle Genetic Research Center (IGRC) (Table 12)

Rainfall: The rainfall during 2007 was 19% lower than long term mean. Contributions during Jan-Mar, Apr-Jun, Jul-Sep and Oct-Dec to the annual rainfall were 3.6%, 32.4%, 14.9% and 49.10% respectively. The significant reduction (76%) could be observed in first quarter rainfall compared to past 10 year average of corresponding figure.

Temperature: Mean monthly maximum temperature was 31.8 ^{0}C and it varied from 29.3^{0}C during December to 34.4^{0}C during March. Lowest minimum temperature was recorded during February and minimum temperature increased from February to May and then decreased up to December.

Evaporation: Monthly evaporation was low during the year and mean daily evaporation was 3.1 mm. The highest evaporation was recorded during March (3.9 mm) and lowest was in October (2.6 mm).

Relative Humidity: The average relative humidity in the morning was 83% and it was similar to long-term average. The relative humidity in the afternoon was 70% and it is below the long-term average. The morning relative humidity was highest during November and January. Relative humidity afternoon was lowest during February and highest during June & October.

5.4 Climate at Maduru Oya Seed Garden (MOSG) (Table 13)

Rainfall: Unlike other locations the rainfall in 2007 has increased by 10% from the distribution of the long-term means. Total rainfall during the year was 1858.9 mm. The contributions by three monthly seasons to the total were 15.3%, 22.9%, 8.2% and 53.6% respectively. Although the annual rainfall has increased the rainfall in the first quarter has reduced by 33% of long-term average.

Temperature: Maximum temperature was lowest during January (30.3^{0}C) and it showed increasing trend from January to June (35.^{0}C). Minimum temperature varied from 20.4^{0}C during February to 23^{0}C during July.

Sunshine: Mean sunshine duration during the year was 5hrs/day and it varied from 4.5 hrs/day (in May) to 5.6 hrs/day (February & July).

5.5 Rainfall at Poththukulama (PRS), Walpita (WE) and Pallama Genetic Resource Center (PGRC) (Table 14)

The total rainfall during the year in all 3 stations was lower than the long-term average. The monthly rainfall distribution in 2007 at Poththukulama Research Centre (PRC) was almost similar to the distribution of long-term monthly distribution, but rainfall during March, April & November in 2007 was significantly lower than the corresponding long-term means. Similar trend was found in Pallama as well. In all 3 rainfall stations, the first quarter rainfall has reduced by more than 50% and rainfall from September & December has increased by more than 50% compared to the long-term averages of respective values.

Bi-monthly rainfall distribution during 2007 of the four agro-meteorological stations and three rainfall stations are shown in Figures 8 and 9 respectively.

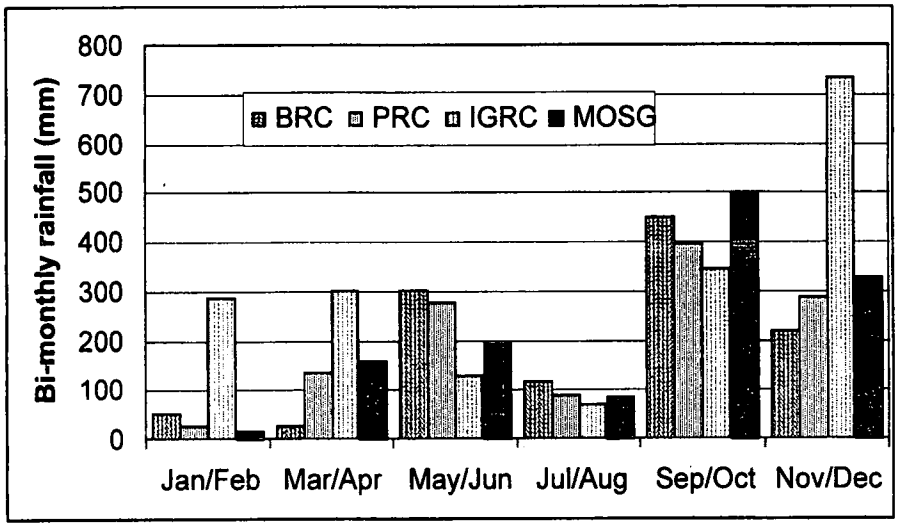

Figure 8: Bi-monthly rainfall distribution in 2007 in BE, RE, ISG and MO

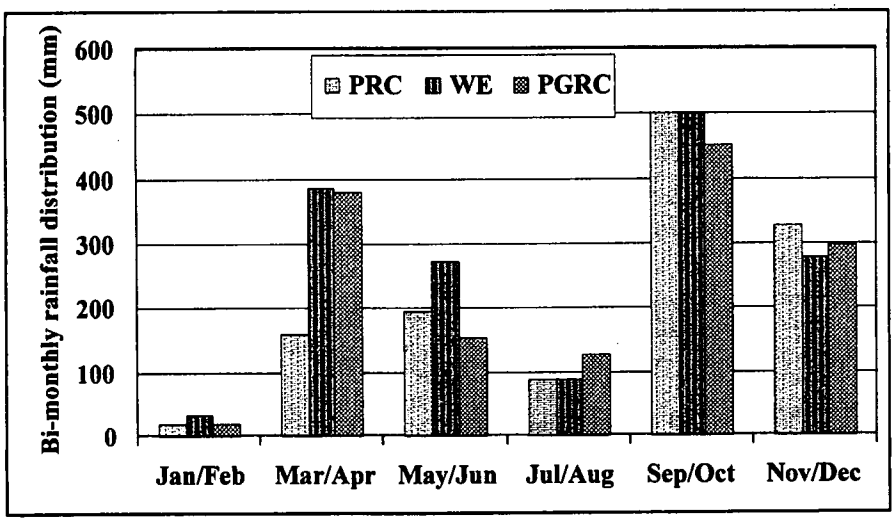

Figure 9: Bi-monthly rainfall distribution in 2006 in PRC, WE & PGRC

6. ACKNOWLEDGEMENTS

The assistance and co-operation given by the District Secretaries, Divisional Secretaries, Grama Niladareis and their staff towards consumer survey and by all the Regional Managers, Coconut Development Officers and Mr. M D Karunathilaka, Manager (M & E), NLDB towards data capture survey is greatly appreciated. Thanks are due to co-operation and assistance extended by all staff members of the Biometry Division to complete this report.

Table 10: Monthly climate variables in Bandirippuwa (BE) Main Research Centre in 2006 and 10-year average

Variable	Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
RF (mm)	2007	49.7	0.0	52.4	203.6	195.8	104.1	26.0	89.5	120.0	325.6	92.0	125.1	1383.8
	1997-2006	66.3	43.1	94.4	178.7	190.3	129.8	76.6	72.3	129.7	427.3	279.8	78.8	1767.1
Tmax (°C)	2007	32.1	32.4	33.2	33.1	32.3	31.5	30.6	31.1	30.8	30.1	31.4	30.7	31.6
	1997-2006	31.1	32.8	32.9	32.5	31.9	31.2	30.6	30.7	29.7	30.7	30.9	31.3	31.4
Tmin (°C)	2007	21.4	21.1	22.4	23.6	24.9	23.6	23.5	24.0	23.5	23.5	22.3	21.7	23.0
	1997-2006	21.5	21.7	22.2	23.6	24.3	23.9	24.1	23.9	24.1	22.8	22.4	21.9	23.0
Sunshine (hrs)	2007	5.9	8.0	8.1	6.0	6.8	5.6	6.6	7.4	4.0	3.9	6.3	5.3	6.2
	1997-2006	7.5	8.6	8.2	7.4	6.8	7.0	6.9	7.5	7.7	6.6	5.3	7.0	7.2
Evap. (mm)	2007	4.3	4.9	3.9	2.8	3.4	3.2	3.5	3.8	3.4	2.3	2.9	2.8	3.4
	1997-2006	4.1	4.4	4.4	4.4	3.7	3.7	4.0	3.9	3.8	3.1	3.2	3.8	3.9
RHam (%)	2007	84	81	84	85	83	83	83	82	86	85	85	86	84
	1997-2006	83	82	81	82	83	85	84	84	82	85	85	83	83
RHpm (%)	2007	77	71	68	79	80	81	79	82	84	85	79	81	79
	1997-2006	71	70	70	74	79	80	78	77	77	78	80	74	76

Table 11: Monthly climate variables in Ratmalagara (RE) Research Centre in 2007 and 10-year average

Variable	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
RF (mm)	2007	8.3	5.1	69.6	157.7	175.7	92.4	72.0	85.5	146.1	337.3	151.4	149.6	1450.7
	1997-2006	57.2	39.6	89.8	170.8	181.1	104.4	52.4	46.1	115.9	410.0	372.1	114.8	1756.4
Tmax (°C)	2007	32.5	34.2	34.7	33.5	32.6	31.9	30.9	31.3	31.0	30.9	31.7	31.2	32.2
	1997-2006	31.7	33.4	34.2	33.1	32.1	31.2	30.9	31.5	31.9	31.0	31.3	31.0	31.9
Tmin (°C)	2007	21.3	21.6	22.7	24.1	24.9	24.8	25.0	24.7	25.0	23.8	22.6	22.4	23.6
	1997-2006	21.5	22.2	23.2	24.1	25.2	25.1	24.9	24.7	24.2	23.7	23.1	22.0	23.7
Sunshine (hrs)	2007	6.2	7.3	7.8	6.9	7.3	5.2	6.4	6.5	5.8	5.1	6.4	4.4	6.3
	1997-2006	5.0	6.4	6.6	6.3	5.6	5.4	5.1	6.0	5.7	5.3	5.0	5.3	5.6
Evap.(mm)	2007	3.1	3.5	3.3	2.6	3.1	2.5	2.9	2.8	2.3	1.9	2.4	2.1	3.2
	1997-2006	2.9	3.5	3.7	3.9	3.4	3.3	3.0	3.0	3.1	2.9	2.5	2.7	3.2
RHam (%)	2007	86	86	84	83	79	83	81	80	84	82	81	82	82
	1997-2006	87	86	87	85	84	83	81	80	81	86	89	89	85
RHpm (%)	2007	58	52	57	64	69	71	73	72	74	73	71	70	67
	1997-2006	67	61	65	70	76	77	75	72	71	76	77	72	72

Table 12: Monthly climate variables in Ambakelle (ISG) Genetic Resource Centre in 2007 and 10-year average

Variable	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
RF (mm)	2007	20.5	4.5	18.1	114.8	218.7	54.5	44.2	42.6	92.0	302.4	71.7	214.2	1198.2
	1997-2006	46.6	54.0	81.5	166.2	160.9	69.5	50.2	27.4	112.3	330.0	264.6	122.7	1485.9
Tmax (^{0}C)	2007	30.7	33.1	34.4	33.4	32.1	31.6	31.4	31.9	31.5	31.1	30.6	29.3	31.8
	1997-2006	31.3	32.9	33.6	33.3	32.6	31.4	31.2	31.7	32.0	31.1	31.0	31.8	32.0
Tmin (^{0}C)	2007	21.9	21.7	22.5	24.5	25.4	25.2	25.0	24.5	24.7	23.4	22.2	21.9	23.6
	1997-2006	21.7	21.8	23.0	23.9	25.0	25.2	24.9	24.9	24.4	23.7	23.2	22.6	23.7
Evap. (mm)	2007	3.0	3.5	3.9	3.0	2.9	2.8	3.2	3.3	2.9	2.6	3.1	3.4	3.1
	1997-2006	3.0	3.6	3.9	3.2	3.3	3.2	3.5	3.8	3.5	3.7	4.6	3.4	3.6
RHam (%)	2007	85	83	82	84	82	82	81	79	83	83	81	88	83
	1997-2006	86	84	82	82	84	84	83	80	80	85	86	85	83
RHpm (%)	2007	64	55	59	74	74	75	73	68	74	75	71	73	70
	1997-2006	69	66	67	74	77	77	81	76	71	70	73	79	73

Table 13: Monthly climate variables in Maduru Oya (MO) Genetic Resource Centre in 2007 and 10-year average

Variable	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
RF (mm)	2007	166.5	116.5	00	300.0	84.7	39.9	42.3	27.6	82.4	261.6	153.3	579.1	1853.9
	1997-2006	249.4	128.6	43.9	105.1	60.0	14.6	46.9	44.6	66.1	212.9	366.6	340.6	1679.3
Tmax (^{0}C)	2007	30.2	31.9	33.7	34.0	35.6	34.2	33.9	34.8	33.9	33.1	32.1	31.3	33.2
	1997-2006	30.3	31.7	34.1	34.8	35.1	35.2	34.9	35.2	35.6	33.7	30.9	30.5	33.5
Tmin (^{0}C)	2007						25.1	25.2	24.4	24.0	23.7	21.8	20.8	23.6
	1997-2006	20.8	20.4	20.6	22.0	22.3	22.7	23.0	22.5	22.3	22.1	22.4	21.8	21.9
SS (hrs)	2007	5.0	5.6	5.2	4.6	4.5	5.2	5.6	4.7	5.2	4.7	4.7	5.0	5.0
	1997-2006	5.6	6.4	8.2	7.1	6.8	7.0	8.0	7.7	7.3	6.2	5.0	4.8	6.7
Evap. (mm)	2007	3.7	4.0	5.0	4.9	4.7	5.2	5.3	4.9	5.3	5.2	5.0	4.5	4.8
	1997-2006	3.2	3.5	4.0	3.7	4.6	5.2	5.6	5.3	5.3	5.0	3.5	3.9	4.4
RHam (%)	2007	86	88	89	86	72	73	68	71	66	74	86	91	79
	1997-2006	76	72	63	61	63	59	58	60	58	66	75	75	79
RHpm (%)	2007	72	66	55	69	55	57	56	55	57	66	72	78	63
	1997-2006	75	68	62	66	62	58	57	55	57	65	75	77	65

Table 14: Monthly rainfall of the research centers at Poththukulama (PRS), Walpita and Pallama in 2007and ten year average

Location	Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
PRS	2007	18.0	0.0	42.7	117.0	144.3	50.6	49.7	37.1	141.0	359.2	137.2	191.5	1288.3
	1997-2006	39.9	38.2	102.8	179.3	117.6	65.8	43.7	30.1	87.2	298.2	258.4	113.2	1374.4
Walpita	2007	32.9	0.0	27.0	358.4	126.2	147.6	112.8	112.0	361.7	403.3	115.3	163.3	1960.5
	1997-2006	93.7	73.4	116.0	262.7	246.8	180.6	111.2	135.5	210.1	448.5	335.5	86.0	2300.0
Pallama	2007	19.8	0.0	23.0	96.7	101.0	52.8	67.8	59.6	102.4	348.7	119.7	176.2	1167.7
	2001-2006	47.0	29.0	91.0	243.3	130.3	86.5	50.2	13.8	67.3	328.8	291.1	98.8	1477.1

REPORT OF THE TISSUE CULTURE DIVISION
Head – L. K. Weerakoon, Ph D

1. GENERAL

Generation of double haploid coconut plants by anther culture was a major accomplishment made during the year. This is the first successful attempt of anther culture in any palm species.

Thirty eight exotic coconut plants developed through embryo culture were handed over to Genetics and Plant Breeding Division for field planting. A few of the plants raised from Ivory Coast material are at acclimatization stage whereas 67 of them are still growing in culture.

A total of 382 Dikiri embryos were cultured during the year and 173 *in vitro*-raised plants were transferred to soil for acclimatization. Forty five more embryo-cultured Dikiri palms were field planted at Middeniya Research Station whereas 39 plants were sold to growers.

The growth of tissue-cultured coconut plants established at Bandirippuwa Estate, Lenawa Estate, Daisy Valley Estate and Pallama Seed Garden was found to be satisfactory and nearly 50 % of them are at flowering or bearing stage. No abnormalities in vegetative growth or nut characters were observed in these palms.

Callus induction in immature embryo and plumule explants was seriously affected by activated charcoal used in the culture medium. Therefore, much emphasis was placed on overcoming this problem. Oven-drying (at 150 °C for one hour) of different samples of activated charcoal revealed that under normal storage conditions, adsorption of moisture by charcoal could be as high as 25 %. This can create undefined culture conditions with regard to hormones and other substances adsorbed by charcoal, leading to inconsistent callusing. Oven-drying of activated charcoal is a novel approach to overcome this problem and it was possible to define optimum combination of charcoal and 2, 4-D for callogenesis.

The feasibility of using coconut shell charcoal (CSC) in coconut tissue culture media was tested as CSC is locally available at a low cost and continuous use of one type of charcoal can be guaranteed. Different types of CSC in combination with different 2, 4-D levels were tested to select the best combination for callus induction in immature embryo explants. Further, freely available 2, 4-D in different culture media was determined by HPLC analysis to estimate the adsorption capacity of each charcoal type. The results indicated the possibility of using CSC for immature zygotic embryo culture. The effective level of 2, 4-D and the callusing frequency depended on the type of charcoal used.

Based on the results of immature embryo culture, the effect of CSC on callusing in plumule explants was also tested. The results revealed that CSC can be used effectively for callus induction in plumules and over 60 % callusing was observed with the use of CSC. Multiplication of plumule-derived calli was possible by careful selection of embryogenic calli and repeated subculture of them to callus induction medium.

An increase in callus production in immature embryo explants was observed when glutamine (900 mg/L) was incorporated into the medium. The callusing frequency in glutamine-

containing medium was 72.6 % whereas only 49.2 % callusing was observed in medium devoid of glutamine.

Many experiments were undertaken to improve somatic embryogenesis and plant regeneration. Addition of glutamine at callus multiplication stage and subsequent stages improved regeneration frequency. Interestingly, plantlet regeneration was observed in many treatments but all of them were derived from 2 plumules obtained from a tissue-cultured coconut palm. A similar observation was made previously with the same palm. This observation clearly shows that the regeneration potential of calli is highly genotype-dependant. This was further supported by the results of other experiments. As a measure of improving shoot growth of clonal coconut plants, the synergistic effect of germinating coconut zygotic embryos co-cultured with slow growing coconut shoots is being studied.

The unfertilized ovary was shown to be a promising explant for clonal propagation of coconut. Therefore much emphasis was given to research on ovary culture. With the assistance of breeders, a group of elite palms were selected to collect ovary explants. Since tissue culture response is highly genotype dependent, the most responsive palms among the group will be selected. Once this is accomplished, ovary culture will be continued using explants collected from these palms.

The results obtained from anther culture experiments were quite promising. Ploidy analysis revealed that some of the anther-derived structures were haploid whereas the others were diploid. Microsatellite marker analysis revealed that all the tested tissues (calli, embryos and plantlets) containing diploid chromosome compliment, were double haploids. This is the first report of the production of double haploid coconut plants, which can be considered as a significant achievement. Further experiments are in progress to improve the anther culture protocol.

The recently developed protocol for cryopreservation of coconut plumules (encapsulation in sodium alginate and pre-treatment in 20 µM ABA + 1 M sucrose) was tested with 4 different varieties of coconut namely, Sri Lanka Tall, Dwarf Red, D X T hybrid and Gon thambili. Mature zygotic embryos, stored in the form of endosperm plugs or in solidified agar for 7 days were used for plumule excision. The results showed that the recovery rate of cryopreserved plumules depended on the genotype and higher rate of recovery was observed with D X T hybrid and Gon thambili. Further, pre-storing of embryos in solidified agar enhanced recovery of cryopreserved plumules.

Micropropagation of banana (cultivars 'Nethrampalam' and 'Agawiyaru") and pineapple was continued successfully and field evaluation of micropropagated material is underway. More than 500 *in vitro* raised pineapple plants were successfully acclimatized and 150 plants have already been established at Bandirippuwa Estate and Walpita Estate. Tissue-cultured banana plants have been established at several locations including Bandirippuwa Estate, Walpita Estate, Makandura Estate and Middeniya Research Station.

Micropropagation of 4 ornamental plants (4 commercial varieties of *Quisqualis indica, Cordyline terminalis, Ananas comosus* and *Dieffenbachia*) were also attempted. The in vitro regeneration protocols of *Cordyline terminalis* ('Count dracula') and *Dieffenbachia* ('Tropic snow') were perfected and mass propagation of them are in progress. Experiments are in progress to increase the multiplication rate *of Quisqualis indica* (double petal) whereas different procedures are being tested for culture establishment of the other ornamental plant.

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)

A total of 382 Dikiri embryos were cultured during the year and 173 *in vitro*-raised plants were transferred to soil for acclimatization. Thirty nine embryo-cultured Dikiri plants were sold to growers and 45 more plants were field planted in the demonstration plot at Middeniya Research Center. Out of the 73 Dikiri plants established at Bandirippuwa Estate, 44 are at bearing stage.

L K Weerakoon, T R Gunathilake, K P I E Ambagala and E S Santha

Experiment 18.1.6: Cryopreservation of coconut embryos and plumules

The recently developed protocol for cryopreservation of coconut plumules (encapsulation in sodium alginate and pre-treatment in 20 µM ABA + 1 M sucrose) was tested with 4 different varieties of coconut namely, Sri Lanka Tall, Dwarf Red, D X T hybrid and Gon thambili. Mature zygotic embryos, stored in the form of endosperm plugs or in solidified agar (0.45 %) for 7 days were used for plumule excision. The results revealed that the recovery rate of cryopreserved plumules depended on the genotype and higher rate of recovery was observed with D X T hybrid and Gon thambili (Fig. 1). Further, pre-storing embryos in solidified agar enhanced recovery of cryopreserved plumules.

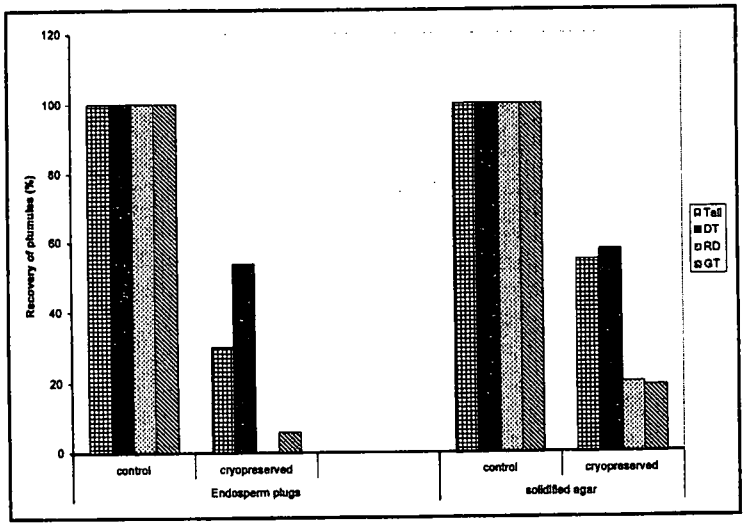

Figure 1: Recovery of cryopreserved plumules of different coconut varieties.

H D D Bandupriya and S C Fernando

Experiment 18.1.7: Exchange of coconut germplasm through embryo culture

Field planting of 38 exotic coconut plants (raised through embryo culture from Ivory Coast material) was accomplished during the year and a few more are at acclimatization stage. Sixty seven plants are still growing in culture and their growth was found to be poor.

L K Weerakoon, E S Santha, T R Gunathilake, K P I E Ambagala, L Perera and C Bandaranayake

18.2: Studies on clonal propagation of coconut

Experiment 18. 2. 1. *In vitro* culture of immature zygotic embryos of coconut

Previous experiments revealed the necessity of using a single activated charcoal type and determining the optimum level of 2, 4-D to be used with a particular type of charcoal for consistent callusing in immature embryos. However, further inconsistent results suggested that the variable moisture content of different batches of charcoal might be a contributory factor for such variation. Therefore, much emphasis was placed on overcoming this problem.

Different samples of activated charcoal were oven-dried at 150 °C for one hour and moisture content of each sample was determined. The results revealed that under the normal storage conditions, adsorption of moisture by charcoal could be as high as 25 %. This can create undefined culture conditions with regard to hormones and other substances adsorbed by charcoal, leading to inconsistent callusing. Thus oven-drying of activated charcoal was attempted as a novel approach to overcome this problem and it was possible to define optimum combination of charcoal and 2, 4-D for callogenesis.

The feasibility of using coconut shell charcoal (CSC) in coconut tissue culture media was tested as CSC is locally available at a low cost and continuous use of one type of charcoal can be guaranteed. Four different types of CSC (designated A, B C and D; kindly provided by Haycarb PVT Ltd.) were tested. Immature zygotic embryos (of the variety Sri Lanka Tall) were cultured in medium 72 supplemented with different levels of 2,4-D and 0.1 % of CSC (A-D).

Generally, activated charcoal adsorbs 2,4-D present in the culture medium, leaving only a fraction of free 2,4-D, which is mainly responsible for callogenesis. The freely available 2, 4-D in the presence of different types of CSCs was estimated by HPLC analysis, to determine the optimum level of 2, 4-D to be used for callus induction.

Table 1: ***Effect of different types of coconut shell charcoal on callusing in immature zygotic embryos of coconut***

Charcoal type	Surface area (m^2 g^{-1})	Range of 2,4-D (μM) tested	Effective 2,4-D level (μM)	Free 2,4-D available at effective level (μM)	Callusing (%)	Remarks
CSC A	875	50-200	125	2.47	59	Poor mixing with medium
CSC B	1500	150-250	175	1.69	63	-
CSC C	200	5-30	<5	< 2.8	> 14	Quick sedimentation of particles and slow growth of callus
CSC D	200	8-30	<8	< 1.4	40	Slow growth of callus
BDH (control; not derived from coconut shell)	1000	175-275	225	2.11	63	

As shown in Table 1, the effective level of 2, 4-D and the callusing percentage varied with the type of CSC. The effective level of 2, 4-D increased with the increase in surface area of charcoal. However, when the control (BDH charcoal) was compared with CSC B, the effective level of 2, 4-D was higher in BDH charcoal even though it had a lower surface area (1000 m^2 g^{-1}) than that of BDH charcoal (1500 m^2 g^{-1}). This may be due to the differences in pore structure of the two charcoal types, which are of different origin.

HPLC analysis revealed that despite the differences in effective 2, 4-D levels, the free 2, 4-D level was more or less similar for the different types of charcoal tested. This indicated the possibility of using HPLC analysis in establishing effective combinations of activated charcoal and 2, 4-D level without actual culturing of explants.

The callus production with CSC A and CSC B were comparable to the control. However, mixing quality of CSC A was poor and thus CSC B can be considered as the most suitable type of CSC to be used for coconut tissue culture media. The growth of calli produced with CSC C and D was slow and this might be due to the low adsorption capacity (200 m^2 g^{-1}) of these two charcoal types.

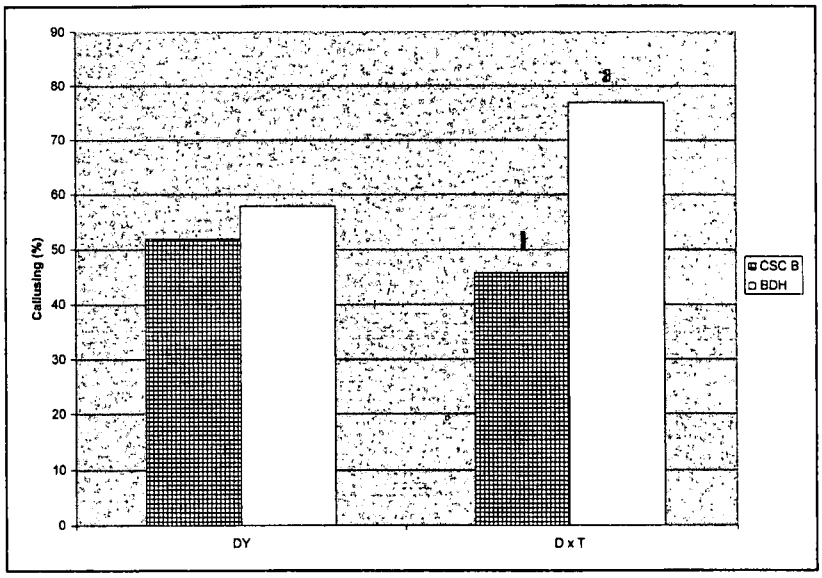

Figure 2: ***Effect of charcoal type on callogenesis in immature zygotic embryos of different coconut varieties.***

The effect of CSC B and BDH charcoal on callusing in immature zygotic embryos of two other coconut varieties (Dwarf Yellow and D X T hybrid) was also compared. The results (Fig. 1) showed that CSC B is effective in inducing calli in these two varieties as well.

The above study clearly indicated that CSC can be used effectively for induction of callus in immature zygotic embryos of different varieties of coconut and the level of 2,4-D needs to be optimized in each case.

An increase in callus production in immature embryo explants was observed when glutamine (900 mg/L) was incorporated into the medium. The callusing frequency in glutamine-containing medium was 72.6 % whereas only 49.2 % callusing was observed in medium devoid of glutamine.

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Experiment 18. 2. 5. Culture of plumule explants (1997)

Based on the results of immature embryo culture, the effect of CSC on callusing in plumule explants was also tested. Plumules (excised from fresh mature zygotic embryos) were cultured in 72 medium supplemented with 200-225 µM 2,4-D and 0.1 % BDH charcoal (control) or 150-175 µM 2,4D and 0.1% CSC B. Over 60 % callusing was observed with both types of charcoal, indicating that CSC B can be used effectively for callus induction in coconut plumules as well. Multiplication of plumule-derived calli was possible by careful selection of embryogenic calli and repeated subculture of them to callus induction medium.

Many experiments were undertaken to improve somatic embryogenesis and plant regeneration. Addition of glutamine at callus multiplication stage and subsequent stages

improved regeneration frequency. Glutamine was added at 900 mgl^{-1} during callus multiplication stage and this was increased by three times during regeneration phase. Different combinations of 2,4-D (60, 30, 0 µM) and 2ip (40, 20 µM) were also tested to improve regeneration. Interestingly, plantlet regeneration was observed in many treatments but all of them were derived from 2 plumules obtained from a tissue-cultured coconut palm. A similar observation was made previously with the same palm. This observation clearly shows that the regeneration potential of calli is highly genotype-dependant. This was further supported by the results of several other experiments in which application of abscisic acid, different auxins and heat pre-treatments were tested to improve regeneration frequency.

The plantlets regenerated showed poor growth and as a measure of improving shoot growth, the synergistic effect of germinating coconut zygotic embryos co-cultured with slow growing coconut shoots is being studied. Attempts were also made to improve rooting in the regenerated plantlets and they were pre-treated with 100 µM IAA for 3 days in the dark and transferred to hormone free medium for root initiation. More than 50% of the plants produced good roots and ten of them were transferred to soil for acclimatization.

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Experiment 18. 2. 7. Studies on coconut anther, unfertilized ovary and ovule culture (1997)

Unfertilised ovary culture

With the assistance of breeders, a group of elite palms were selected to collect ovary explants. Since tissue culture response is highly genotype dependent, the most responsive palms among the group will be selected. Once this is accomplished, ovary culture will be continued using explants collected from these palms.

Anther culture

A significant progress was made in anther culture experiments. Ploidy analysis revealed that some of the anther-derived structures were haploid whereas the others were diploid. Microsatellite marker analysis revealed that all the tested tissues (calli, embryos and plantlets) containing diploid chromosome compliment, were double haploids. This is the first report of the production of double haploid coconut plants and this achievement will have a significant impact on improvement of coconut breeding programmes. Further experiments are in progress to improve the anther culture protocol.

For the experiments conducted so far, anthers were excised from male flowers collected from the middle part of the rachillae. However, observations revealed that androgenesis is not induced in all the anthers cultured (Fig. 3). This may be attributed to the variation in microspore developmental stage which is one of the critical factors affecting anther response. Thus a study was initiated to determine the effect of the position of male flowers (from which anthers are excised) within an inflorescence on androgenic response.

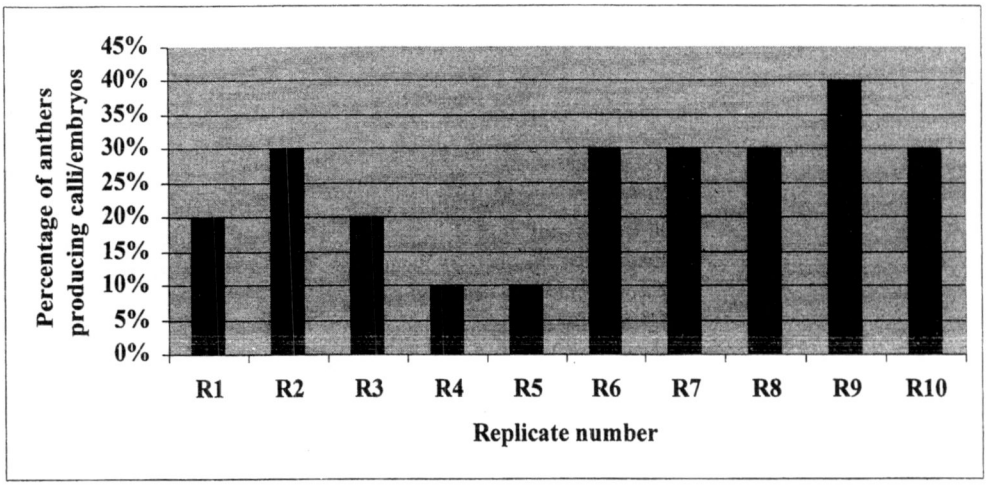

Figure 3: Variation in anther response in different replicates

Anthers excised from male flowers at different positions on the inflorescence (solitary male flowers at the top part of rachilla, mature and immature flowers of the diads in the middle part and mature and immature flowers of the diads in the basal part) were cultured separately to evaluate their performance.

The physical state of the culture medium is an important factor to be considered in the development of an efficient anther culture protocol. Liquid cultures were used for previous studies and poor regeneration capacity of the calli/embryos produced and high rate of vitrification were the main constraints observed. Thus the performance of anthers in both liquid and solid media was tested.

The results of the maximum likelihood analysis of variance are summarised in Table 2.

The production of calli/embryos was high in all three treatments. However, a significant difference was observed in the performance of the calli/embryos produced in the 3 different culture media, once they were sub-cultured to somatic embryo induction, maturation and germination media. A significantly higher percentage of embryos (87%) was produced in the medium solidified with phytagel when compared to the other two media (G^2=17.01; $p<0.0001$ and G^2=17.69; $p<0.0001$). The highest embryo germination frequency of 21.5% was also attributed to the medium solidified with phytagel when compared to agar solidified media (10%) (G^2=7.49; $p<0.01$) and liquid media (2.4%) (G^2=13.99; $p< 0.001$). Only the anthers that remained floated on the liquid medium gave rise to embryos whereas those submerged produced calli which were vitrified and turned brown later.

High vitrification was a common feature in all the liquid cultures. Even though the vitrification was slightly lower (64.62% and 60.77%) in media solidified with phytagel and agar, the difference was not significant (Table 2).

Table 2: The effect of the physical state of culture medium on the performance of cultured anthers

Physical state of the culture medium	Number of calli/embryos per 100 anthers[1]	Percentage of embryos[2]	Percentage of germinated embryos[3]	Percentage of vitrified embryos/calli[4]
Liquid medium (T_1)	95.4	50	2.4	79.23
Medium solidified with agar (T_2)	86.2	54	10	60.77
Medium solidified with phytagel (T_3)	103.9	87	21.5	64.62
MLAOV	NS	25.88****	18.68****	NS
Contrastes	Chi-square			
T_1 VS T_2	NS	NS	3.98*	NS
T_1 VS T_3	NS	17.01****	13.99***	NS
T_2 VS T_3	NS	17.69****	7.49**	NS

[1] *Mean of 13 replicates.*

P I P Perera and L K Weerakoon

Experiment 18. 2. 14: Micropropagation of high-value crops (2002)

Micropropagation of banana (cultivars 'Nethrampalam' and 'Agawiyaru") and pineapple was continued successfully and field evaluation of micropropagated material is in progress. Tissue-cultured banana plants have been established at several locations including Bandirippuwa Estate, Walpita Estate, Makandura Estate and Middeniya Research Station and some of these plants are at bearing stage. According to preliminary results, the performance of tissue-cultured banana plants is highly satisfactory. Over 500 *in vitro* raised pineapple plants were successfully acclimatized and 150 plants have already been established at Bandirippuwa Estate and Walpita Estate.

Micropropagation of 4 ornamental plants (4 commercial varieties of *Quisqualis indica, Cordyline terminalis, Ananas comosus* and *Dieffenbachia*) were also attempted. The in vitro regeneration protocols of *Cordyline terminalis* ('Count dracula') and *Dieffenbachia* ('Tropic snow') were perfected and mass propagation of them are in progress. Experiments are in progress to increase the multiplication rate *of Quisqualis indica* (double petal) while different procedures are being tested for culture establishment of the other ornamental plant.
V Vidhanaarachchi, S C Fernando, L K Weerakoon, T R Gunathilake, K P I E Ambagala and E S Santha

3. ACKNOWLEDGMENTS

The assistance and co-operation of the staff of the Tissue Culture Division in conducting the experiments and compiling this report are gratefully acknowledged. Thanks are due to the Head and the staff of the Biometry Division for their assistance in designing experiments and statistical analysis of data. Thanks are extended to the Head and staff of Coconut Processing Research Division for their assistance in HPLC analysis. The assistance provided by the Head and the staff of the Genetics and Plant Breeding Division in the germplasm exchange program and SSR marker analysis is gratefully acknowledged.

REPORT OF THE COCONUT PROCESSING RESEARCH DIVISION
Officer-in-charge - J.M.N. Marikkar, PhD

1. GENERAL

During the year 2007, Coconut Processing Research Division, has given more emphasis on product development, process improvement and machinery development activities.

As a part of the research program, studies on defatted coconut flour were under taken to utilize it in the preparation of traditional foods such as *Tosai, Pittu* and *Roti.* Another study was undertaken to evaluate the quality of deep frozen fresh matured coconut. This could help improving the storage of fresh coconuts which are targeted for consumers in far away places in the world.

Under machinery development program, CPRD was able to complete the fabrication of a gasifier unit for production of charcoal out of coconut shells.

A fair amount of attention was also given to the quality control and quality assurance aspects of the coconut processing sector. Under quality control, an alternative method for iodine value (IV) determination was looked into. Since IV is a basic characteristic of any oil or fat, it can be used to detect adulterations of oils. Therefore, a study was conducted to develop a predictive model for determination of iodine value of coconut oil using gas liquid chromatographic analysis of fatty acid data. Under quality assurance, a survey was conducted to identify the ways and means of promoting HACCP adoption by the coconut processing sector.

Under machinery development program, attempts were made to fabricate low-cost machinery for the promotion of coconut processing activities. In this regard, a coconut shell gasification unit was fabricated to generate heat while producing good quality charcoal in an environment-friendly manner.

Experiment 01: Exploring Constraints and Motivations of HACCP Adoption in the Virgin Coconut Oil and White Edible Copra Industries of Sri Lanka

Need for Quality and Food Safety Management in the Coconut Processing Sector

Quality is a key issue in any kind of food processing operation. There are many reports dealing with quality related problems of coconut kernel industry. Some of the studies already indicated that prevailing practices of copra processing are not satisfactory and not fulfilling the minimum requirements of the modern food processing operation. For example, copra processed under unhygienic conditions could be susceptible to microbial invasion and insect attack. According to a past study, as many as six different insects were connected with copra due to poor manufacturing practices. Similarly, microbes such *Rhisopus* spp, *Aspergillus* spp and *Penicillium* spp were reported to be responsible for spoilage of copra. The economic losses incurred to the coconut industry by these quality related problems are much. There are health related issues associated with these problems. In fact, these quality problems are a great challenge to the Sri Lankan coconut processing sector to survive in a competitive marketing system. Over the years, public health concern has

increased considerably and international food regulations, therefore, become more and more stringent. Hence, the Sri Lankan coconut processing sector should give more emphasis for food quality and safety strategies.

Food Safety through HACCP Implantation

The HACCP which is abbreviated for Hazard Analysis and Critical Control Point is a safety management system initially introduced to the NASA space programs in the USA. The principal objective of HACCP is to control the production process from farm to table. It will have a deeper look on to the operation specifically for food safety and takes controls measures on those steps which are vulnerable. Thus, it can reduce the chance for food-borne illness and food contaminations by way of eliminating physical, chemical and biological hazards.

Survey on the Coconut processing Sector

This study dealt with virgin coconut oil (VCO) and white edible copra (WEC) industries with the objectives of identifying constrains and motivations to implement HACCP system. A survey was conducted using a pre-tested structured questionnaire with ten respondents from each industry in the Western and North western provinces of Sri Lanka. Data were analyzed using Principal Component Factor Analysis technique with SPSS software.

Regarding constrains of HACCP adoption in two industries a three factor solution resulted, with the factors being labeled as *internal environment, organization's structural barriers and management attitudes*. It revealed that the barriers associated with internal environment have showed significant impact on HACCP adoption. Among those barriers to WEC industry, the belief among producers that the "current food safety controls are sufficient" has been the major barrier. Among the other barriers "resistant to change by employees" and "greater priority given to other issues" were found. In VCO industry, the belief among the producers of "the scale of operation is too small to have HACCP" is the major barrier. "Difficulties found in getting help and advice for implementation of HACCP system" and "lack of skilled-personnel necessary to implement the HACCP system" were also found as barriers associated with VCO industry.

With regard to motivations, three factor solution resulted, with the factors being labeled as *profit oriented, reputation, and market driven* in WEC industry while *internal environment, strategy related motivation and market driven motivations* in VCO industry. In VCO industry, major motivational drive to adopt HACCP was related to the expectation of the producers that their clients may request HACCP certification in the future. Organizing training programs focusing on food safety and HACCP implementation are highly important for these two industries.

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Experiment 02: Predictive Model for the Determination of the Iodine Value of Coconut Oil by GLC Analysis of Component Fatty Acids

Iodine value is one of the most important and frequently used quality parameters of coconut oil. Determination of IV of a oil or fat can help to predict its stability during storage or in frying operation. Since IV is a basic characteristic of any oil or fat, it can be used to establish adulterations of oil or fat samples. A study was conducted to develop a predictive model for determination of iodine value (IV) of coconut oil using gas liquid chromatographic (GLC) analysis of fatty acid (FA) data. Altogether twenty six samples were selected to represent three sub-categories of coconut oil, namely ordinary coconut oil, virgin coconut oil, and coconut paring oil.

Development of calibration model for iodine value

Out of the twenty six, fifteen samples were used as calibration set. All the twenty six samples were analyzed for IV using the AOCS method Cd Id– 92 and for FA composition using GLC detection of fatty acid methyl esters (FAME). Pearson correlation analysis between IV and individual FA indicated that lauric ($C_{12:0}$), myristic ($C_{14:0}$), palmitic ($C_{16:0}$), oleic ($C_{18:1}$) and linoleic ($C_{18:2}$) were the five parameters having strong correlation with changing IV. When these five parameters were used as independent variables in the stepwise regression procedure, a predictive model for IV was obtained with $C_{16:0}$ and $C_{18:1}$ as independent variables (coefficient of determination, $R^2 = 0.9611$ and standard error, SE=0.93).

Table 2.1: Summary of Stepwise Regression Analysis with GLC Fatty Acid Parameters Verses Iodine Values[1]

Step	Regression equation	R^2	SE
1	$IV = -1.13 + 1.08\ C_{18:1}$	0.9523 ($p<0.0001$)	1.55
2	$IV = 7.52 - 1.6\ C_{16:0} + 1.79\ C_{18:1}$	0.9611 ($p<0.0001$)	0.95

[1]Abbreviations: IV, iodine value; $C_{18:1}$, oleic acid proportion; $C_{16:0}$, palmitic acid proportion; R^2, coefficient of determination; SE, standard error.

Validation analysis

The validation set contained eleven samples which were not represented in the calibration data set. Based on the outcome of the validation test, the relationship between actual IV (IV_{Act}) and the predicted IV (IV_{Pre}) could be given by a regression equation as given below:

$$IV_{Act} = 1.07\ IV_{Pre} - 0.74\ ; \qquad R^2 = 0.946 \text{ and } SE = 0.95$$

According to the validation analysis, IV of coconut oil samples can be predicted within a standard deviation of 0.95 IV units. Although there is a fair comparison between the predicted and actual values of IV, a cross-validation with commercial samples of coconut oil could provide an added degree of confidence to this method. As such the fatty acid data for three commercial VCO samples

were substituted in the prediction model and the values obtained for IV $_{Pre}$ and IV $_{Act}$ are compared with IV (Wij's) of these samples as shown in Table 2.2.

Table 2.2: Cross-validation with Selected Commercial Samples of Virgin Coconut Oil[1]

Sample	Relative Proportion of C16:0	Relative Proportion of C18:1	IV (Wij's)	IV $_{Pre}$	IV $_{Act}$
VCO-a	9.6	7.94	5.2	6.37	6.05
VCO-b	7.9	6.1	5.8	5.80	5.45
VCO-c	8.3	6.4	5.3	5.7	5.3

[1]Abbreviations: IV_{pre}, predicted IV; IV_{Act}, actual IV. For other abbreviations see Table 1.

Obviously, IV $_{Act}$ for VCO-a and VCO-b did not tally with IV (Wij's) but the deviations were found to be within the limit of the standard error calculated for the predictive model (Table----). Of course, this kind of discrepancy could arise due to experimental errors associated with the instrumental analysis. As noted before, the method described here is dependant on the estimation of the relative proportions of the C16:0 and C18:1 fatty acids. In general, accuracy of the estimation of these two fatty acids might be affected by the baseline drift in the GLC chromatograms. Baseline drifts in GLC chromatogram are sometimes observed when the sample analysis reached higher temperature region of the temperature program. Therefore, this aspect has to be taken into consideration when developing a in-house calibration for GLC analysis.

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Experiment 03: Physico-chemical and sensory evaluation of coconut flour

Coconut meal or coconut residue is the by product of coconut oil production. The coconut meal is rich is protein and fibre. Therefore it can be used for human consumption if it is hygienically processed. Coconut flour is prepared using the oil meal obtained from virgin coconut oil production which is done in controlled and hygienic way. Earlier reports indicated that the bakery products can be made using the coconut flour by substituting wheat flour up to 30%. The objective of this study is to study chemical and physical properties of coconut flour and to investigate the feasibility of preparing traditional foods using coconut flour. Commercially available wheat flour was treated as the control in each study. The proximate composition of coconut flour and wheat flour is given in Table 3.1. According to the Table 3.1, coconut flour has higher fibre, protein, sugar and mineral content than the wheat flour.

Table 3.1: Composition of coconut and wheat flour

Parameter	Coconut flour %	Wheat flour %
Moisture	3.15	6.97
Ash	7.31	0.61
Protein	22.43	14.54
Sugar	20.2	2.30
Fat	6.19	8.09
Crude fibre	16.3	0.48

Preparation of samples

Dried coconut kernels were expelled using DD85 Komet expeller to obtained virgin coconut oil. The residue left after the 2nd extraction was ground using 3 types of mills namely CPRD grinder (grinder fabricated by Coconut Processing Research Division), local flour mill, and hammer mill to study grinding characteristics. After grinding each sample was separated into different particle size fractions using a set of sieves conforming B.S standard with 425 μm – 53 μm range. Percentage retained on each screen was calculated results are given in Table 3.2. Each value is the mean value of triplicate analyses.

Table 3.2: Particle size distribution of coconut flour obtained from different grinding techniques

Sieve size (μm)	Percentage retained on each sieve (%)			
	Local flour mill	CRI grinder	Hammer mill	Wheat flour
425	70.5715	24.5410	25.3023	7.00
300	21.4327	63.6060	29.8550	59.70
212	6.6182	10.9662	9.2298	25.45
150	0.6457	0.1988	35.1401	6.14
106	-	-	-	1.67
75	-	-	-	-

Reduction in particle size has significance effect on the physical structure of the fibres which is related to hydration properties such as water holding capacity, water retention capacity and swelling capacity. These are important factor for the food industry. According to Table 3.2, the particle sizes varied with mill/ grinder type. The locally available flour mill gave larger particle sizes (70.57% retained in larger sieve) while CRI grinder and hammer mill gave finer particles (24.54% and 25.30% retained in larger sieve respectively). Wheat flour contained highest particle sizes in 300-212 μm range (85.15%) and is widely used for all types of food preparations. Locally available flour mill is not efficient for grinding the coconut residue. However, CRI grinder and hammer mill can grind it to give better particle size distribution. Hammer mill is the best having 74.23% particles distributed in 300-150μm range. The particle size distribution affects the quality of the food and the substitution level of coconut flour. According to the technical personnel grinding of coconut residue is very difficult in each type of grinders and the technique has to be improved.

Water absorption capacity of coconut flour

Coconut flour sample (500 mg) was weighed into 50 ml centrifuge tubes. De-ionized water (10 ml) was added into the centrifuge tube. Six such samples were prepared. The samples were shaken for 5 minutes. Then the samples were centrifuged at different time intervals (15, 30,45,60,90,120 minutes) at 3000 rpm for 20 minutes. The supernatant was discarded and the residue was weighed.

Oil absorption capacity of coconut flour

Coconut four sample (500 mg) was weighed into 50 ml centrifuge tube. Corn oil (10 ml) was added to the centrifuge tubes. Six such samples were prepared. Each sample was shaken for 5 minutes and centrifuged at different time intervals (15, 30,45,60,90,120 minutes) 3000 rpm for 20 minutes. The supernatant was discarded and the residue was weighed.

Each experiment was carried out in triplicate and mean value was calculated. The results are given in Table 3.3. According to the table 3.3, coconut flour has higher water absorption capacity when compared with that of wheat flour. The high water absorption capacity of coconut flour is due to the high fibre content (Table 3.1). The water absorption capacity does not change with time significantly. Oil absorption capacity of coconut flour is similar to that of wheat flour and it did not change with time. This information is important in food industry as oil absorption and water absorption play an important role in preparation of food.

Table 3.3: Water absorption and oil absorption capacities of coconut flour

Time interval/min	Water absorption capacity		Oil absorption capacity	
	Coconut flour	Wheat flour	Coconut flour	Wheat flour
15	6.90	2.53	2.32	2.18
30	6.99	2.74	2.25	2.11
45	7.60	2.87	2.24	2.18
60	7.24	2.58	2.07	2.36
90	7.57	2.35	2.06	2.12
120	7.54	2.58	2.17	1.98

L.L.W.C. Yalegama, G. D. J. Madhubashini and Ajith Kumara

Experiment 04: Organoleptic evaluation of coconut flour substituted traditional foods

The objective of this study is to find out the level of substitution of coconut flour to wheat flour in preparation of traditional foods like *Roti, Pittu, Hoppers* and *Tosai*. Our earlier reports showed the possibility of substituting coconut flour to various bakery products up to 30 %.

Preparation of traditional foods

Tosai, Pittu and *Roti* were prepared by substituting 10%, 20% and 30% coconut flour into wheat flour while hoppers were prepared by substituting 10%, 20% and 30% coconut flour into rice flour.

Sensory evaluation of non-fermented traditional foods

Sensory evaluation was carried out to find out the best flour combination for preparation of the above foods with the help of sensory panel consisting of 25 semi-trained panelists. A nine point hedonic scale was used to test appearance, taste, texture and overall acceptability. The mean sensory scores for different sensory attributes are given in Table 4.1.

Table 4.1: Mean sensory attributes for non-fermented traditional foods

Sensory attribute	Mean sensory score							
	Roti				*Pittu*			
	Control	10%	20%	30%	Control	10%	20%	30%
Colour	8.0	6.8	7.3	7.6	7.5	7.0	7.5	7.9
Flavour	7.8	6.2	7.2	7.4	7.5	6.5	6.8	7.2
Texture	8.5	6.1	7.2	7.5	8.0	6.8	7.2	7.4
Taste	8.9	6.9	7.6	7.8	8.5	7.3	7.9	8.1
Overall acceptability	8.8	6.8	7.8	7.7	8.5	7.1	7.7	7.7

According to the Table 4.1, the *Roti* and *Piitu* prepard with wheat flour (control) obtained the highest sensory scores for all the sensory attributes. When coconut flour was substituted the sensory scores decreased and lower sensory scores were obtained by 10% substitution level. However, 20% and 30% coconut flour substituted *Roti* obtained scores above 7.0 indicating the levels are accepted by panelists. Similarly, 10%, 20% and 30% coconut flour substituted *Piitu* was accepted by panelists, except the flavour and texture of 10% substitued product which scored less scores.

The results indicated that coconut flour can be substituted to non –fermented traditional food items up to 20-30 % of wheat flour.

Sensory evaluation of fermented traditional foods

According to the mean sensory attributes for *Tosai* (Table 4.2) the panelists scored the highest score for all the attributes except the colour. Substitution of coconut flour to wheat flour all the sensory attributes decreased except the flavour. However, overall acceptability of *Tosai* prepared with wheat flour was preferred by most of the panelists. The 20 % and 30% coconut flour substituted *Tosai* were accepted by the panelists scoring more than 7.

Table 4.2: Mean sensory scores for fermented traditional foods

Sensory attribute	Mean sensory score							
	Tosai				*Hoppers*			
	Control	10%	20%	30%	Control	10%	20%	30%
Colour	7.5	6.6	7.2	7.4	8.0	6.2	6.9	7.3
Flavour	7.5	6.6	7.5	7.5	8.2	6.8	7.4	7.6
Texture	8.4	7.1	7.8	8.1	8.5	5.8	6.0	6.3
Taste	8.4	6.9	7.8	8.0	8.5	7.1	8.4	8.8
Overall acceptability	8.7	6.9	7.7	7.8	9.0	7.4	8.4	9.0

According to the mean sensory attributes for hoppers (Table 4.2) the panelists scored highest sensory scores for the overall acceptability of the control and the 30% substituted product. The table indicates that taste of hopper was improved by substitution of coconut flour and 30% substituted products obtained the highest score. But colour, flavour and texture should be improved.

The results in Table 4.2 indicate that coconut flour can be substituted in 20-30% level to prepare fermented traditional foods like *Tosai* and hoppers. However, slight improvements to the sensory attributes needed.

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Experiment 05: Identification of microbes enhancing the retting process

Retting is the preliminary step of extracting brown and white fibre for the coir industry. This conventional retting process takes around six to twelve months of period. Therefore, it is necessary to develop an appropriate technology to reduce the retting period to improve the productivity of coir fibre industry.

From previous investigation, twelve microbial strains capable of degrading pectin & phenolic compounds were isolated and identified. Microbial strains were isolated by the standard dilution plate technique and incubating the plates at 37 ^{0}c for 48 hrs.

The most effective microbial strains in the retting process were identified by inoculating the isolated strains individually and in combination of two microbial strains. The retted husks were de-fibered using the Ceylon drum at St. Jude coir fiber mill at Wennappuwa. From this experiment, the most effective retting enhancing microbial strains are given in the table 5.1.

Table 5.1: Most Effective Retting Enhancing Microbes by individual treatment

Sample Code No	Name of the Treated Organism
12	*Pseudomonas aeriginosa*
08	*Bacillus macerans*
06	*Bacillus badius*
02	*Bacillus firmus*
05	*Serratia liquifaciens*

Further experiments were conducted to identify the most effective consortium of microorganisms by inoculating the husk samples with combination of microbial strains as given in Table 5.2. *Pseudomonas aeriginosa* was omitted as it is a human pathogen.

Table5.2: Microbial consortia inoculated for the Retting process

Sample Code	Microbial Combinations used
(A)	2,8,6,5
(B)	2,8,5
(C)	2,8,6
(D)	Control (With out microorganisms)

After three weeks, samples treated with combinations were defibered using the Ceylon drum. The pith content adhered to the bristle fiber & the balace were determined by visual observation is given in Table 5.3 in an increasing order.

Table 5.3 Pith content adhered to the bristle fiber & the balace

Sample	Pith content
(C)	Less ↓ High
(B)	
(A)	
(D)	

The variation in Plate Count, pH, Electrical Conductivity (EC) is given in Tables 5.4, 5.5 and 5.6, respectively.

Table 5.4: Plate count in the ret liquor in weekly interval

Sample	Plate count (Micro- organisms per ml)		
	1st week	2nd week	3rd week
(A)	$1.25x10^7$	$7.56x10^6$	$7.27x10^4$
(B)	$4.57x10^6$	$3.62x10^6$	$4.24x10^6$
(C)	$1.09x10^6$	$3.10x10^6$	$8.50x10^6$
(D)	$5.15x10^6$	$1.98x10^6$	$1.81x10^4$

It is obvious that the plate count in sample (c) & (B) has increased with time. This is due to the growth of microbes decomposing pectin & phenolic compounds.

Table 5.5: pH in the ret liquor in weekly interval

Sample	pH		
	1st week	2nd week	3rd week
(A)	5.46	6.12	6.48
(B)	5.36	6.13	6.38
(C)	5.29	6.31	6.57
(D)	5.21	6.04	6.12

It is observed that the pH level of the ret liquor is increased with time in all samples. This is due to the Poly phenolic compounds including tannin adding in the process of degrading coconut husks.

Table 5.6: Electric Conductivity in the ret liquor in weekly interval

Sample	Electric Conductivity		
	1st week	2nd week	3rd week
(A)	0.33	2.16	2.38
(B)	0.22	2.26	2.43
(C)	0.22	2.26	2.49
(D)	0.20	1.90	2.21

The EC in all samples is increased with time. It is because of the increase of ions added to the ret liquor by degrading coconut husks.

Same experiment was repeated and the most effective microbial consortia were selected in the descending order from the result of pith content adhered to the fiber & the balace, plate count, EC, PH & temperature as given above.

Table 5.7: Most Effective consortia of Retting Enhancing Microbes

Consortium of microbes	
2,8,6	Accept ◄
2,8,5	↓
2,8,6,5	Non Accept
Control	

Based on the results presented in table 5.4, 5.5, 5.6 and 5.7 the most effective microbial consortium was selected. These microbial consortia were determined in the descending order as given in table 5.7. Further trials are underway to confirm the above results.

J.A.K.M. Fernado, & U. Dushanthi

Experiment 06: Development and Improvement of coconut fibre based products

Coconut fibre products have a great potential in domestic and international market in view of the world trend towards natural products. Coconut coir has extremely desirous qualities to qualify as a raw material for a range of products and uses. Development and improvement to coconut coir products are essential in gaining a premium price for such products.

At the initial stage, a coir defibring machine and a coir press machine were fabricated and installed at the Bandirippuwa Research Station for the manufacture of products such as weed control mats, turfs, coir grow bags etc. Different kinds of mats were prepared using mixed fiber, cut fiber, omatt fibre & mattress fibre with rubber latex. Then the prepared mats were utilized to produce weed mats with one feet diameter and for turfs. Investigations are underway to check the durability, water permeability & weed control of the mats when applying them to rubber seedlings.

Trials were conducted to test the suitability of the mats for growing turfs. In this three kinds of grass such as buffalo grass, carpet grass and bermilinda were tested by varying the percentage of top soil, coir pith & composts. Liquid fertilizer was also being applied to accelerate the growth.

Percentages of the materials applied for manufacturing turfs are given in table 6.1.

Table 6.1: Percentages of the materials applied for manufacturing turfs

Trial no.	Top soil	Coir pith	Composts
1	20 %	20%	60%
2	40%	20%	40%
3	10% -sand 10% - top soil	20%	60%

It is premature to give any results.

J.A.K.M. Fernando & J.R. Kelum

Experiment 7: Development of heat recovery unit for production of good quality charcoal and dried pulverized kernel

In Sri Lanka, the traditional charcoal production is done by pit firing. In this method, lot of heat is wasted and the smoke emitted causes environmental pollution. Hence, it is very essential to develop alternative technology to address these issues. In this project, a prototype gasifier was developed using crushed coconut shells as fuel source. According to initial test trials, a combustible producer gas was generated.

Coconut processing sector can be a source of self-generation of power using by products such as coconut shell. Processing of 1000 nuts for copra can yield about 165 Kg of dried shells. The moisture content of input fresh coconut kernel is 47%. It is expected to reduce moisture content up to 2-3 %. The optimum temperature for drying is 70°C.

Previous studies suggested that partial burning of coconut shell can produce a combustible gas whose composition may vary depending on the gasifier type and oxygen supply. The producer gas composition is as follows.

Table 7.1: Composition of Producer Gas

Gas Component	Composition (%)
CO	19-22
CO_2	10-13
N_2	50
H_2	18-20
CH_4	3

After the installation of heat recovery unit, test trials will be conducted using different types of fuels such as wood (glyricidia) and wood by-products (saw dust), paddy straw, rice husks, sugar cane stalks, corn cobs etc.

Table 7.2: Gasifier Parameters

Parameters	Value
Feeding Capacity	16 - 20 Kg /hr of crushed coconut shell
Fuel dimension	2"-2.5" Size
Moisture content of fuel	< 10%
Charcoal out put	20 % (wt/wt)
Thermal out put	60 Kw
Flame temperature	700-900 °C

Controlling of the Tar liquor and removal of ash particles are two issues given consideration. The presence of volatile matter including tar liquor would be effectively avoided by proper insulation and full burning. Similarly, ash particles in the producer gas are needed to be removed by a cyclone separator. The fabrication of cyclone separator using locally available material also completed. This will help to overcome disturbances inside the burner and heat exchanger.

Gas burner- the producer gas coming out of the cyclone separator is intended to pass on to the burner. A burner with good fine tune has also been fabricated using locally available materials. When the gas was passed into a burner, it gave a yellowish red colored flame with a temperature reaching 850°C. Most importantly, the flue gas coming out of the burner is colorless satisfying the requirement for environmental pollution control. However, further fine tuning of the burner is required to go for full combustion of the gas so that a blue colored flame with a high temperature could be expected.

The heat generated by the flame can be transferred to a dehydration chamber via a heat exchanger. For this purpose an efficient heat exchanging system has been fabricated. All the components are assembled together to build the heat recovery unit. The test trials were conducted for trouble-shooting. We found some problems such as gas leakages; break down of burning front and fluctuation of producer gas. Those problems could be able to solve successfully. The performance of the unit is in acceptable stage. With the availability of CESS funds from this years budget, fabrication of an efficient drying chamber is planed as future work.

J. R. Kelum & J. M. N. Marikkar

Experiment 8: Development of coconut milk pouch for domestic consumption

Storage study of coconut milk

Ready to use coconut milk has high demand in the market. Coconut milk in a stable and homogenous form is a convenient product to use in domestic level. A study was conducted to develop a coconut milk pouch from mature coconut kernel and determine its keeping quality under different conditions. Coconut cream was obtained form grated coconut without adding water. The cream was diluted by addition of water to get four different fat levels: 15%, 20%, 25% and 30%. Each fat level was pasteurized at 70°C for one minutes and packed in polyester LDPE pouch and stored in cold room at 4°C. Storage study was performed at two days interval to monitor the changes in FFA level, Brix value and pH of the product.

Each fat level was pasteurized at 70°C for one minutes and packed in polyester LDPE pouch and stored in cold room at 4°C. Storage study was performed in two days interval. Free fatty acid (FFA) level, Brix value and pH of the product were determined during the for storage study. Fig. 8 1 shows the variation of FFA content of coconut milk samples during storage. All the samples had similar FFA values before storage and it increased steadily during storage. Samples with high fat content showed higher variation. FFA of samples with 15% and 20% fat contents was below 1% after 10 days of storage. Other samples reached this level in 2 days. However all the samples were in good condition after 2 weeks of storage.

Initial pH value of fresh coconut milk was 6.2. However, pH value decreased during storage up to 4.5. This trend is explained by high FFA level too. Fig. 8.2 shows variation of pH values of stored coconut milk samples during the storage. Brix value did not change significantly during storage (Fig 8.3).

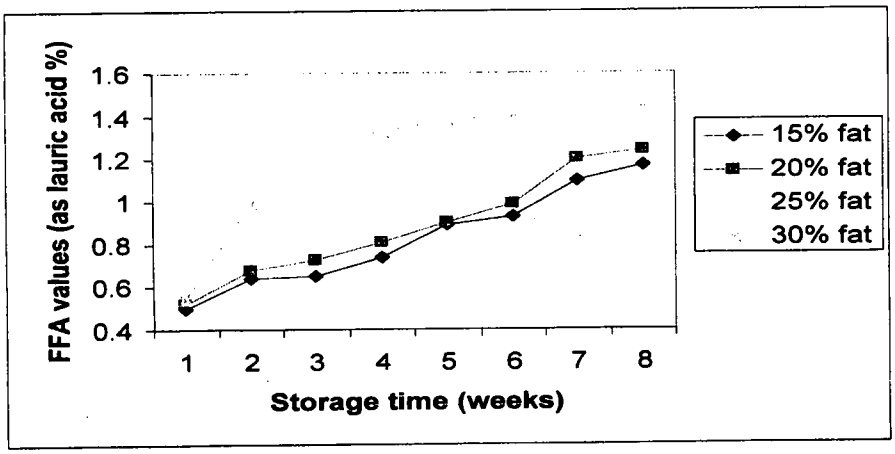

Figure 8.1: Variation of FFA content of coconut milk samples during storage

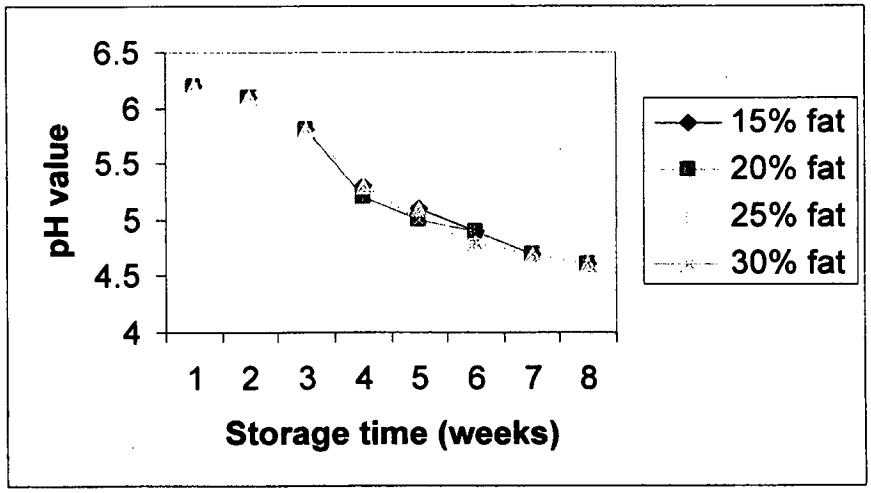

Figure 8.2: Variation of pH values of coconut milk samples during storage.

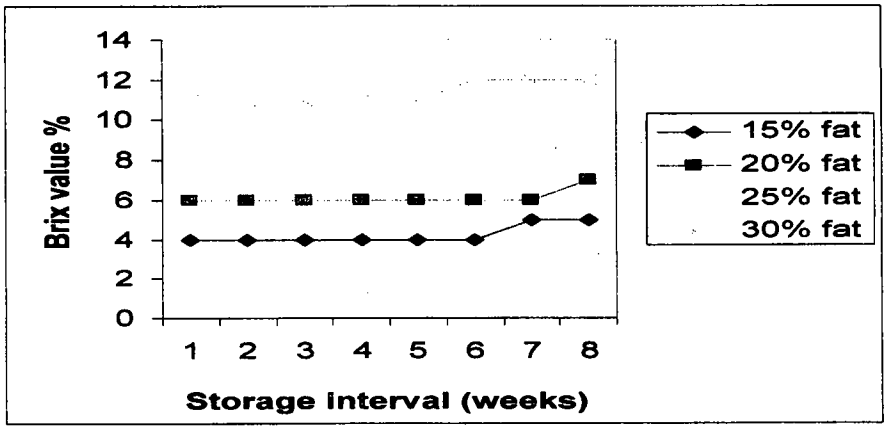

Figure 8.3: Variation of Brix value of coconut milk during storage

Determination of best fat content for domestic use

It is very important to have certain fat level which is suitable for direct use when developing a commercially available coconut milk pouch. This will reduce the waste of coconut by consuming unnecessary fat level at domestic level. Therefore a study was conducted to study the best fat level for domestic consumption.

The most suitable fat content for the domestic use was determined from a sensory evaluation test. The coconut milk samples with 15%, 20%, 25% and 30% fat contents were used for the study. Standard potato curry was prepared from each sample and served to a sensory panel consisting 30 semi trained panelists. The colour, taste, aroma and consistency of each sample were evaluated in a

five point hedonic scale. The results were analysed by using Kruskal Wallis test in MINITAB computer soft ware package. Hand squeezed coconut milk samples (15 samples) were collected randomly from households and analysed for fat content. Probability values and mean scores of sensory attributes for stored coconut milk are given in Table 8.1. According to the table panelists gave highest sensory scores for the potato curry prepared with 20% fat. Potato curry with 30% fat scored lower values in 5 point hedonic scale. The results indicated that taste, consistency, overall acceptability were significant ($P<0.05$) with fat content. Appearance and aroma were not significant ($P>0.05$) with fat level. Analysis of series of domestically prepared coconut milk indicated that it contained 12.5 % fat level. However the panelists preferred 20% for potato curry. So 20% fat content was selected as the most suitable fat content for pasteurized coconut milk pouch.

Table 8.1: Probability and mean sensory attributes of coconut milk at different fat levels

Attribute	p value	15%	20%	25%	30%
Appearance	0.092	3.33	4.16	3.8	3.66
Taste	0.008	3.76	4.16	3.34	3.36
Aroma	0.069	3.43	4.03	3.23	3.3
consistency	0.024	3.5	3.98	3.3	2.9
Overall acceptability	0.015	3.5	3.97	3.5	3.3

Study on addition of stabilizers to coconut milk

Coconut milk separated into two layers on storage. This is due to the instability of emulsion formed with fat protein and water. This causes a main draw back in processing of coconut milk for commercial purposes. Therefore a study was carried out to find out suitable stabilizer for coconut milk for preparation of coconut milk pouch for domestic consumption. Coconut milk pouch containing 20% fat used for studying the effect of stabilizer. Commercially available food grade stabilizers used in this study. Three treatments were carried out as given in Table 8.2.

Table 8.2: Treatments for studying suitable stabilizer for coconut milk

Treatment	Stabilizer	Level of addition
1	Pectin	0.1%
2	Guar gum	0.1%
3	Corn flour	0.1%

Sensory evaluation was carried out to find out best stabilizer among the different treatments. Standard potato curry was prepared from coconut milk from each treatment and served to a sensory panel consisting 30 semi trained panelists. The color, taste, aroma and consistency of each sample were evaluated in a five point hedonic scale. The results were analyzed by using Kruskal Wallis test in MINITAB computer soft ware package and given in table 8. It shows that 0.1% pectin added coconut milk scored highest scores indication that it is preferred by the panelists. However all the products are accepted by scoring more than 3.5 in 5- point hedonic scale. So pectin was used as the best stabilizer for processing coconut milk. But the storage studies indicated pectin could stabilize the coconut milk only for 3 days.

Table 8.3: Mean sensory scores of sensory attributes for coconut milk processed with stabilizer

Sensory attribute	Mean scores		
	Pectin 0.1%	Guar gum 0.1%	Corn flour 0.1%
Appearence	4.1	4.0	3.9
Aroma	4.3	3.6	3.7
Consistency	4.2	3.5	3.9
Taste	4.2	3.5	3.9
Overall acceptability	4.1	3.6	3.8

Observation was carried out during storage of processed coconut milk (stabilizer added). Taste, odor and color were retained in good condition for 14 days of storage. Layer separation was observed in the 3-4 days of storage when processed with 1% pectin. The observation further indicated that the processed coconut milk deteriorated within 2 hours with exposure to room temperature. Therefore the studies are continued to improve the quality of the product.

L.L.W. C. Yalegama, P. Gunathillake and M.A. I. Perera and A.R. Kulathunga

Experiment 9: Storage studies on frozen coconut based products

Storage of fresh coconuts in the frozen form is advantageous for export market trying to serve consumers in far away places in the world. Therefore, a study was conducted to evaluate the keeping quality of deep-frozen fresh matured coconut in different forms of servings. Three different types of fresh coconut samples were used for evaluation in this study. They were coconut chips, scrapped coconut and coconut cream.

(i) Fresh coconut in scraped

Coconut were scraped without touching the brown testa using a electric greater and steamed for 1.5 minutes.

(ii) Fresh coconut in chips

Coconut kernel was chopped into fine pieces after removal of the brown testa and steamed for 1.5 minutes.

(iii) Fresh coconut in cream

Coconut cream was obtained from de-pared scrapped kernel without addition of water using the Sakaya hydraulic press machine.

Each product was packed using Nylon LDPE (Low density polyethylene), Triple Laminate and Polyethylene as packaging materials and kept under frozen storage in a domestic freezer at -10°C.

The keeping quality of the frozen pouched coconut cream, scraped coconut, and coconut chips were monitored using FFA content and PV as parameter in biweekly intervals. Results showed that FFA content of the samples gradually increased with time. At the beginning, scraped coconut and coconut chips had similar FFA contents, but the FFA content of the coconut cream was little higher. At the end of eight weeks storage, the highest increment of FFA content was seen in coconut cream. But the changes were very marginal.

Table 9.1: Variation of FFA content of deep frozen coconut products

Storage period (weeks)	Packaging material	FFA value (as % lauric acid) Coconut cream	Coconut chips	Scraped coconut
2	Nylon LDPE	0.028	0.031	0.025
4		0.034	0.037	0.029
6		0.037	0.039	0.033
8		0.040	0.043	0.035
2	Triple laminate	0.023	0.032	0.041
4		0.024	0.035	0.042
6		0.027	0.037	0.046
8		0.031	0.039	0.049
2	Poly ethylene	0.039	0.042	0.037
4		0.046	0.048	0.042
6		0.052	0.056	0.047
8		0.056	0.061	0.053

Table 9.1 further showed the variation of the FFA content in each frozen product packed in different packaging materials. FFA content increased in each product packed in all the three packaging materials. But the products packed in triple laminates show comparatively slow increase and lower FFA values. FFA value produced by nylon LDPE is slightly higher than the values given by triple laminate packages. Polythene shows highest FFA values indicating it is not suitable for packaging of coconut products. The critical limit for FFA is considered as 1% for edible products. Peroxides were not detected for any of the products during the storage period due to the low temperature condition maintained throughout the experiment. During the storage period any of the products did not exceed this limit due to the low temperature condition operated in this experiment. All the products were in good condition even after the end of the 2nd week but it deteriorated very soon when exposed to room temperature. Shelf of coconut cream was not satisfactory when it exposed to room temperature. The reason may be the blanching time or temperature which was given initially were not sufficient. Therefore the further studies are continued to increase the quality of the deep frozen coconut products.

Microbiological quality

The total plate count/g of each product packed in different packaging material showed in the table 9.2.

Table 9.2: Variation of TPC of frozen coconut products

Storage period (weeks)	Total plate count/g			
	Packaging material	Coconut cream	Coconut chips	Scraped coconut
0	-	$2.14*10^3$	$2.05*10^3$	$1.97*10^3$
2	Nylon LDPE	$2.65*10^4$	$2.37*10^4$	$2.55*10^4$
4		$2.80*10^4$	$2.55*10^4$	$2.78*10^4$
6		$2.80*10^4$	$2.55*10^4$	$2.78*10^4$
8		$2.01*10^6$	$1.10*10^6$	$1.83*10^6$
2	Triple laminate	$2.80*10^4$	$2.55*10^4$	$2.78*10^4$
4		$2.44*10^4$	$2.25*10^4$	$2.34*10^4$
6		$2.68*10^4$	$2.53*10^4$	$2.43*10^4$
8		$1.67*10^6$	$1.05*10^5$	$0.35*10^6$
2	Poly ethylene	$2.48*10^4$	$2.33*10^4$	$2.37*10^4$
4		$2.75*10^4$	$2.65*10^4$	$2.58*10^4$
6		$1.92*10^6$	$1.10*10^5$	$1.33*10^5$
8		$1.92*10^6$	$1.10*10^5$	$1.33*10^5$

The total plate count increased with the storage period. The organoleptic changes observed during storage also can be due to the exceeded levels of micro organisms.

When considering the processing techniques the plate count of fresh product is performed soon after the blanching. Growth of micro organisms can takes place to some extent due to the time taken for packaging. Also during the thawing period some organisms which were inactive at freezer condition but can become active. Therefore, the increase of plate count can take place. Therefore the process should be improved to increase the quality of the product by increasing the blanching time, pasteurization of the products before packing...etc. organisms inside the packed products at the freezer storage.

Sensory evaluation

Frozen coconut cream, scraped coconut and coconut chips evaluated by subjecting to general scrutiny such as observations on odor, taste, appearance, color and overall acceptability in two weeks intervals using 25 semi trained panelists. Fresh coconut samples were served as the reference. The products packed triple laminates used in the evaluation of sensory property under Triangle Test and the results were interpreted under 0.05 significant level. The products packed in triple laminates were used in the sensory evaluation as it shoed lower FFA values during the storage period. Probability values are given in table 9.3.

Table 9.3: The probability values of the sensory attributes of deep frozen coconut products

Storage time (weeks)	Probability value		
	Coconut milk	Coconut chips	Scraped coconut
2	0.013	0.013	0.01
4	**0.092**	0.013	0.01
6	**0.092**	0.013	**0.848**
8	**0.194**	0.013	**0.92**

Probability value P <0.05 significant

Coconut cream was accepted only up to the 2 nd week of the storage due to the development of undesirable colour and smell and due to the layer separation. But no flavor change was observed. Coconut chips were accepted for a period of 8 weeks. The panelists rejected scraped coconut at the 4th week of its storage. The rejection of scraped coconut was due to development of sweet flavor which can be easily recognized compared to the fresh scraped coconut.

P. Gunathilake, C. Yalegama and L.A.C.N.L.Arachchi

2. Extension activities

Several demonstrations were conducted at Coconut Processing Research Division, for students from Universities, technical collages, schools and industrialists.

The staff of Coconut Processing Research Division held a training program for Assistant Estate Superintendents on "coconut products" at the Coconut Processing Research Division.

The staff of Coconut Processing Research Division conducted a one day workshop on the production of good quality copra and coconut oil for entrepreneurs from various parts of the country.

Mrs. JAKM Fernando & Mr. J.R.Kalum Asanka participated for the regional coir value chain development steering group meetings held at, Goldi sand Hotel –Negembo, IDB- Pannala CRI-Lunuwila , Chamber of Commerce- Chilaw. These meeting were organized by the Enter- growth project of Puttalm District.

Mrs. JAKM Fernando participated at steering committee meetings held at Industrial Technology Institute & Coconut Development Authority on Pilot facility for efficient coir processing & quality control.

3. Awards and Recognition

J.M.M.A. Jayasundera was honored with a Presidential Award for her research work on charcoal fired modified copra kiln

REPORT OF THE PLANT PHYSIOLOGY DIVISION

Acting Head – A D Nainanayake, Ph D

1. GENERAL

Research programme of the division was conducted using the consolidated fund and the coconut CESS fund. Evaluation of hybrid vigour of dwarf crosses at different agro-ecological regions i.e. three sites did not reveal potential varieties for hybrid vigour based on physiological parameters due to the well spread rainfall experienced during the year in three experimental sites. A long-term experiment at Wanathavilluwa (DL3) (S_2 with *Gambura* and *Mavillu* series) was started last year to determine the effect of irrigation on the vegetative growth, flowering time and yield under different land suitability classes. Irrigation @ 10 litres / seedling / day during first two years improved the vegetative growth by about 15% in both TT and DT seedlings while doubling the rate i.e. irrigation @ 20 litres / seedling / day, improved it by more than 40% in both TT and DT compared to the non-irrigated controls.

The rain water harvesting project that started in 2005, primarily intended to construct small rain water harvesting tanks for collecting runoff in CRI estates. The post evaluation of the improvement of yield surrounding three such tanks constructed at Bandirippuwa estate revealed that palms in those three fields have recorded about 20% above mean yields in 2007, even when the rainfall is 20% lower than the mean rainfall for last seven years. Contribution in this regard by the constructed rain water harvesting tanks and the consistency of maintaining such yields are yet to monitor in years to come. Evaluation of a model drought management system for mini-coconut triangle was started at Middeniya Research Centre with the objective to identify an overall drought management package for drought prone areas in the mini coconut triangle. DT and Kapruwana (DG x SR) showed significantly higher vegetative growth towards the latter part of the year while five Kapruwana seedlings started initial flowering at the approximate age of two years and three months.

A study carried out to determine the effect of the soil condition (land suitability class, LSC) on the growth of root system of seedlings showed that seedlings in S4 LSC at 3.5 yrs of age showed significantly low growth performance in above ground parts, physiological activities and roots when compared to those in S2 and S3. The provision of a better environment for root growth in the planting hole, which facilitated good environment for the moisture conservation and root growth, was the main reason for more or less uniform growth performances of seedlings in three different LSC in first few years. This emphasizes the importance of the well prepared planting hole for the growth of coconut seedlings in first few years in the field especially in S4 or similar soils. Heat based sap flow techniques appeared promising to evaluate the water status of coconut palm under field conditions and indicated the possibility of using this method for screening coconut varieties for drought tolerance.

The protocol for quality preservation of tender king coconuts for a period of one month was obtained by 6 exporters during the year and permits were issued for exporting two consignments of preserved king coconuts during the year. A study was initiated to compare total sugars and polyphenol contents in the soft tissues under the perianth of mite-infested and mite-free nuts in different cultivars with the assistance from the Faculty of Science, University of Peradeniya.

2. PROJECTS

THRUST AREA: CROP IMPROVEMENT

PROJECT: STUDIES ON FACTORS LIMITING DRY MATTER PRODUCTION IN COCONUT VARIETIES AND HYBRIDS

Experiment: Evaluation of hybrid vigour of Dwarf Brown x Tall, Tall x Dwarf Brown and Dwarf Brown x San Ramon for yield and tolerance to moisture stress in different agro-ecological zones (Raddegoda, RE and Wanathavilluwa)

Dwarf Brown appears promising for plant breeders as an ideal parent material due to some characteristics such as non seasonality, high yielding capacity (higher number of nuts per bunch and higher no of inflorescence per palm per year) and relatively higher tolerance to water stress conditions compared to those of other dwarf varieties. Therefore, a number of hybrids were developed using Dwarf Brown as male as well as female parents. The objective of this experiment was to evaluate the 'hybrid vigour' of such hybrids based on their vegetative, physiological, drought tolerant and yield characteristics under different agro-ecological regions i.e. Raddegoda (IL3), Rathmalagara (IL1) and Wanathavilluwa (DL3). Hybrids under evaluation were Dwarf Brown x Tall, Dwarf Brown x San Ramon, Tall x Dwarf Brown, Dwarf Green x Tall, Dwarf Green x San Ramon, Tall x San Ramon along with Tall x Tall and Dwarf Brown as controls. Experiments were established as RCBD in all three experimental sites.

Physiological characteristics were measured approximately for one year period at Raddegoda (IL3) experimental site while measurements were just started at other two sites. No significant differences were observed among hybrids during this period with respect to any of the physiological parameters monitored at Raddegoda. For instance, mean rate photosynthesis of all seven hybrids was shown in Fig. 1, along with monthly rainfall (mm). Well-spread rainfall experienced during the period under investigation indicates that plants were not exposed to an extreme moisture stress during the year and hence, the varietal differences were not conspicuous. Data collection is in progress at all three experimental sites.

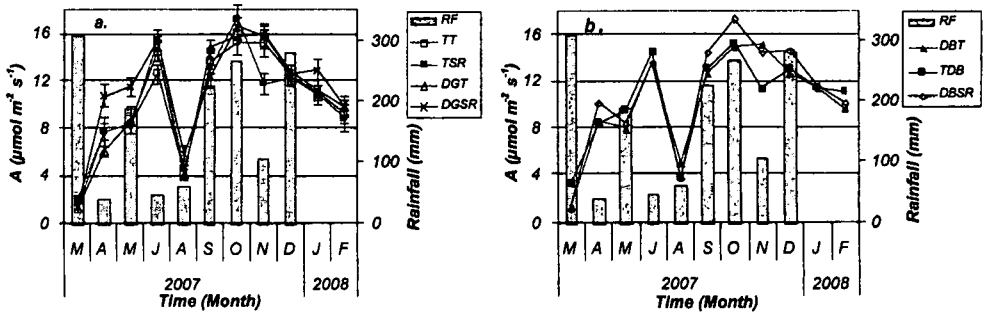

Figure 1: Mean rate of photosynthesis (A, µmol m^{-2} s^{-1}) of seven hybrids and monthly rainfall (mm) at Raddegoda.

A Nainanayake, C S Ranasinghe, H C Mendis, R D N Premasiri, L R S Silva

Experiment: **Coconut Genome mapping (collaborative experiment with GPBD)**

A mapping population of coconut was developed by crossing between single tall pollen donor and 26 genetically identical Dwarf Red mothers by GPBD. The characterization of seedlings from 26 families using physiological characteristics such as net assimilation rate, water use efficiency and related biochemical parameters under plant house conditions could not be implemented as scheduled due to the delays in the construction of the plant house. Therefore, seedlings were planted at Walpita Research Station and the physiological characterization is yet to start after the establishment of seedlings under field conditions.

A Nainanayake, C S Ranasinghe, S A C N Perera (GPBD)

THRUST AREA: **CROP PRODUCTION**

PROJECT: **STUDIES ON WATER, LIGHT, HEAT STRESS AND ELEVATED CO_2 EFFECTS ON PRODUCTIVITY**

Experiment: **Effect of irrigation on physiological, vegetative and yield characters of Tall x Tall and Dwarf Green X Tall crosses**

Objectives of this study is to identify and quantify potential benefits of irrigation on two commercially available coconut cultivars in different land suitability classes by investigating vegetative growth, physiological and yield characteristics. This would provide site-specific recommendations for coconut cultivation under irrigation. Two commercially available improved coconut cultivars (CRIC 60 and CRIC 65) were used.

Treatments

T1 - Control (No irrigation but with general management practices)
T2 - Irrigation @ 40 litres / palm / day during dry spell
(Irrigation @ 10 litres / palm / day for first two years, 20-30 litres / palm / day until 5 years of age & thereafter 40 litres / palm / day)
T3 - Irrigation @ 80 litres / palm / day during dry spell
(Irrigation @ 20 litres / palm / day for first two years, 40 litres / palm / day until 5 years of age & thereafter 80 litres / palm / day)

Irrigation was started after a 15 days of continuous rain-free period.

Location : Thapal watta, Wanathawilluwa,
DL3 (Latasol & regosol region of the dry low country region)

Soil type and land suitability :

a. *Mavillu* series

S2 (suitable to highly suitable)
Imperfectly drained
Very deep (> 120 cm)
Sandy loam to sandy clay loam soil
Slope approx. 3%
Potential yield 12,500 – 15,000 nuts/ha/year (5,000 – 6,000 nuts/ac/year)

b. *Gambura* series

S3 (suitable)
Well drained
Very deep (> 120 cm)
Sandy loam to sandy clay loam soil
Slope approx. 3%
Potential yield 10,000 – 12,500 nuts/ha/year (4,000 – 5,000 nuts/ac/year)

Seedlings were planted in early 2006 and all seedlings were uniformly treated until they established well in the soil. Seedlings of both varieties under T3 maintained the highest rate of photosynthesis which differed significantly ($P < 0.01$) from those of T1 and T2 in both LSC throughout the period (Fig. 2). However, these differences were marginal during wet periods (e.g. September, 2007) due to uniform wetting of the soil with raining.

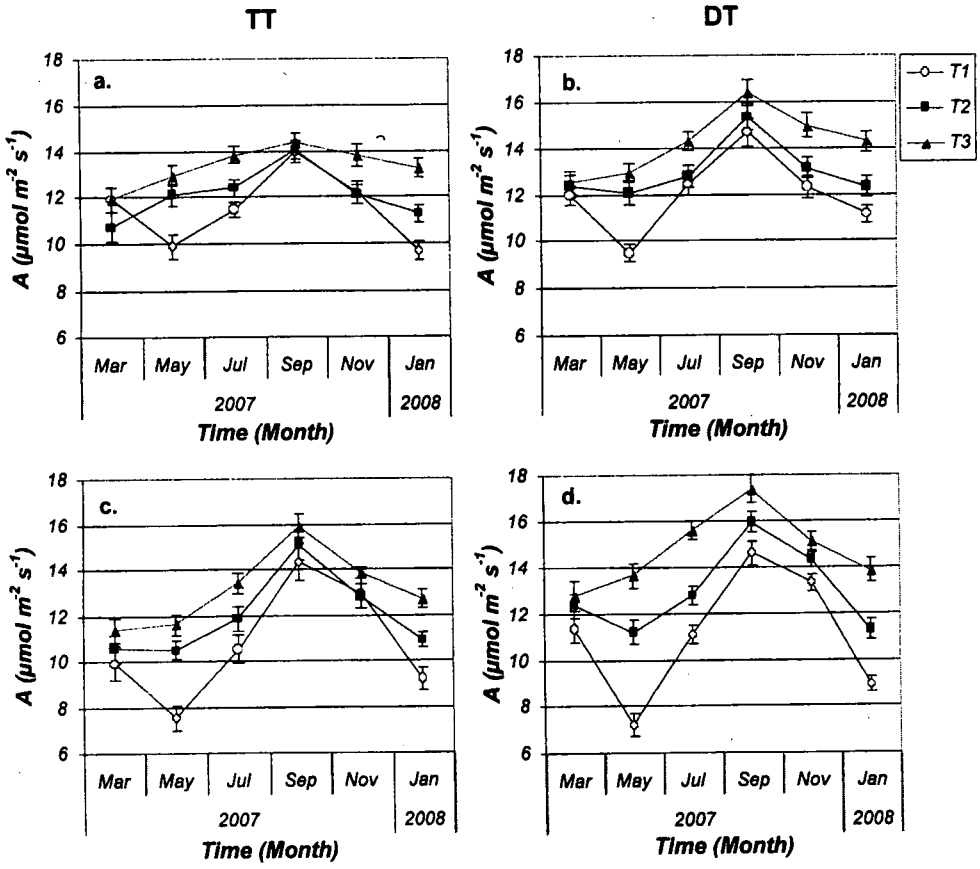

Figure 2: Mean rate of photosynthesis (A, µmol m^{-2} s^{-1}) of TT & DT seedlings in (a & b) Gambura series and (c & d) Mavillu series soils

DT showed higher (8%) overall photosynthetic rate compared to that of TT and this difference was more pronounced in irrigated plots, especially in T3 (11% in *Mavillu* and 7% in *Gambura* series). Both varieties showed marginally higher photosynthetic rates (3%) when grown in *Mavillu* series soils compared to those in *Gambura* series soil. Although no significant differences were observed between treatments with respect to the girth of seedlings until March 2007, seedlings of both irrigation treatments (T2 & T3) showed significantly higher ($P < 0.01$) mean girth at collar region compared to that of controls (T1) (Fig. 3).

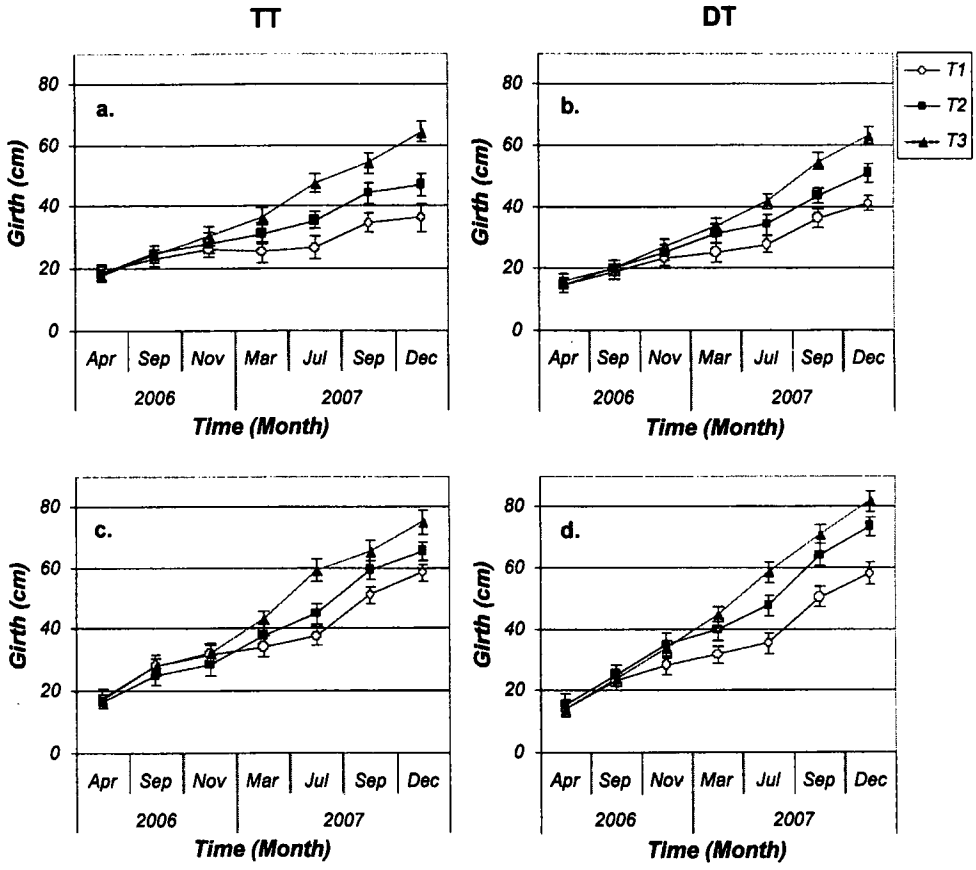

Figure 3: Mean girth at collar region (cm) of TT & DT seedlings in (a & b) Gambura series and (c & d) Mavillu series soils

TT seedlings in T2 and T3 plots under *Gambura* series soil showed 30% and 80% higher girth respectively at the end of the year compared to that in control plots (Fig. 4). Similarly, 25% and 55% higher girth was observed respectively in T2 and T3 treatment plots of DT seedlings under the same soil. Even when seedlings were grown in *Mavillu* series soil, girth was significantly higher in T2 and T3 treatment plots of TT (10% & 30%) and DT (30% & 40%). Therefore in general, irrigation @ 10 litres / seedling / day during first two years has improved the girth at least by 20% in both TT and DT seedlings. Similarly, doubling the rate i.e. irrigation @ 20 litres / seedling / day during first two years, improved the girth by about 50% in both TT and DT compared to the non-irrigated controls.

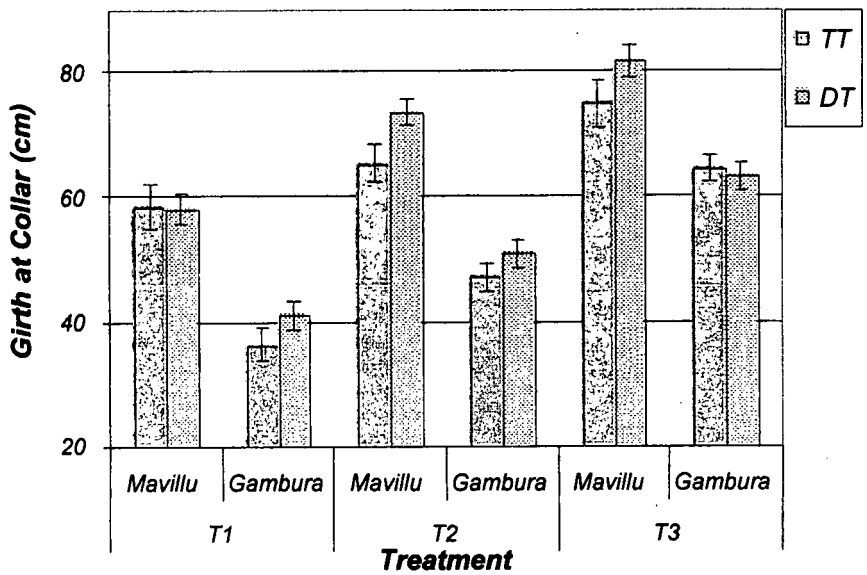

Figure 4: ***Mean girth at collar region (cm) of TT & DT seedlings in Gambura and Mavillu series soils at the end of the year***

Similar pattern was observed for the total number of leaves also. TT seedlings in T2 treatment showed 10% and 20% higher total number of leaves respectively in *Gambura* and *Mavillu* series soils while the same was 20% and 40% higher in T3 treatment plots (Fig. 5). DT showed 15% and 30% higher total number of leaves respectively in T2 and T3 treatment plots irrespective of LSC. Accordingly, irrigation @ 10 litres / seedling / day during first two years improved the total number of leaves approximately by 15% in both TT and DT seedlings while doubling the rate, improved it by about 30% in both TT and DT compared to the non-irrigated control plots.

Studies on root growth aspects i.e. No. of roots, rooting depth, root length, root length density are scheduled for next year. Experiment is in progress.

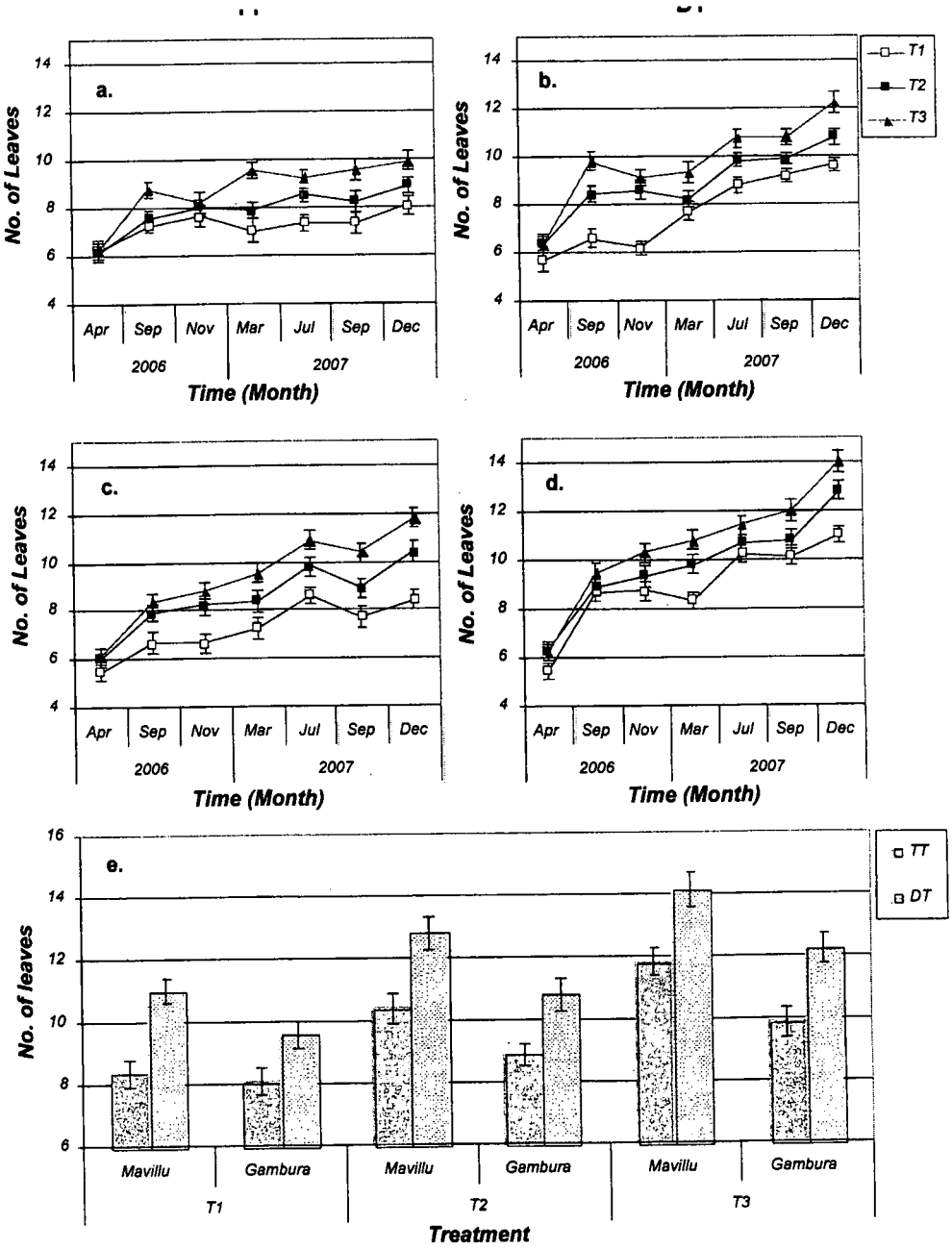

Figure 5: ***Mean No. of leaves of TT & DT seedlings in (a & b) Gambura series and (c & d) Mavillu series soils and (e) Mean No. of leaves of TT & DT seedlings at the end of the year***

A Nainanayake, H C Mendis, R D N Premasiri, L R S Silva

Experiment: **Yield improvement in coconut lands by Rain water harvesting techniques**

The intermediate zone of Sri Lanka where coconut is highly concentrated, receives substantial amount of rainfall of high-intensity with short-duration. Due to the surface runoff more than 70% of water ends up in streams causing soil erosion and nutrient losses.

Rain water harvesting is the collection of such surface runoff water for productive purposes reducing the soil erosion and nutrient loss. Collected runoff water helps to maintain the water table and also replenish deeper soil layers which can be exploited by deeper roots. If the infiltration of the soil is low, surface collection can be utilized for irrigation purposes and also helps to make favourable changes in the microclimate. The objective of this experiment is to construct rain water harvesting tanks with substantial catchment area in CRI estates and improve soil moisture content during subsequent dry spells and thus reduce yield drops in effective areas of the surrounding coconut plantation.

The scheduled construction of one rain water harvesting tank at Maduru Oya GRC was suspended due to the financial constraints. Improvements in field-wise yield data and soil moisture content in the surrounding and low lying areas were monitored on three such tanks constructed at Bandirippuwa estate having capacities of 270 m^3 (0.22 acre feet), 1800 m^3 (1.60 acre feet), 4600 m^3 (3.72 acre feet) in field no 2, 3 and 7 respectively. The observed above mean yields in all three fields in 2000, 2001 and 2006 are explained up to some extent by the above mean rainfall levels received in respective previous years (Fig. 6).

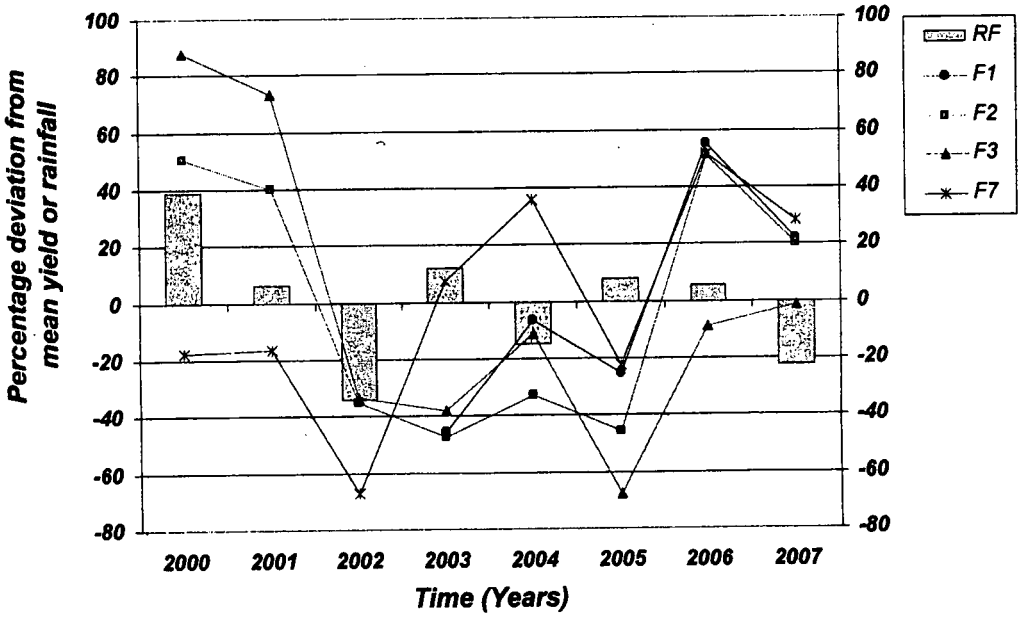

Figure 6: ***Percentage deviations of field-wise yield data and annual rainfall from means for the period from 2000-2007***

However, even with the above mean rainfall levels, coconut yields in same fields were dropped by more than 20% in 2003 and 2005. This may be due to the dragged effects of low rainfall conditions experienced in respective previous years, 2002 and 2004. Palms in those three fields have recorded about 20% above mean yields in 2007, even when the rainfall is 20% lower than the mean rainfall. Constructed rain water harvesting tanks in those fields in 2006 may have contributed in this regard resulting in the improvement and maintenance of the water table even during dry spells. Although it is yet to monitor the consistency of these results in subsequent years and to identify possible contributory factors compounded, some positive trends are already indicated.

A Nainanayake, N A Tennakoon (SPND)

Experiment: **Evaluation of a model drought management system in Middeniya Research Station**

Although the Middeniya area in the Hambantota district receives an average rainfall of about 1300 mm with two peak periods in October- December and March-May, a substantial dry spell can be observed from June to September each year. These droughts result in a marked reduction in yield in the area. However, the average annual rainfall and its monthly distribution for last two decades revealed a possibility to reduce the effects of dry spells substantially, if proper soil moisture management practices are adopted. Therefore, the objective of this experiment was to develop a new coconut plantation with an overall drought management practices (mulching, husk burial, incorporation of organic material, introduction of cover crops (*Peuraria*) and some nitrogen fixing trees (*Gliricidia*)). It was expected to evaluate all improved cultivars released by CRISL so far under these conditions [Tall x Tall (CRIC 60), Dwarf x Tall (CRIC 65), Tall x San Ramon (CRISL 98), Dwarf Green x San Ramon (Kapruwana) along with Rumassala (local accession from Southern Province)]. Five coconut cultivars in three blocks under three treatments were planted with 9 seedlings per plot in Randomized Complete Block Design.

Treatments

a. Control with only fertilizing but without any soil moisture conservation practices
b. Application of overall soil moisture conservation and improvement practices
   Mulching, husk burial (10 x 4 x 4 pits between rows)
   Incorporation of organic material (cow dung) for the improvement of soil texture and moisture holding capacity.
   Introduction of cover crops and NFTs (*Peuraria* and *Gliricidia)*
c. Irrigation @ 10 litres per seedling per day during drought period for first 2 years, 20 litres per seedling per day during drought period until the age of 5 years and thereafter 40 litres per palm per day during droughts. Irrigation will be started after a continuous rain-free period of 15 days.

All plots are separated by a guard row and there are 405 and 372 seedlings in treatment plots and guard rows respectively amounting to a total of 777 seedlings planted in a 8 m x 8 m square system spreading over 12 acres of land.

DT and Kapruwana (DG x SR) showed significantly higher vegetative growth i.e. girth at collar, height and number of leaves, towards the latter part of the year (Fig. 7). No significant differences were observed between varieties or between treatments with respect to the physiological parameters during the period. This may probably be due to the well spread rainfall experienced during the year without a conspicuous dry spell. The construction of the ferro-cement tank and the installation of a new irrigation system were completed during the year and therefore the irrigation treatment (T3) is yet to start with the subsequent dry spell. This resulted in the observed no differences between treatments (especially in T3) but it is expected to observe the effect of irrigation in years to come. Initial flowering was observed in five Kapruwana seedlings just at the approximate age of two years and three months. Experiment is in progress.

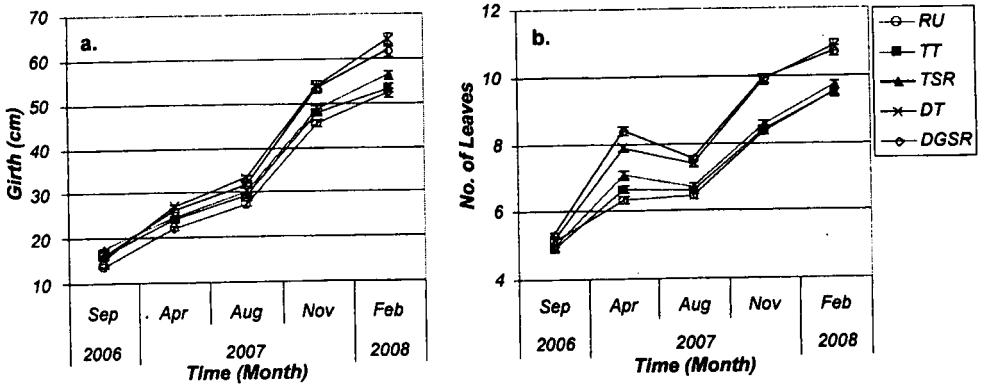

Figure 7: ***Mean girth and number of leaves of five improved cultivars at MRC***

A Nainanayake, H C Mendis, L R S Silva, R D N Premasiri

Experiment: **The effect of CO_2 elevation in the atmosphere on acclimatization of embryo-cultured plants**

The adaptation of embryo-cultured coconut seedlings grown under laboratory conditions to the external environment is relatively a slow process. This substantially extends the time taken up to field planting. Thus the objective of this experiment was to determine the effect of elevation of atmospheric CO_2 during the acclimatization, on vegetative growth of embryo-cultured coconut plants and thus to improve the acclimatization protocol of embryo-cultured plants. Embryo cultured plants were placed in two open top chambers (OTC) (4.3 m diameter x 2.8 m height, covered with UV treated polythene) at Bandirippuwa Estate and exposed to either elevated CO_2 (500-550 ppm) or ambient CO_2 (350-360 ppm). Mean photosynthetic rate was 10% lower in embryo-cultured seedlings grown under ambient air in OTC compared to that of ordinary tall seedlings of same age grown in pots under open atmospheric conditions (Fig. 8a).

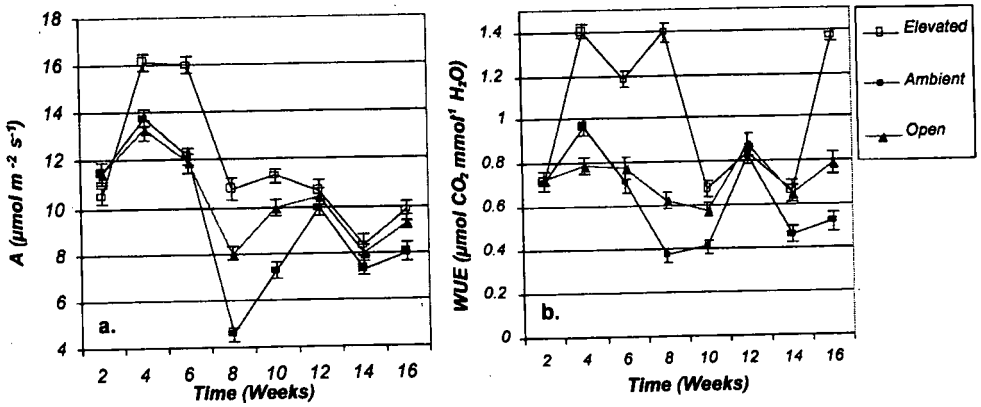

Figure 8: ***(a) Mean rate of photosynthesis (A, µmol m^{-2} s^{-1}) and (b) mean water use efficiency (µmol CO_2 $mmol^{-1}$ H_2O) of Dikiri coconut seedlings grown under ambient and elevated CO_2 levels compared to ordinary tall coconut seedlings grown in pots under open air.***

However, the elevation of atmospheric CO_2 concentration increased the mean photosynthetic rate of embryo-cultured seedlings by about 25% and this improved rate was 15% higher than the rate of photosynthesis of ordinary seedlings. Similarly, the mean instantaneous water use efficiency ($_i = A/E$) of embryo-cultured seedlings was 13% lower and 43% higher under ambient and elevated CO_2 levels respectively when compared with the $_i$ of ordinary coconut seedlings (Fig. 8b). Thus the elevation of CO_2 increased the $_i$ by about 65% within the 16 week period. However these differences were not so conspicuous in vegetative growth parameters (data not shown) and this indicates that CO_2 elevation for a short time period i.e. 3 months may not be sufficient to achieve improvements in vegetative growth in coconut although improvements were observed in physiological parameters. This indicates that although there is a potential of increasing the growth rate of embryo-cultured seedlings by CO_2 elevation, exposure of substantial period is required to gain significant impact in seedling growth.

A Nainanayake, W W I L Fernando, C S Ranasinghe, L R S Silva

PROJECT: **STUDIES ON ROOT GROWTH, ROOT ACTIVITY AND ROOT FUNCTIONS IN RELATION TO WATER AND NUTRIENT UPTAKE**

Experiment: **Investigation of growth performances of Tall x Tall coconut seedlings grown in different land suitability classes, with particular reference to root system.**

This experiment was established in 2003 to investigate the effect of land suitability class (LSC) on the above ground and below ground growth performances of coconut seedlings. 24 seedlings of CRIC 60 (TT) were planted in three land suitability classes; S2, S3 and S4. The effect of LSC on the growth and the development of roots were evaluated by destructive sampling. Two destructive samplings were conducted one year and one and half years after establishment and six seedlings grown in each suitability class were uprooted. The rest of the seedlings were allowed to grow in the field and used for root density studies. The first root density measurement was conducted 2.5 yrs after planting at 0-30 cm depth and the second was performed 3.5 yrs after planting at 0-60 cm depth using core sample method. Leaf area measurements were taken at 6 month-intervals regularly.

Significant differences ($p<0.001$) were observed in height and the leaf area of seedlings grown in three LSC 1.5 year after planting (Fig. 9). Seedlings in S2 showed the highest leaf area while seedlings in S4 showed the lowest. Although there was no significant difference in water relation measurements between seedlings in different LSC at the initial stage, seedlings in S2 and S3 showed higher transpiration and leaf water potential at 3.5 year after planting which was significantly differed ($p<0.001$) from that of S4 (Table 1). There was no significant difference in total root density (0 – 60 cm depth) between S2 and S3 LSC but it was significantly lower ($p<0.01$) in seedlings grown in S4 soils (Table 2).

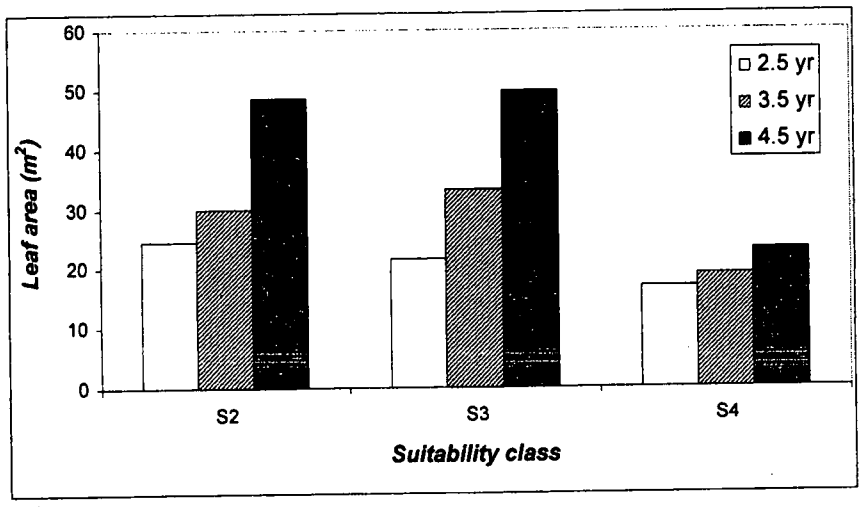

Figure 9: ***Leaf area of the saplings measured at three different time period***

Table 1: ***Mean Leaf Water Potential (_), Transpiration (E), Stomatal Diffusive Resistance (r_s), Relative Water content (RWC) and soil moisture content at 0-30 cm depth measured in seedlings grown in suitability class 2,3 and 4 after 3.5 years of planting***

LSC	(MPa)	E (μg cm^{-2} s^{-1})	r_s (s cm^{-1})	RWC (%)	Soil moisture (%)
S2	-1.12^a	2.79^a	7.07^b	96.58^a	7.49^a
S3	-1.14^a	2.75^a	7.33^b	96.48^a	7.07^a
S4	-1.37^b	1.49^b	12.68^a	93.43^b	4.76^b

Means are average of six replicates. Means connected vertically with the same lower case letter are not significantly different at p=0.05

Table 2: ***Root density and diameters measured at 2.5 year and 3.5 year after planting***

	2.5 year after planting		3.5 year after planting		2.5 yr	3.5 yr
	Root density		Root density		Large root Diameter	
Suitability class	Large roots (Diameter >3mm) (g mL^{-1})	Fine roots (Diameter <3mm) (g mL^{-1})	Diameter >5mm (g mL^{-1})	Diameter <5mm (g mL^{-1})	Diameter >3mm	Diameter >3mm
S2	1.065^a	0.98^a	1.221^a	1.345^a	5.91^a	5.9^a
S3	0.913^a	0.92^a	1.321^a	1.411^a	4.92^b	5.4^b
S4	0.586$_b$	0.43^b	0.678^b	0.875^b	3.75^c	4.4^c

Means are average of three replicates. Means connected vertically with the same lower case letter are not significantly different at p=0.05

Similarly, the fine root density (diameter less than 5 mm) also showed the lowest in S4 and deferred significantly ($p<0.01$) from the rest. Though there was no significant difference in root relative water content (RWC_{root}) between LSC, leaf RWC (RWC_{leaf}) was significantly ($p<0.0001$) lower in S4 than those of S2 and S3 at 2.5 and 3.5 yr after planting (Table 1). However, seedlings in S4 LSC at 3.5 yrs of age showed significantly low growth performance in above ground parts, physiological activities and roots when compared to those in S2 and S3. The results suggested that, there were no significant effect of suitability classes on the physiological performances of seedlings grown in three land suitability classes until 2.5 yrs except LWP observed in dry periods. The provision of a better environment for root growth in the planting hole, which facilitated good environment for the moisture conservation and root growth, could be the main reason for more or less uniform growth performances of seedlings in three different LSC in first few years. This indicates that the importance of the well prepared planting hole for the growth of coconut seedlings in first few years in the field. Also, the seed hole of 3'x3'x3' could facilitate the seedlings only for limited period; i.e. 2- 2.5 yrs after which seedling growth is substantially affected, if the surrounding soil is not conducive for root growth as observed specially in S4 soils. Hence the preparation of larger planting holes, 4'x 4'x 4' or even larger may facilitate seedling growth for extended periods nullifying the effect of LSC especially in S4 or similar soils. The experiment was terminated.

W S Madurapperuma, R D N Premasiri, M Gunawardane

Experiment: **An Investigation of drought tolerance mechanism in coconut (*Cocos nucifera* L); with particular reference to roots**

Studies on plant water status provide a way for understanding the drought tolerance mechanisms in plants. Since the introduction of thermodynamic methods for studying the plant water status, it has widely been adopted as a convenient and reliable technique to estimate the rate of water use by plants. Heat pulse based sap flow measuring techniques have so far not been used for coconut to estimate plant water status or to evaluate drought tolerance mechanisms. Therefore, particular attention was paid to investigate the possibility of using the heat based sap flow techniques to evaluate the plant water status of TT and DT palms under field conditions to explore the possibility of using this method for screening purposes.

Compensation Heat Pulse Method (CHPM) was used to measure the sap flow in palms. Heat pulse velocity was determined by this method in DT and TT coconut palms grown under two different land suitability classes (S2 and S4) in two Agro-Climatic Zones (WL2 and IL1). Trunk samples were collected from respective palms to measure the thermal properties of the sap wood which was used to convert the heat pulse velocity to sap flux.

An initial experiment was started with the objective to determine the suitable depth to install the sap flow probes. The probes that were installed at the depth of 7.5 cm and the 7.0 cm didn't show any significant difference between sap flow values and gave a higher flow rates than the probes installed at a depth of 6 cm or the 6.5 cm. The depth less than 6.0 cm did not result a smooth base line or the flow rate indicating a lesser amount of vascular bundles or a higher amount of non functional vascular bundles towards the bark. This significant reduction of the amount of sap flow (34% and 48% at the depth of 6.5 and 6.0 cm when compared with 7.5 cm) with decreasing the depth (Fig. 10) indicated that the depth of 7.5 cm or 7.0 cm (which did not give significant differences ($p<0.01$) between these two depths)

was better than the depth of 6.5 or 6.0 cm to install the sap flow sensors. Hence, the depth of 7.5 cm was selected as the most suitable depth for installation of sap flow probes in coconut palms.

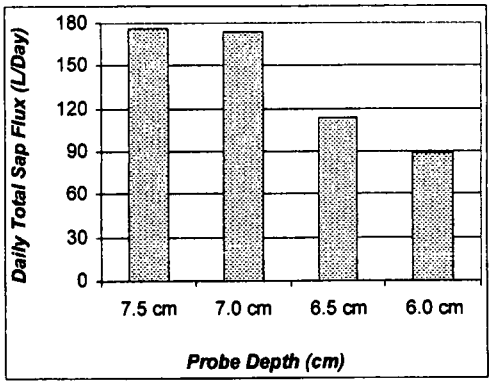

Figure 10: Total daily average sap flow at different depths

Sap flow measurements of two adult palms (20 years of age) of TT grown in WL2 were carried out initially. Both TT palms grown in S2 soils in WL2 showed a similar pattern in sap flux with time and the maximum amount of sap flux was indicated by the height of the peak. The maximum hourly sap flow was 22 L in TT palms grown in S2 soils and varied between 15 - 22 L in different days (Fig. 11). No rains were experienced during the period of study and the soil moisture content remained relatively constant (21-24% gravimetric water content at 50 cm depth).

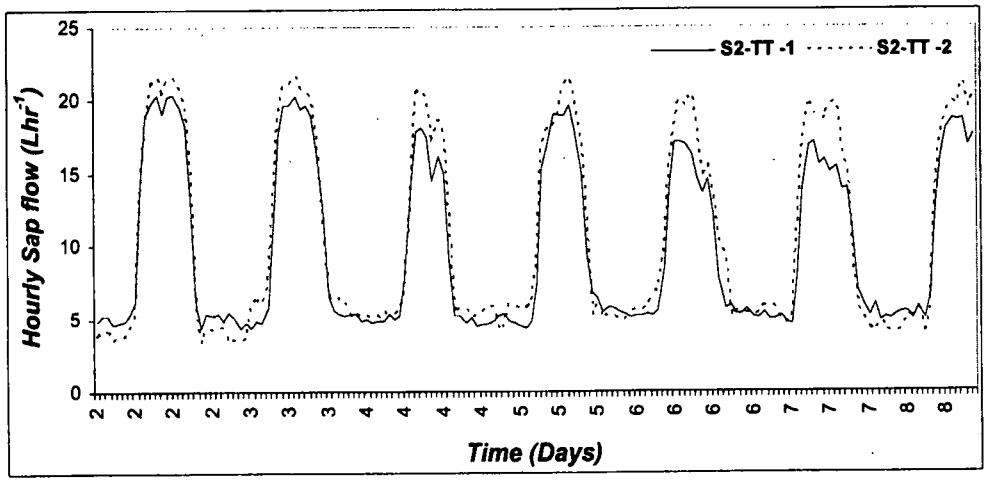

Figure 11: Diurnal course of hourly sap flow in two different TT palms grown in S2 soils

The calculated daily whole-plant water use (sap flow) of the TT palms grown in S2 soils of WL2 was estimated as in the range of maximum 202 L of water and the minimum 150 L with the average daily total sap flow of 176 L day^{-1}. There was no significant difference ($p<0.01$) between palms of similar varieties grown in similar environment. The time of starting sap flow movement could not be identified exactly as the base line started at 4-5 L (Fig. 12). Hence, it has possibly masked the actual situation that occurred during the night

time showing that there was a sap flow of 4-5 L hr^{-1}. Therefore, when the daily total sap flow per palm was calculated, the daily sap flow from 6.00 am to 6.00 pm was considered. Once the flow reached the maximum value around 10.00 a m, it remained at the same level with miner fluctuations for about 5-6 hours showing the same pattern every day.

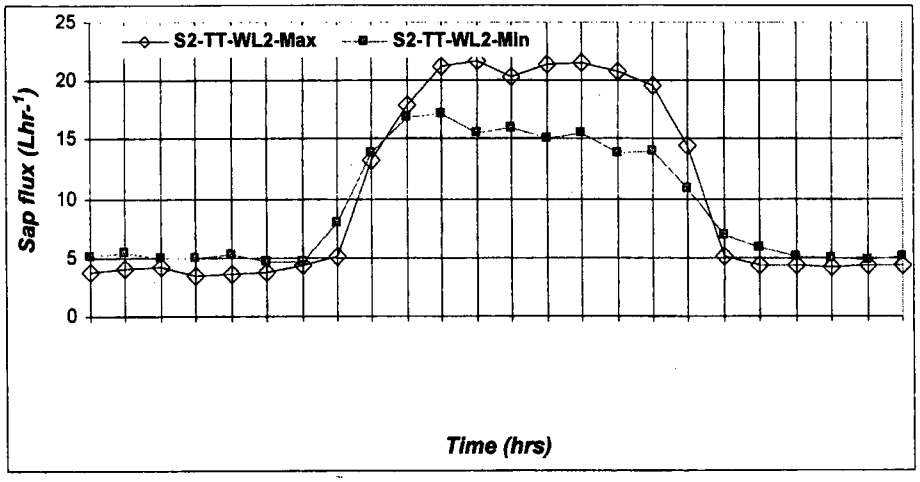

Figure 12: Pattern of changing sap flow within a day of TT palm grown in S2 soil (WL2)

The diurnal fluctuation of hourly sap flow of a TT palm under S4 soils gave the maximum hourly sap flow of 15 L and fluctuated within 5 L range with the minimum amount around 10 L. The maximum amount of water loss (sap flux) of the TT palms grown in S4 soils in WL2 was 150 -160 L day^{-1} and the minimum was 105 -112 L day^{-1} with the average daily total of 134 L day^{-1} which is 24 -17% lesser than the TT palms grown in S2 soils under similar climatic conditions (WL2) indicating the effect of soil suitability class on the transpiration loss of palms. The diurnal time course of sap flux of TT palm in IL1 is illustrated in Fig, 13a and the daily total sap flux was shown in Fig. 13b.

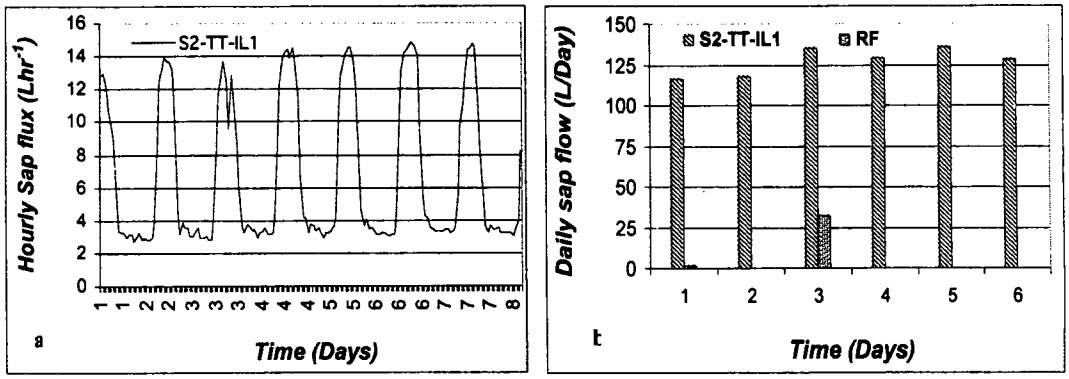

Figure 13: Diurnal time course of sap flux of a TT palm grown in IL1 (4A) and the daily total sap flux (4B)

The maximum hourly sap flux of TT palm grown in S2 soil was 15 L (Fig 13a) and under that condition TT palms grown in S2 soils showed the daily total average sap flux of 127 L day^{-1} with the maximum of 136 L day^{-1} and the minimum of 117 L day^{-1} (Data were average of two palms). The maximum hourly sap flow of TT palms grown in S4 soils in IL1 was 10 L hr^{-1} (Fig. 14a) and the daily total average sap flow was 93 L which showed the maximum of 100 L and the minimum of 90 L (Fig. 14b)..

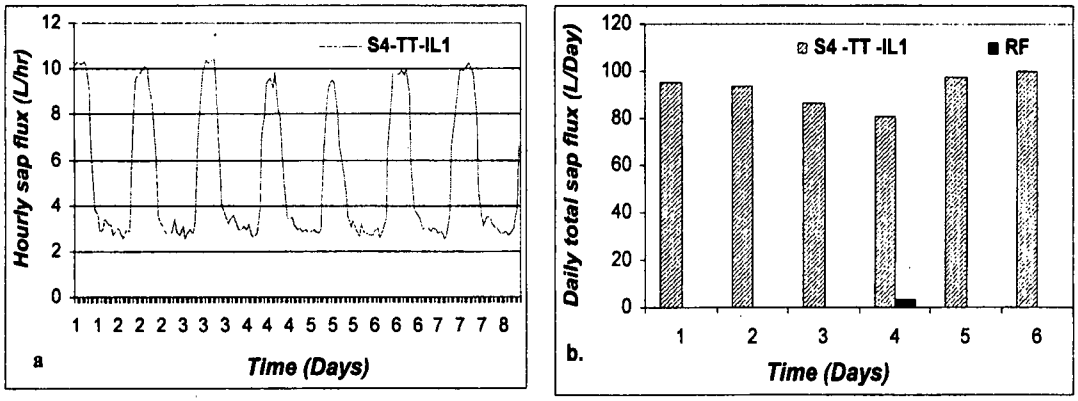

Figure 14: Diurnal time course of sap flux of TT palms (a) and the daily total sap flux of TT grown in S4 soils (b) in IL1

Results showed changes of sap flow of TT palms grown under different conditions. TT palms showed a higher amount of daily total average sap flow in S2 soils than in S4 soils. When the ACR is concerned, the sap flow was higher in WL2 than in IL1 indicating the effect of climatic condition and LSC on the sap flow of coconut palms. Data are being calculated for the DT palms grown under similar conditions which would enable to compare the differences in sap flow in two important commercial varieties. Based on these results, it would be possible to evaluate the suitability of CHPM to investigate the sap flow in different varieties which ultimately could be used as an index to measure the plant water status that helps in screening coconut varieties.

W S Madurapperuma

PROJECT: IMPROVEMENT OF THE PROTOCOL FOR SHELF LIFE IN TENDER COCONUTS

Experiment: Improvement of shelf-life of tender king coconut

The protocol for quality preservation of tender king coconuts for a period of one month was obtained by 6 exporters during the year. Permits were issued for exporting two consignments of preserved king coconuts during the year.

C S Ranasinghe, W S Madurapperuma, W P K K Fernando

PROJECT: MITE INFESTATION IN COCONUT

Experiment: Comparison of biochemical contents of mite-infested and mite free nuts

This is a study on mite-feeding areas (soft tissues under the perianth) of mite-infested nuts and mite-free nuts collected from different areas using selected biochemical parameters i.e. total sugars and polyphenol contents. The objective of this experiment was to identify any biochemical characteristic in the mite feeding area in relation to their vulnerability or tolerance to mite. Varieties with different sensitivities to mite infestation were selected for the preliminary investigation which included *Dwarf Yellow*, *Gon thembili*, (tolerant), *San Ramon* (less sensitive), *Tall* (sensitive) and *Dwarf Red* (very sensitive). Discussions are in progress to conduct polyphenol profiles with the assistance from the Faculty of Science, University of Peradeniya.

C S Ranasinghe, W P K K Fernando

3. MULTI DISCIPLINARY PROJECTS
Project Coordinator – C S Ranasinghe, Ph D

THRUST AREA: CROP PRODUCTION

Participating Divisions: Plant Physiology Division
Crop Protection Division
Soils and Plant Nutrition Division
Agronomy Division

Summary

Transmission Electron Microscopy (TEM) analysis on Leaf Scorch Decline (LSD), Tapering Disorder (TD) and Coconut Rapid Decline (CRD) affected palms were conducted to determine the presence of sub-cellular pathogens and cellular abnormalities. Although the preliminary images revealed the presence of suspicious phytoplasma and virus-like bodies, further verification by an expert from UK confirmed those bodies as artifacts. Further image analyses did not reveal such phytoplasma and virus-like bodies and thus confirmed that samples were free of sub-cellular pathogens and cellular abnormalities as indicated by the TEM analyses. Five different treatments were imposed to investigate the improvement / recovery of LSD, TD and CRD-affected palms. Although no significant improvements were observed within the first year after treatment application with respect to most of the canopy and yield characteristics, some positive trends were observed in parameters such as length of the newly opened fronds and length and diameter of the inflorescence prior to opening.

PROJECT: STUDIES ON PLANT DISORDERS, LEAF SCORCH DECLINE (LSD), TAPERING DISORDER (TD) AND COCONUT RAPID DECLINE (CRD) OF COCONUT

Experiment: Detail anatomical studies on cellular and vascular abnormalities (Plant Physiology Division)

The objective of this study was to determine the presence of sub-cellular pathogens and cellular abnormalities of LSD, TD and CRD-affected palms by Transmission Electron Microscopy (TEM). Tender flower stalk, mid rib (ekel), root tip and trunk samples of mild and moderate stages of Leaf Scorch Decline (LSD), Tapering Disorder (TD), Coconut Rapid Decline (CRD)-affected palms and apparently healthy palms were collected from BE, MSG and PRS. Samples were fixed in a buffer solution (3% Glutaraldehyde, 3% Formaldehyde in 0.1 M Phosphate buffer, pH 7.0), stored under 4°C for more than 48 hours and sent for TEM analysis at Iowa State University, USA. Preliminary images revealed the presence of suspicious phytoplasma and virus-like bodies but further verification from the Rothermstead Research Station, UK confirmed them as possible artifacts rather than actual phytoplasma or virus-like bodies. As these suspicious bodies were found abundantly in root tips in preliminary images, a further set of samples only from root tips were analyzed for TEM images for further confirmation. All images obtained were free from those bodies. Therefore, TEM analysis did not provide consistent and confirmed results to prove the presence of sub-cellular pathogens and cellular abnormalities of LSD, TD and CRD-affected palms. Experiment was terminated.

C S Ranasinghe, H C Mendis

Experiment: Assessment of the efficacy of various treatments on improvement/recovery of LSD, TD and CRD-affected palms (Plant Physiology Division, Soils and Plant Nutrition Division, Crop Protection Division)

The main objective of this experiment was to evaluate the effect of different treatments on the recovery of decline symptoms of palms of three types of disorders i.e. Leaf Scorch Decline (LSD). Tapering Disorder (TD) and Coconut Rapid Decline (CRD) in Makandura Research Station (MRS). Based on the detailed soil map prepared for MRS, six major soil types from 'very suitable' to 'not suitable' for coconut cultivation were identified with their LSC and other soil properties as shown in Table 3. Coconut palms showing above three disorders (LSD. TD and CRD) were selected into an experiment with Randomized Complete Block design with five treatments (T1, T2, T3, T4, and T5; details are given below), two blocks (B1 covering S2 LSC [*Halpe* series] and B2 covering S3 and S4 LSC [*Kandetiya* and *Makandura* series]) with three palms per plot thus including 90 palms altogether for evaluation.

Treatments:

T1- Control (no specific treatment but with the basal application of 3 kg of APM and 1 kg of Dolomite per palm year)
T2 - Charcoal and poultry manure (90 kg of Charcoal and 60 kg of Poultry manure per palm per year; 3:2 ratio)
T3 - Vermicompost (60 kg per palm per year)
T4 – Oxytetracycline (5g of OTC / 5 ml of water per palm with two treatment applications a year)
T5 – Commercial compost (60 kg per palm per year)
T6- Irrigation (Application rate)

Table 3: Major soil types, their properties and land suitability classes of different soils available at Makandura Research Station.

Soil Type	**Properties**
1 (*Halpe* series)	S2 (Suitable to very suitable) Well drained, deep (>120 cm), Sandy loam, sandy clay loam
2 (*Kandetiya* series)	S3 (Suitable) Moderately well drained, deep (>100 cm), sandy clay loam to clay loam
3 *Kandetiya* series (moderately deep phase)	S4 (Moderately suitable) Moderately well drained, moderately deep (70-100 cm), sandy loam to sandy clay loam
4 *Makandura* series	S4 (Moderately suitable) Imperfectly drained, moderately deep (60-80 cm), sandy loam to sandy clay loam
5 *Mahayaya* series	NS (Marginally or not suitable) Poorly drained, moderately deep (60-70 cm), Loamy sand to sandy loam
6 *Toppuwa* series	NS (Not suitable) Poor to very poor drained, moderately deep to shallow, Sandy clay loam, silty clay loam

The first treatment application was completed by December 2006 after preliminary data collection. Canopy observations (Total number of fronds, number of affected fronds, length of the newly opened frond, length and the circumference at the broadest position of the inflorescence prior to opening, girth of the trunk just below the last leaf base and 1 foot below and canopy photographs to monitor the visual changes at the canopy) and yield parameters (total number of female flowers, number of set nuts, final yield and fruit components) were recorded in three-month intervals. No significant improvements were observed within the first year after treatment application with respect to canopy and yield characteristics. However, some positive trends could be observed in some parameters such as length of the newly opened fronds and length and diameter of the inflorescence prior to opening. Compared to controls, palms in all four treatments showed higher lengths of the newly opened fronds in three disorders under both soil categories, although the results were not consistent throughout the year (Fig. 15).

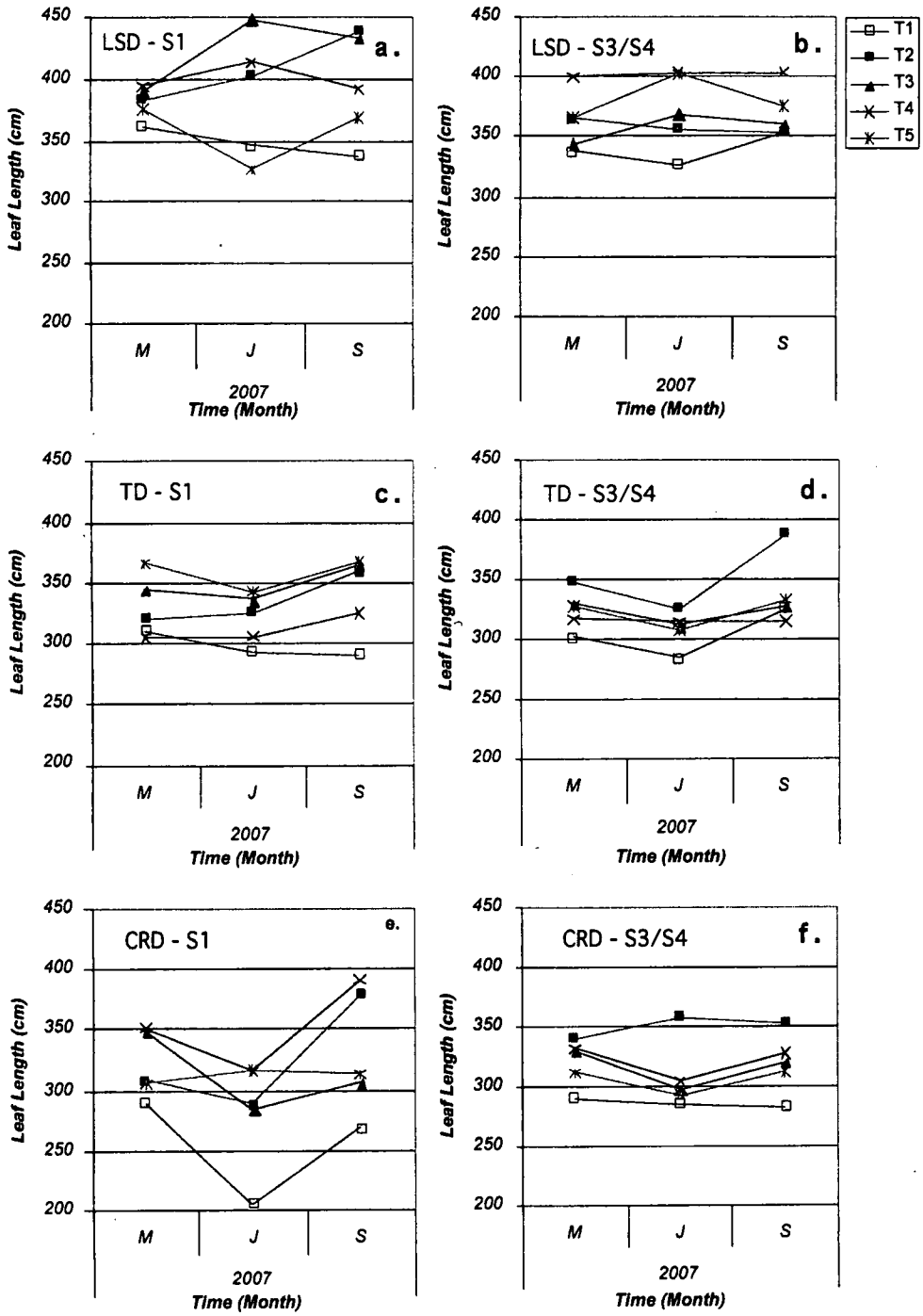

Figure 15: Length of the newly opened frond (cm) of palms with three disorders (LSD, TD and CRD) in two soil categories (S1 & S3/S4) under different treatments at MRS.

Length and the circumference of the inflorescence showed significant increases in LSD affected palms compared to controls in almost all treatments in S1 soil (Fig. 16a & c). Length of the inflorescence was 60%, 80% and 45% higher in T3, T4 and T5 treatments respectively (Fig. 16 a) while the circumference was 25%, 80% and 70% higher for same treatments in S1 soil (Fig. 16 b). However, LSD palms in poor soils (S3/S4) showed significant responses only in T2 and T3 for same parameters (Fig. 16 b & d). More or less similar pattern of improvement was observed in TD palms in S1 soils but there were no such responses in poor soils. Although some improvements were observed in CRD affected palms under same treatments, patterns were not consistent. Conducting assays for soil chemical and physical properties (Macro and micro nutrients, cation exchange capacity, soil pH, electrical conductivity, organic carbon content, soil compactness, water holding capacity, field capacity, bulk density and soil microbiological parameters) and root parameters (number of new roots in a volume of one cubic feet at the manure circle) are scheduled for the next year.

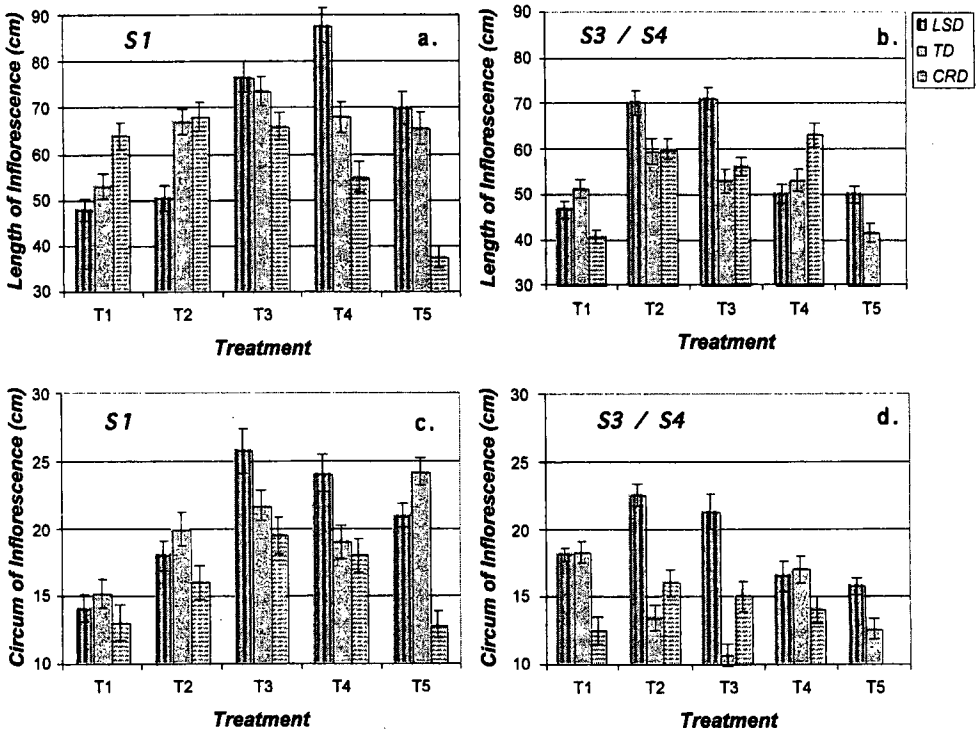

Figure 16: ***Length and the circumference of the inflorescence of palms with three disorders (LSD, TD and CRD) in two soil categories (S1 & S3/S4) under different treatments at MRS.***

C S Ranasinghe, A Nainanayake, A Tennakoon, R Wijesekara, H C Mendis, C Fernando, D Paramasivam, R D N Premasiri, U S S Perera, D P Panditaratne, K R E M Fernando

4. TRAINING AND EXTENSION ACTIVITIES

Ms W W I L Fernando of University of Peradeniya completed her B Sc final year research project on 'Physiological and vegetative growth performance of embryo cultured coconut (Cocos nucifera L.) seedlings in response to elevated CO2' from November, 2007 to March, 2008 under the supervision of Dr. N P A D Nainanayake.

5. ACKNOWLEDGEMENT

The co-operation and assistance extended by staff of the Plant Physiology Division in conducting experiments, data collection and in compiling this report is gratefully acknowledged.

REPORT OF THE AGRICULTURAL ECONOMICS AND AGRIBUSINESS MANAGEMENT DIVISION

C. Jayasekera, Ph D

1. GENERAL

The research programme of the Division was aimed at five major studies namely a) determination of optimum tariff for substitute oil imports b) exploring the potential for home gardening in urban and semi-urban areas c) evaluation of *Samurdhi* Coconut Cultivation Development Programme d) increasing productivity and profitability of coconut cultivations through fertilizer application and toddy tapping and e) price and production risk in coconut cultivation.

The difference between the consumer price of domestically produced coconut oil and imported edible oils were narrowed down during the year as a result of domestic price increase in imported edible oils mainly due to the increase in tax and tariff imposed on importation of edible oils. The results revealed that continuation of present tariff structure on importation of edible oils is more appropriate in order to facilitate reasonable farm-gate price for the fresh nuts and to protect the domestic coconut oil industry from the foreign competition.

Urban and semi-urban households are net consumers of culinary fresh coconut consumption which is the biggest demand of coconuts in the country. A survey conducted in Heenkenda *Grama Niladari* Division to explore the possibility of converting these net consumers in to self sufficiency or net producers level through expansion of cultivation of coconuts in home gardens in urban and semi-urban areas households. The study revealed that around 29 per cent of the net consumers in Heendenda *Grama Niladari* Division could be converted into self sufficiency in coconuts by introducing home gardening programme.

The effectiveness of *Samirdhi* Coconut Cultivation Programme was analyzed and the target group selection of the programme satisfied the original objective of the programme. Nearly 80 per cent of the distributed coconut seedlings were exists in the field after one year of distribution. However, technology dissemination was inefficient.

The return on investment of application of fertilizer for coconuts was nearly three folds under prevailed prices during the year and it was beneficial to the grower even the price of coconuts and fertilizer fluctuates by 50 per cent.

Toddy tapping is an alternative to increase income which is practiced in coastal belt from Chilaw to Aluthgama. Lack of skill labor, irregular labor, low participation of young generation in toddy tapping, low sap yield and legal constraints are the major draw backs in toddy tapping industry.

One of the major issues that the stakeholders of the coconut sector facing at present is lack of proper information regarding "what it would happen in the industry in future?" specially with respect to annual production and price. Therefore, a study was conducted with the purpose of analyzing the past performance (1970-2005) of the sector and to compare that with other major coconut producing countries. The results imply that Sri Lankan coconut growers have faced with high production and price variability, and care must be taken to at least maintain

the current status so that the country can withhold its existing position in the world market. The shown an increasing trend in annual production.

One feasibility study was conducted for the establishment of a virgin coconut oil extraction plant in Katukenda Estate, Badalgama, which is managed by the Chilaw Plantation Ltd.

2. RESEARCH PROJECTS

PROJECT 1: ECONOMIC STUDIES ON POLICY ISSUES

Experiment 1: Determination of optimum tariff for substitute oil imports

In 2007, imported edible oil prices have reached to the level of coconut oil market price in Sri Lanka due to many reasons. Among them, adoption of taxes and CESS charges were prominent. Therefore, the edible oil was not available to the consumers at a cheaper price they enjoyed earlier. Concerning the consumer welfare, there was a demand to reduce the tax on edible oil importation. To analyze and make suggestions to overcome the problem a study was conducted by the division to make aware the relevant authorities the impact of tax reduction. The current scenario opened up opportunities for local oil millers and discouraged the adulteration of coconut oil giving a reasonable price to coconut. If growers do not get a satisfactory income for their produce they will leave from the industry. Therefore, any improper adjustment will affect the industry and the equilibrium set upon by the tariff imposition. According to Colombo Consumer Price Index (CCPI); expenditure on coconut based products by the consumers is less. But, concerning the increasing input prices of soap, margarine and other related goods, it is suggested to propose a tax rebate on the basis of output. Through this intervention, price levels of these products could be maintained bringing benefits for the consumer.

I M S K Idirisinghe & P M E K Pathiraja

Experiment 2: Exploring the Potential for Home Gardening in Urban and Semi-urban Areas: A Case Study Approach.

The inadequacy of coconuts for the industrial purposes has lead to a competition among coconut kernel-based industries. The reason for the inadequacy is due to several factors among which increased culinary requirement is notable. The biggest contributors to the domestic culinary consumption are urban and semi-urban households. While they produce some coconuts from their home gardens, bulk is purchased, thus they are becoming net consumers. However, the full potential available in their home gardens has not been utilized. As a remedy, home-gardening development programmes are identified and being carrying out by government authorities

The objectives of this study were to identify the actual number of coconut palms that can be grown by land size classes, the constraints these households have been experiencing, willingness to participate in a planting program, to calculate the net coconut producing or consuming status of urban and semi-urban households according to their land size classes and size of household, and to launch a pilot planting program in selected two communities.

In 2006, a case study was conducted in Heenkenda GN division to explore the possibility of strategically converting these households from 'net consuming state' to 'net producing state'. In 2007, this study was extended to another two GN divisions called Rathupassara and Jayasiripura found in Gampaha and Anuradhapura districts respectively. The table 1, 2 and 3 shows the existing coconut consumption status of the households in Heenkenda, Rathupassara and Jayasiripura GNDs respectively.

The results revealed that there is a possibility of converting 28.5% of the net coconut consumers (or 14% of the respondents) to self sufficient state in Heenkenda GND. Average saved nuts from a household per annum is around 193 (93 per house hold). The gap between the total observed number of palms and the potential number of palms shows that there is a possibility of cultivating another 105 palms in the surveyed area. In terms of nut savings, additional 20% of the culinary nut requirement can be saved in Heenkenda.

Table 1: Coconut consumption status of the Heenkenda households

Land size class	*% of Net Consumers*	*% of Self sufficient home gardeners*
<20 Perches	85	15
>20-50 Perches	33	67
>50-100 Perches	20	80
>100 Perches	0	100

In Rathupassara, the observed number of palms in the sample was 194 and there is a potential to grow 249 palms. Therefore, there is a possibility of planting another 55 palms in the surveyed area. If the land is utilized to the optimum level, there is a possibility of converting 18% of the net consumers (12% of the respondents) to the self sufficient status. Average saved nuts from a household per annum will be around 143.

Table 2: Coconut consumption status of the Ratupassara households

	Land size class	% of net consumers	% of self-sufficient home-gardeners
1.	< or = 20 perches	88%	12%
2.	> 20 perches	41%	59%

The observed number of palms in the sample was 90 and there is a potential to grow 114 palms. Therefore, there is a possibility of planting another 24 palms in the surveyed area.

Table 3: Coconut consumption status of the Jayasiripura households

	Land size class	% of net consumers	% of self-sufficient home-gardeners
1.	< or = 20 perches	92%	8%

About 92% of the respondents in Heenkenda were willing to participate in a coconut home gardening program while this was 68% and 54% respectively in Rathupassara and Jayasiripura, implying that the human corporation and the land availability to implement such a home garden program might be comparatively conducive in semi-urban areas.

There is a huge knowledge gap for proper coconut cultivation technology and accessibility to improved varieties. By filling this gap a higher yield would be obtained and it will reduce the culinary demand on coconut and ultimately to save more nuts for the industrial purposes.

P M E K Pathiraja, M T N Fernando, I M S K Idirisinghe and S D J N Subasinghe

Experiment 3: Evaluation of "Samurdhi" coconut cultivation development programme-2005

The Evaluation of Samurdhi Coconut Cultivation Development Programme was conducted and the preliminary analyses were done in 2006. The objectives of this study were to evaluate the effectiveness of SCCDP and to propose the improvements required for the SCCDP. The finalizing of the research outcome and publishing the outcome was done in 2007. The results revealed that an average respondent in Gampaha region spend 2% of weekly food expenditure on coconut whereas in Auradhapura and Moneragala it is around 3% and 9% respectively. The SCCDP programme aimed to overcome this expenditure.

Target group selection is at a satisfactory level regardless of the region. The majority has an interest on coconut home gardening as they look for technology, seedlings and fertilizer subsidies further. Fertilizer distribution among Samurdhi beneficiaries is inefficient in Gampaha due to poor packing material and handling. The technology dissemination process has not been functioned well. In Gampaha region around 34% of the respondents did not receive advice whereas in Anuradhapura and Moneragala it is 17% and 8% respectively. As there is a clear difference between advice receivers and non-receivers in practicing each activity in planting a seedling, technology dissemination process needs to be revised. Among the distributed seedlings, 89% exists in the field in Gampaha, 81% in Anuradhapura and 84% in Moneragala. In Anurdhapura and Moneragala, pest and diseases was the major death causing factor contributing 33% and 45% of the loss. Major cause in Gampaha was cattle damage which contributed 30% of lost seedlings. Drought was a death cause for around 29% of the lost seedlings in Moneragala and 27% in Anuradhapura. Inorganic fertilizer application is poor in all the regions. The use of kitchen waste and ash as a fertilizer source is popular among 41% in Gampaha region and 20% and 33% in Anuradhapura and Moneragala regions respectively. The present management level of the seedlings is at a satisfactory level and it can be concluded that this programme is a successful strategy to expand coconut cultivation.

P M E K Pathiraja, I.M.S.K.Idirisinghe, V.A.R.P.Vithanaarachchi,G.G.D.S.Priyankara, H.A.J.Gunathilake, S.D.J.N.Subasinghe

PROJECT 2: ECONOMIC STUDIES ON PRODUCTION

Experiment 4: a) Production and cost of production of coconuts and major coconut products at provincial level

In par with preliminary cost of production survey conducted in 2006, an expanded survey was conducted to calculate the cost of production of fresh coconut, coconut oil and desiccated coconut in coconut triangle which is important in calculating provincial/regional GDP. This study will be continued to 2008 as monitoring of the project is needed for a continuous data collection.

b) Impact of fertilizer use in increasing the productivity and profitabilityof coconut plantations

Nutrients are regularly removed from a coconut plantation through the removal of its nuts, fronds etc. In order to compensate this, a regular supply of nutrients is required. Although most of the growers are willing to apply fertilizer for their plantations, the escalating prices of inorganic fertilizers and labour charges compared to the farm gate price of coconuts, discourage application of fertilizer due to poor return on their investment. There is an information gap due to the lack of an up to date economic analysis to facilitate this decision. First, a preliminary economic analysis was done using experimental data of Soil and Plant Nutrition Division of CRI. According to the analysis under present circumstances the return on investment is nearly three fold of its investment and it can be concluded that the fertilizer application for coconut is economically beneficial to the growers even the prices of both fertilizer and nut are fluctuated in a range of 50%. But this finding cannot be generalized to the all circumstances as the data obtained for this analysis is very specific to that site conditions. The rate of fertilizer applied for this site is optimum to this site and in general growers are practicing a general recommendation which would not give out the same result in different lands. Another most important yield determining factor is the rainfall and it will also change the outcome drastically. Therefore, economics of fertilizer application under the common recommendation in each soil type and agro climatic zone should be further investigated and a comparison analysis should be done in order to find out the economics of differential fertilizer recommendations. Therefore, a survey was conducted in coconut triangle considering the land suitability classes to find out the real situation. The sample selection for this study was completed and data collection and monitoring part of the study is continuing for 2008 as well.

Experiment 5: Potentials for increasing income and enhanced competitiveness of the coconut industry through toddy tapping

Toddy tapping is an alternative to increase income instead of producing green nuts from a coconut inflorescence. It is practiced in coastal belt from Chilaw to Aluthgama. This study focused on identifying the constraints attached with legal, social and institutional set-up for toddy tapping as well as the market opportunities existing to increase the income through toddy tapping.

The results revealed that there is a seasonality in toddy production which peaks in May -June period and then tend to decline. The majority constrained by management for which 70% of the respondents were agreed. Around 25% of the respondents were having legal constraints and social constraints were experienced by 20% of the respondents (see figure).

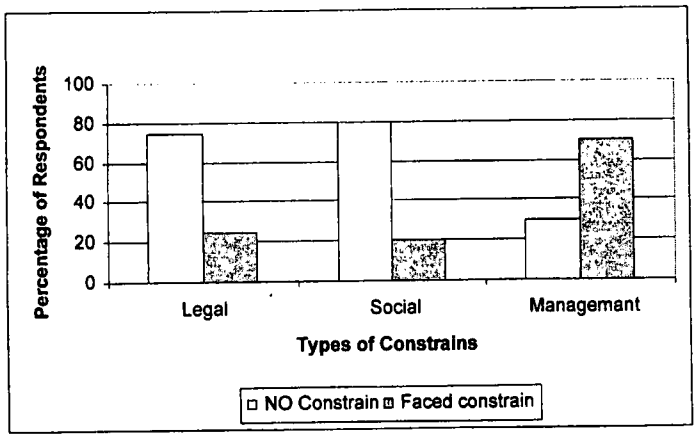

Figure 1: ***Constraints faced by the respondents***

The availability of skilled labour, irregularity of labour and reluctance of youth to take toddy tapping as their carrier were the major social constraints. Low sap yield was another problem and they were not aware of the CRI introduced "Ethral" method. Majority of the tapped palms were leased and around 15% was tapped by the owner. Around 95% of the respondents sell their produce to Distilleries Corporation (DCSL). Import of low cost spirits is a major drawback in demanding a better price for them. Through toddy tapping a net return of around Rs 1 057 can be earned per palm per year which is quite higher than the income through green nut production.

A W A D R Abeysekara and I M S K Idirisinghe

Experiment 6: **Price and Production Risk in Coconut Industry in Sri Lanka: A Comparison with the Leaders in the World Market**

The relative importance of coconut sector in the national economy of Sri Lanka has eroded to a larger extent in recent times. Yet, thousands of people have still to depend on this sector for their livelihood. One of the major issues that the stakeholders of this sector facing, at present, is lack of proper information regarding "what it could happen in the industry in future?" specially with respect to annual production, price and revenues etc. The purpose of this study was, therefore, to analyze the past performance of the sector and to compare that with other major coconut producing countries.

The leading players in the world trade of coconuts are Philippine, Indonesia, India and Sri Lanka. The average contribution of these four countries for the world coconut production is 55 per cent in 2005. The extent under coconut cultivation in Indonesia and Philippine the biggest producers, are 3.89 million ha and 3.24 million ha respectively. India and Sri Lanka followed as third and fourth largest with 1.94 million ha and 0.394 million ha respectively. The contribution of coconut sector to the national economy of Sri Lanka has eroded in the recent past. Yet more than 135 thousand people directly and indirectly depend on this sector for their livelihood. One of the major issues that stake holders are facing at present is lack of proper information regarding what it would happen in the industry in future specially regarding to production, price and revenue. Farmers are always facing with risk in their production price and income. Risk is uncertainty that affects an individual's welfare and is

often associated with adverse condition and loss. In technical terms risk can be expressed as the probability of variation in outcome or situation. In other words outcome is determinate. Coconut growers are also not an exception from this situation.

Coconut growers are lack of proper information regarding future coconut production, fresh coconut price and income from coconuts. Therefore, coconut growers are faced with risk in yield and input and output prices. The aim of this study is to analyze the yield and price variability to coconut growers in Sri Lanka and to compare that with other major coconut producing countries.

The secondary data explaining the national annual coconut production and farm-gate prices of fresh coconuts for the period of 1970 to 2004 were analyzed by a number of qualitative and quantitative data analysis techniques, including calculation of Mean, Coefficient of Variation (CV) and Residual Plots to examine the variability of these factors for both total and potential per capita availability of coconuts.

The national coconut production of Sri Lanka was plotted against time (Figure 1). The mean national coconut production during 1970 to 2005 period is 2 447 million nuts. The coconut production does not show any considerable increase over the analyzed period.

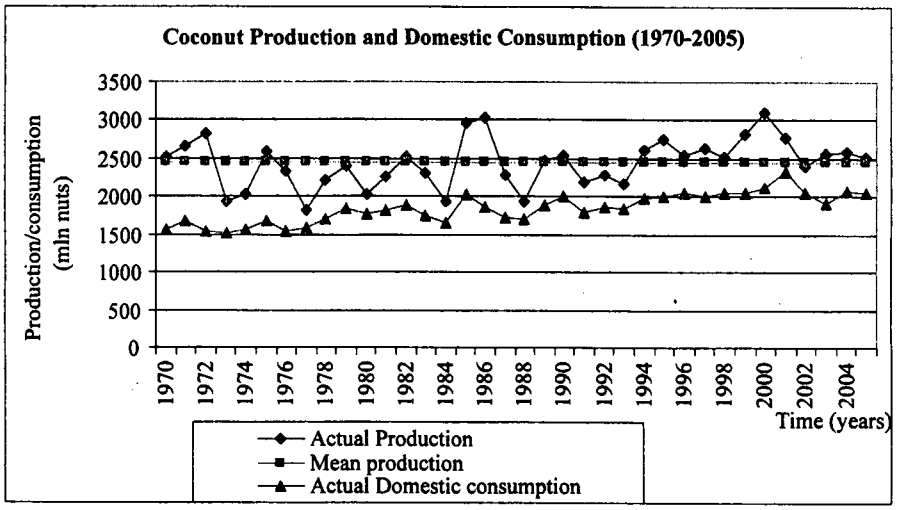

Figure 1: ***National Coconut Production and Domestic Consumption in Sri Lanka (1970-2005)***

The coefficient with respect to time trend was 10.481 which indicate that coconut production has been increased by 10.481 million nuts annually. Therefore the annual national coconut production has shown increasing trend over the last few decades.

The Figure 2 shows the change in potential per capita availability of coconuts during considered time period.

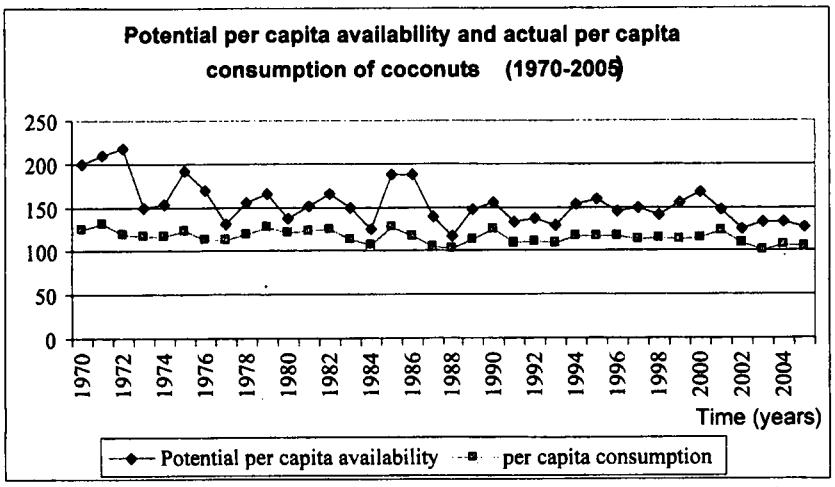

Figure 2: ***Potential per capita availability and per capita consumption of coconuts in Sri Lanka***

The potential per capita availability of coconuts has been decreased over the time. That means the coconut production has not been increased sufficiently to meet the requirement of increasing population. The per capita availability should be increased with the increasing population in order to increase of production to be potentially sustainable. This implies that even though the coconut production has shown increasing trend over the years the increase is not sustainable. This implies that the coconut production has not been increased substantially during the last few decades.

The coefficient of time trend is negative indicating that there is a decrease in per capita availability of coconuts over the years. That means the increase in coconut production is not sustainable. Therefore, coconut production is at risk.

The following figure shows the change in production risk and per capita availability risk (Figure 6). The year to year fluctuation of per capita availability of coconuts is lower than that of coconut production resulting high risk in coconut production than in per capita availability. If the production or per capita availability line goes parallel to zero, theoretically it says that there is no risk.

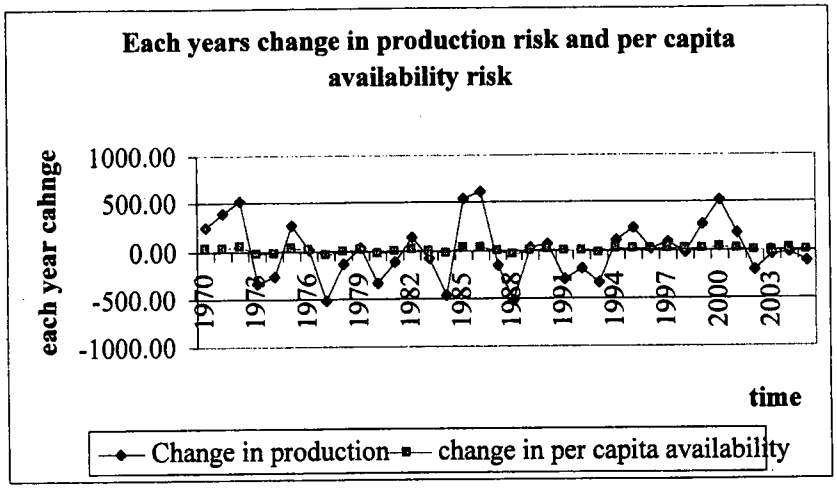

Figure 3: ***Each years change in production and per capita availability of coconuts in Sri Lanka***

In the mean time, the other major coconut producing countries, including the Philippines, Indonesia and India have shown an increasing trend (Figure 4) in annual national coconut production. The CV of production of these countries was 19%, 31% and 35% respectively.

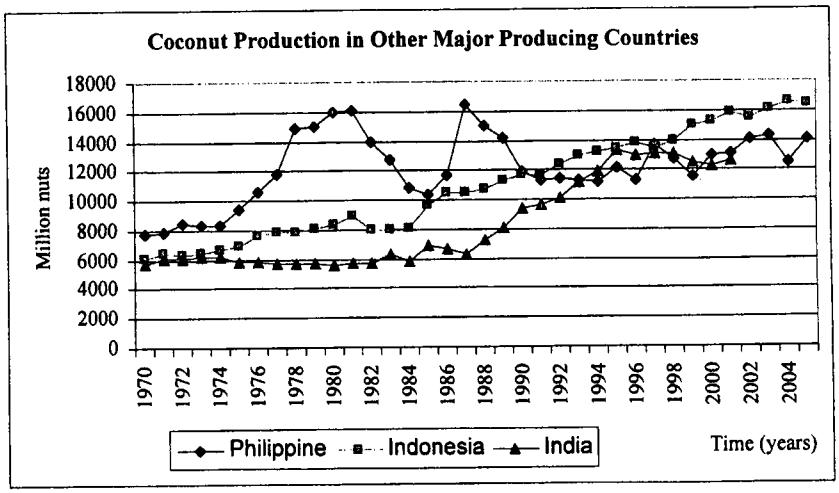

Figure 4: ***Coconut Production in other major producing countries***

The wholesale prices of fresh coconuts of Sri Lanka were considered as a proxy for the farm gate price. The real prices were taken by dividing the nominal price by WPI (food).
The real wholesale price drastically fluctuates around its mean during analyzed period. The trend coefficient was 0.0632 implying that the real price has been increased by 0.0632 annually over the last two and half decades.

The Figure 5 shows the price risk of fresh coconuts. The price fluctuates around the zero line drastically indicating high price risk for the coconut growers.

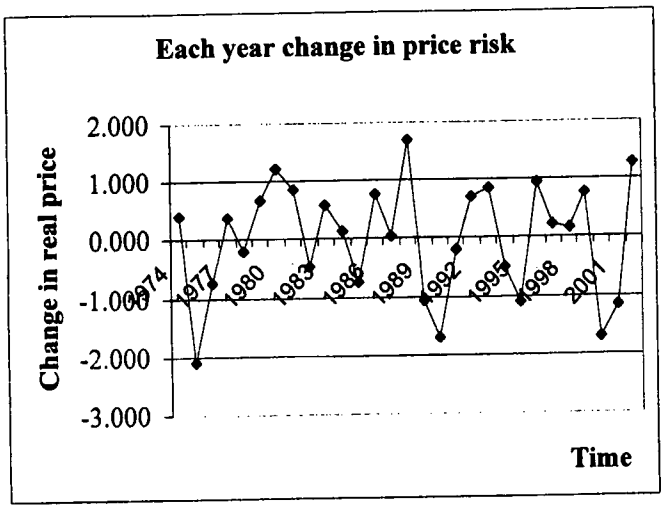

Figure 5: Each years change in price risk

Coconut production has shown increasing trend over the analyzed period. However, the per capita availability of coconuts has not been increased to meet requirement of the growing population. Therefore, coconut production is at a risk. The farm-gate price of coconuts has fluctuates widely over the years. Price of fresh nuts is an important criteria in the decision making process of the coconut grower.

The results show that coconut production of Sri Lanka was subject to a sizeable risk with CV of 13%, and that of the real price of fresh coconuts was 22% indicating high price risk for the growers. The potential per capita availability has also been decreased over the time indicating that the production has not been increased sufficiently to meet the requirement of increasing population. The other major coconut producing countries, including the Philippines, Indonesia and India have shown an increasing trend in annual production. The results imply that Sri Lankan coconut growers have faced with high production and price variability, and care must be taken to at least maintain the current status so that the country can withhold its existing position in the world market.

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PROJECT 2: ECONOMIC STUDIES ON FEASIBILITY ANALYSIS

Experiment 6: Feasibility analysis of sub projects of different organizations

A feasibility report was prepared for the establishment of a virgin coconut oil extraction plant in Katukenda Estate, Badalgama, which is managed by the Chilaw Plantation Ltd. Considering the potential for virgin coconut oil and the feasibility of using the available nuts and the infrastructure resources of the company the possibilities of extracting virgin coconut oil was envisaged. Taking into consideration the capacities of the expellers and the

availability of inputs it is decided to initially process 2000 nuts per day. According to the results of the financial analysis, the calculated Internal Rate of Return was 77%. Hence this project becomes viable up to a loan interest rate of 77%. In the second phase, to process 4000 nuts per day machinery capacities and infrastructure facilities need to be expanded. If the factory capacity is improved to process 4000 nuts per day the break even price for 1000ml bottle of virgin coconut oil will be Rs. 254.95. With an additional 10% profit margin the total cost will be Rs. 280.45 and the Internal Rate of Return is 68% in which event the project become viable up to the loan interest rate of 68%. This would indicate that the increase in production will reduce the cost and enhance profitability.

I M S K Idirisinghe

4. ACKNOWLEDGEMENTS

The assistance and co-operation of the staff of the Agricultural Economics and Agribusiness Management Division in conducting research and development activities are gratefully acknowledged. The guidance provided by Dr. M.T.N. Fernando, former head of Agricultural Economics and Agribusiness Management Division is highly acknowledged.

REPORT OF THE TECHNOLOGY TRANSFER DIVISION
Head - P A H Nimal Appuhamy

1. GENERAL

The mission of the Technology Transfer Division is to develop and implement measures for effective two-way channeling of technologies and information to/from stakeholders and acquire information on technology needs and production problems aiming to enhance the profitability of the coconut sector. Based on the main strategies of technology transfer activities, the division implemented several programmes to disseminate coconut cultivation and processing technologies and information to the extension personal of CCB, growers, commercial entrepreneurs and the general public. These programmes also focused on acquiring information about technology needs and production problems. Collaborative programmes were also implemented with CCB regional staff to identify the field problems and technology related issues in the sector. A significant increase in the number of coconut growers who obtained the services under these porgrammes was observed. Studies were also conducted to evaluate the relevance, effectiveness, impact and affordability of technologies.

2. OTHER ACTIVITIES

2.1. Mr. P A H Nimal Appuhamy, Head Technology Transfer Division and Mr. H C Herath, Extension Officer attended A Study Meeting on Knowledge Management Tools for Strengthening Agricultural Research and Extension Systems organized by the Asian Productivity Organization, from 4 to 9 August in Teheran, The Islamic Republic of Iran.

2.2. Mr.J K J P Jayawardene, Assistant Extension Officer, completed his MSc in Agricultural Extension at the Kerala Agricultural University, India under the ICAR/CARP training programme and assumed duties in November.

2.3 Mr. H C Herath, Extension Officer, commenced his PhD programme at the Tomas Bata University in Zlin, The Czech Republic December 2007.

3. COLLABORATIVE ACTIVITIES WITH CCB

The division conducted several collaborative programmes to educate and update technical knowledge of the extension field staff of CCB on new technologies and to identify technology needs related problems faced by coconut growers in different areas.

3.1 The division adopted different methodology to maintain regular contacts with the CCB regional staff. The divisional staff attended special meetings organized for extension staff of CCB at regional level along with the DGM (Extension) to discuss technology related issues in different regions. During the year four such meetings were held at Marawila, Kuliyapitiya, Gampaha and Kegalle. The specific problems identified were informed to relevant research divisions. New extension tools developed by CRI were also introduced to the CCB officers.

3.2 A workshop was conducted on 05 May at CRI for Subject Matter Specialists, and Regional Staff of CCB of Marawila, Kuliyapitiya and Gampaha to introduce interim recommendation on mite management and red weevil detector. A colour leaflet and a poster were issued on the interim recommendation of coconut mite. Several workshops and seminars are conducted for the extension staff of CCB in collaboration with the Crop Protection Division on the management of Weligama Coconut Leaf wilt Diseases(WCLWD).

3.3 A workshop was conducted to educate Coconut Development Officers of Marawila, Gampaha, and Kaluthara regions to introduce new coconut based products developed by CRI on 15 June.

4. TRAINING OF TRAINERS PROGRAMME

The Division conducted programmes to enhance the technical capabilities of grass root level trainers and extension personnel attached to different organizations, who provide advice and guidance to small scale coconut growers on the cultivation and processing technologies. Educational and training programmes for the field level officers and trainers of government and private institutions which involves in the promotion of coconut based agricultural development activities.

4.1 Two day training of trainers programmes were conducted for Agricultural Development and Research Assistants *(KRUPANISA)*and Divisional Officers (DO) in Hambantota District at Middeniya on 01 and 02 March, 05 and 06 April, 17 and 18 May, 14 and 15 June, 13 and 14 September, 01 and 02 October, 06 and 07 December. At the Middeniaya Research Station over hundred KRUPANISA officers received complete training on coconut cultivation and management of estates.

4.2 After the initial discussion with the officials of the Ministry of Science and Technology regarding the possibility of using VIDATHA Centers for coconut technology transfer activities, a meeting was held at CRI on 02 July 2007. Science and technology officers attached to VIDATHA Centers in Kurunegala, Gampaha, and Puttalam districts participated in this study meeting.

4.3 An educational programme was conducted for a group of officers from the Export Development Board on 05 November.

4.4 A familiarization programme was conducted at the institute for a group of coconut researchers from Vietnam on 07 September.

4.5 An attachment training was conducted at the institute for a group of management trainees from the Lalan Rubber Private Ltd from 21 to 24 August.

4.6 An educational programme was conducted for VIDATHA officers in the Kuliyapitiya areas on Coconut Cultivation and Gliricidia planting in coconut lands on 13 July.

5. EDUCATIONAL PROGRAMMES FOR COCONUT GROWERS, MANAGEMENT STAFF OF COCONUT ESTATES AND SMALL ENTREPRENEURS

5.1 **One day educational programme series** conducted by this institute annually is one of the most popular programmes among the coconut growers. This series was designed to improve the knowledge of coconut growers. This series includes seven one-day programmes on specific subject areas. At the beginning of the year complete year schedule is advertised in newspapers requesting interest coconut growers to register. Based on different subject categories coconut growers have the choice to select the subjects that they require. According to the subject areas, these programmes were held in different substations of the Institute facilitating to conduct field demonstrations. The series includes seven technical programmes on different subject areas in order to improve the knowledge and skills of coconut growers from planting to harvesting. The details of the seven programmes conducted during the year are as follows.

- The first programme of the series was conducted on 25 May at the Isolated Seed Garden, Ambakelle on " *Replanting and Underplanting of Coconut*" with the participation of 160 coconut growers.

- The second programme of the series was conducted at Ratmalagara Estate on 29 June on "*Soil and Moisture Conservation Measures and Irrigation for Coconut*" with the participation of 174 coconut growers.

- The third programme was conducted at the Bandirippuwa Estate on 27 July on " *Organic and Inorganic Fertilizer Application for Coconut*" with the participation of 168 coconut growers.

- The forth programme was conducted at the Walpita Reasarch Station on 24 August on " *Intercropping in Coconut Lands*" with the participation of 155 coconut growers.

- The fifth programme was conducted at the Bandirippuwa Estate on 28 September on " *Coconut Pests and Disease Management*" with the participation of 140 coconut growers.

- The sixth programme was conducted Ratmalagara Estate on 19 October 2006 on " *Rehabilitation of Low Yielding Coconut*" with the participation of 130 coconut growers.

- The seventh programme was conducted at the Bandirippuwa Estate on 23 November on " *Coconut Estate Management*" with the participation of 125 coconut growers.

At the end of this programme series certificates were awarded to those who participated in all seven programmes.

5.2 **Field Crop Clinics** - A Crop Clinic was conducted for small scale coconut growers at Deniyaya on 31 August.

5.3 **Training on coconut based products for small scale Entrepreneurs.** The division conducted 19 training programmes in collaboration with the Processing Research Division in Vidatha Centers Kobeigane, Nikaweratiya, Ganewatta, Ja-Ela, Biyagama, Rambukkana, Chilaw, Bingiriya, Paduwasnuwara, Nagoda, Narammala, Madampe, Wennappuwa, Mahawewa, Mundal, Negombo, Walalawita, Polgahawala and Mundalama. Over 400 small and medium entrepreneurs participated in these programmes.

6. ADVISORY FIELD VISITS ON SPECIFIC PROBLEMS

The institute receives a large number of requests from coconut growers requesting to inspect their plantations and provide necessary advice for their field problems from almost all the coconut growing areas. Most of these requests are referred to CCB regional staff for necessary assistance.

During the year 40 such requests were referred to relevant regional managers. But very specific problems and problems which cannot be attended by the CCB personnel are referred to us for inspections. The divisional staff inspects these plantations and provides necessary advice and guidance. During the year 38 field inspections were made on special requests and reports were submitted with necessary recommendations.

7. CONDUCT FIELD DAYS, SEMINARS/ WORKSHOPS

7.1 A full day seminar was conducted at CRI on 24 March for the members of Coconut Growers Association of Sri Lanka on Organic Manure Application for Coconut.

7.2 One day seminar was conducted for coconut small holders on 17 July on scientific coconut cultivation in Dolabawila, in the Southern Province.

7.3 A seminar on coconut cultivation was conducted for a group of coconut growers at Kuliyapitiya on 06 July.

7.4 A workshop was conducted for a group of small entrepreneurs (55) on coconut kernel based products on 30 November.

8. EDUCATIONAL AND FAMILIARIZATION PROGRAMMES FOR STUDENTS AND TEACHERS

8.1 During the year, educational programmes were conducted at the institute for 4235 students and teachers from 40 schools.

8.2 Special service was provided to guide the students for the preparation of their GCE O/Level and A/Level projects on coconut related fields. The division provided necessary

guidance for 34 students visited the institute and posted the required information to 40 student projects.

8.3 During the year 13 educational programmes were conducted for students from universities and higher educational institutions.

8.4 As a collaborative programme with the zonal educational authorities, teacher educational programmes were conducted for science and agriculture teachers in educational zones in major coconut growing areas. Two programmes were conducted in Giriulla and Kurunegala during the year.

8.5 A four months attachment training programme was conducted for seven agriculture diploma students from the School of Agriculture, Kundasale and NAITA.

9. FARMER PARTICIPATORY FIELD PROGRAMMES

9.1 Farmer Field School (FFS) is a new technology transfer tool introduced for the small coconut holding sector. FFS were conducted with great success in various coconut growing areas. These programmes were conducted in collaboration with the regional field staff of CCB. During the year six FFS programmes were conducted at Ratgama, four FFS programmes were conducted at Wadduwa, five programmes were conducted at Middeniya, Six FFS programmes were conducted at Sooriyawewa, four programmes were conducted at Chilaw and three FFS were conducted at Kuliyapitiya.

9.2 The division commenced a farmer collaborative field demonstration progrmme to promote the use of organic manure in coconut plantations. With the cooperation of the Coconut Growers Association of Sri Lanka, a field demonstration programme is in progress to promote the use of organic manure in coconut plantations. Five acre demonstration sites located at the road side of interested growers were selected for this programme. At the end of the year the selection of 15 field demonstration sites were completed. Based on the soil type, coconut plantation and the availability of organic materials suitable organic based packages will be recommended for implementation. Land owners are expected to implement recommended organic packages according to the instruction given by the Institute. The CCB regional staff also collaborates in this programme and these demonstration sites would be used by them as a tool for their organic promotion programmes.

10. PRINTING AND PUBLICATION

10.1 The technical journal of the institute COCOS Vol. 15 was published.

10.2 Seven booklets were issued as a supportive material for the participants of one day educational programme

10.3 Coconut Technology Update was introduced to disseminate information on new technological development within a short period of time. This is published once in every

four months in three languages. During the year, three issues were published in three languages.

10.4 New Series of Advisory Bulletins was introduced in an attractive colour format with detailed information on specific subject areas. These publications are becoming popular among the growers. The first advisory bulletin was published on Coconut Based Products and the full text of next issues on the Use of Fertilizer for Coconut and Land Suitability, and Coconut Pest and Disease Management.

10.5 A colour poster and one advisory leaflet on the interim recommendation to manage coconut mite were published and distributed them to mite affected areas through the extension staff of CCB. These printed materials were used as visual tools for educational and awareness programmes to promote the new interim recommendation.

10.6 The following publications and media materials were produced and issued for the educational and awareness programmes to manage the Weligama Coconut Leaf Wilt Disease and Leaf Rot Disease in the Southern Province.

a. Colour poster (5000 copies) with photos of clear symptoms of two diseases requesting land owners to report the suspected palms to the Regional Office, Matara.
b. A detailed handout on both diseases – 10,000 copies.
c. A set of 10"x 8" colour photos(five photos) for the awareness programme – 2500 sets
d. Digital posters giving the symptoms of diseases

10.7 Printing of new series of CRI Advisory Circulars with specific colour band based on A, B and C series for easy identification was completed. A Series contains circulars on planting materials, planting densities, management of young palms, fertilizer and soil and moisture conservation. B Series contains recommendations on coconut pests and disease management. C Series contains recommendations on planting and management of intercrops in coconut lands.

12. PARTICIPATE IN PUBLIC AND AGRICULTURAL EXHIBITIONS

The division participates and present attractive exhibition stalls in public and agricultural exhibitions to promote cultivation and processing technologies

12.1 Main coordination activities of the Coconut Industrial and Agricultural Exhibition held at the institute from 26 to 29 January.

12.2 Deyata Kirula exhibition at BMICH from 04 to 09 February.

12.3 An exhibition stall was put at the Industrial Exhibition at Dambadeniya organized by the Dambadeniya Development Foundation on 11 February 2007.

12.4 The Institute had a stall at the Industrial exhibition at Damiswara Maha Vidyalaya from 08 to 9 March 2007

12.5 The Institute participated at the *Viyaparika Navodaya* Exhibition held at Kurunegala from 15 to 18 March 2007

12.6 The Institute had a combined stall with CCB at the Industrial Exhibition at the Technical Collage, Ratnapura from 03 to 06 April 2007

12.7 Educational exhibition at the Kingwood College, Kandy from 05 to 08 April 2007

12.8 Exhibition at the Janatha Sathkara Sevaya at the Andrews Collage, Puttalam from 12 – 13 May.

12.9 The Institute had a combined stall at the Janatha Sathkara Sevaya at Polonnaruwa from 16 to 17 June.

12.10 The Institute participated the exhibition organized to mark the World Environmental Day at Dankotuwa from 05 to 06 July.

12.11 The Institute participated the agricultural exhibition at BMICH from 20 to 22 July.

12.12 An educational exhibition at Hiriyala from 13 to 15 October.

12.13 Janatha Sathkara Sevaya exhibition at Gampaha from 20 to 21 October.

12.14 CRI participated the SME Machinery Exhibition at BMICH from 02 to 04 November.

12.15 Agricultural Exhibition at Dankotuwa from 5 to 7 November.

12.16 Janatha Sathkara Sevaya exhibition at Matara from 24 to 25 November

12.17 The Institute participated at the agricultural exhibition at the Negombo International School from 02 to 03 December.

12.18 CRI participated the exhibition at the St Maries Carnival, Negombo from 13 to 17 December.

13. AUDIO VISUAL AND MEDIA MATERIAL PRODUCTION AND MASS MEDIA PROGRAMMES

13.1 Interactive multimedia CDROM (IMMCDROM)

The interactive multimedia CDROM developed on coconut cultivation is an effective extension and learning tool. This was produced in collaboration with the Audio Visual Centre of the Department of Agriculture. Multimedia products mix a range of media elements like sound,

graphics, photos, illustrations, video, animation and text. It requires computer based operations for delivery of information. The first interactive multimedia CDROM produced resembled an electronic hand book on coconut cultivation and management. The second interactive multimedia CDROM on coconut based products is being produced in collaboration with the Audio Visual Centre, Gannoruwa

13.2 Video Documentaries on recommended management practices

The video documentaries produced by the division on coconut cultivation and management technologies were in high demand. Copies of these VCD are available for sale at a subsidized price of Rs. 100/=. Copies of these documentaries were available for coconut growers: *Red Weevil Control, Intercropping under coconut, Irrigation in Coconut Lands, Animal Husbandry in Coconut lands, Coconut Caterpillar Control, Importance of Gliricidia, and Soil Moisture Conservation.*

In addition seven video documentaries were also produced on Tissue Culture and Embryo Culture of coconut, the Coconut sector and the Industry, the Control of Coconut Black Beetle and Plessipa Beetle, the preparation of coconut past, the preparation of quality copra, and preparation techniques of coconut based products.

13.3 Radio and TV programmes

The divisional staff participated in five radio programmes, in "Gewaththa" and live programmes in collaboration with the Radio Broadcasting Service of the Department of Agriculture, Narahempita.

Two TV programmes were produced on the activities of CRI and Ambakele Genetics Resource Centre and telecast as Ritsbury Journey Day on ITN at 6.30 pm on 01 August, and 12 November.

13.4 Print Media

The divisional staff published ten newspaper articles on current issues of the sector.

13.5 Improvement of CRI Museum

CRI museum was developed as an attractive self educational centre for visitors. Items of the museum were rearranged by introducing new posters, exhibits and display boards. Ten colourful display boards were installed in the museum.

REPORT OF THE ESTATE MANAGEMENT DIVISION

Acting Manager (Estates)-E.P.Gunapala (A.P.F.A - BCom (SP),HNDA)

1. GENERAL

The four Genetic Resource Centers and six research sub stations that come under the Estates Management Division were maintained satisfactorily as a self-financial division without depending a treasury fund finance basis. The newly opened subs station at Middeniya is still developing and 2445 a total of coconut seedlings have been established. This sub station to serves coconut growers in the Southern Province conducting various programs to transfer technology. The construction of Superintendent bungalow and Circuit bungalow at the station were completed. This substation was declared opened by Hon. Chamal Rajapaksa Deputy Minister, Plantation Industries were other significant events are, continuation of the development of Pallama Genetic Resource Center for mass production of CRISL98, improvement of Makandura Genetic Resource Centre by planting intercrops, grasses and continuation of multi disciplinary research programs on soil improvement fertility and coconut palm decline syndromes. The overall income from the estates was approximately Rs.97.81 million. Increased nut price in the year contributed to the increased income. The average cost of production (COP) and net sale average (NSA) of all centers were 11.90 and 15.53 respectively.

Among the development programs, continuation of demonstration plots at Pallama, Ambakelle, Poththukkulama and Makandura Research Centers to exhibit recommended field practices, removal of weak and dud palms, continuation of curd and yoghurt production at Bandirippuwa, Rathmalagara, Makandura station and Ambakelle centers, continuation of a nursery for producing different colour forms of dwarf coconut along with high yielding coconut cultivars in Makandura, production of calves through Artificial Insemination, and expansion of pasture production are other important events of the year. Division extended its facilities to conduct one day training programs in its Research Centres and Genetic resource Centers organized by the Technology Transfer Division.

2. PERFORMANCE OF INDIVIDUAL UNITS

2.1 Ambakelle Genetic Resource Centre (AGRC): Pallama

Superintendent	:	Mr. W.M. Upali Rathnayake
Disrict	:	Puttlam
Agro climatic Zone	:	Intermediate Zone
Extent	:	456.20 ha

The total production of nuts during the year was 1.41 million, and it is a 6.86% decrease compared to the previous year. The total number of seed nuts issued was 983,759 and it is a reduction of 1.45% compared to last year. The inappropriate climate having 6 wet days and 43.1mm of rain fall during first three months of the year 2007 contributed mainly for the lowered nut set and selection of seed nuts. The total rain fall received during the year was 1,198.2mm with 88 wet days. General maintenance of the seed garden was satisfactory during the year. Organic manure and inorganic fertilizer was applied to 3,185 and 14,675 palms respectively. The preparation of 700 husk pits of the size of 8' x 4' x 4' were completed. Weeding, mulching and other cultural practices were duly attended.

The available buffalo herd of 54 animals was maintained as extensive system for grassing and thereby it helped to control weeds. Two acres of CO3 fodder grass was established. Production of curd and new born buffalo calves contributed to the additional income. The total income from curd was Rs 410,560.00.

The main income sources are sale of coconut (Seed nut and selected nut), coconut seedlings and other sundries giving a total income of Rs.27,638,995. Cost of production (COP) and net sale average (NSA) for 1000 nuts were Rs. 11,123.26 and Rs. 19,021.59 respectively.

2.2. Bandirippuwa Research Station (BRS)-Lunuwila

Superintendent	:	Mr. Mr.Nimal Hemasiri
Disrict	:	Puttlam
Agro climatic Zone	:	Wet Intermediate Zone
Extent	:	148.1 ha

The total yield received was 690,324 nuts and it was an increase of 15.19% yield when compared to year 2006. The low rainfall of 102.1mm received in 5 days during the first three month of the year may be the reason for yield decrease in the year and removal of palms for research purposes. Also the rain fall received in the year indicates a decreasing trend compared to the last year, receiving a total amount 1,383.8mm and 104 wet days Application of inorganic fertilizer was done to 11,600 of palms. Weeding mulching and other cultural practices were duly attended. One pond was excavated to harvest the rain water for the purpose of moisture conservation and to use of buffalo's wallowing. The selected 135 nos.of weak palms were removed to get a uniform plantation. Road system within the estate was renovated.

Livestock project, consisting 89 cattle and 20 buffaloes was maintained successfully. The total of 866 curd pots and 20,840 yoghurt cups were produced and sold along with 9,331 of raw milk earning significant income. The total income received from the sale of coconut, copra and other estate produces as follows;

Coconut	=	Rs. 11,734,578.00
Copra	=	Rs. 509,733.00
Milk, treacle, fruits, vegetable & timber	=	Rs. 1,034,967.00
Total	=	Rs. 13,279,278.00

Cost of production (COP) for 1000 nuts was Rs. 14,352.48 and Net sale Average (NSA): for 1000 nuts was Rs.16,998.65.

2.3. Dunkannawa Research Station (DRS) - Thabbowa, Naththandiya

Officer In Charge	:	Mr. Newton Gamage
Disrict	:	Puttlam
Agro climatic Zone	:	Intermediate Dry Zone
Extent	:	10.4 ha

This is on development stage with the establishment of new cultivar T x SR (CRISL 98) 974 nos.of four year old seedlings and old stand of 324 palms of tall variety. It has produced 22,419 nuts from old plantation. Total rainfall received in this year was 1,304.7mm and 102 wet days.

A cattle herd comprising 22 animals is maintained in this estate in order to increase the income level and for the purpose of controlling weeds.

The income from coconut, and sundries were Rs.370,586.00 and 887,227.93 respectively. Sale of coconut seedlings and milk has contributed for the sundry income.

Cost of production (COP) for 1000 nuts was Rs. 110,54.16 and Net Sale Average (NSA): for 1000 nuts was Rs. 16,529.99

The existing Cinnamon field as an intercrop was continued with filling vacancies.

2.4. Maduruoya Genetic Resource Centre (MOGRC)-Bogaswewa, Kashyapapura

Assistant Superintendent	:	Mr.D. M I..S.K.Dewameththa
District	:	Polonnaruwa
Agro climatic Zone	:	Dry Zone
Extent	:	85 ha

This seed garden maintained to supply seed nuts to CCB nurseries in the dry zone. The total yield received was 544,878 nuts and it was a 5.9% increase compared to previous year. Effect of drought to this estate has been avoided by having a surface irrigation using water from the Mahaweli System. The rainfall received in this year was 1,768mm and 86 wet days

Income:

Coconut	=	Rs.	7,498,392.00
Sundry	=	Rs.	517,701.00
Total	=	Rs.	8,016,093.00

Cost of production (COP) for 1000 nuts was Rs. 8675.94 and Net Sale Average (NSA): for 1000 nuts was Rs. 13761.59.

2.5. Makandura Genetic Resource Centre (MGRC)-Makandura, Gonawila

Assistant Superintendent	:	Mr. H.W.N.Nandakumara
Disrict	:	Kurunagala
Agro climatic Zone	:	Wet Intermediate
Extent	:	58.20 ha

The total yield of this estate was 531,405 nuts and it was a 16.13% decrease in yield when compared to year 2006. Drop of yield experienced during the year was due to drought condition prevailed with 115.6mm rain and 2 wet days during first three months of the year and it affected the nut set. The total rainfall received during the year was 972.2mm and 44 wet days

With regard to livestock production, this center maintained 125 cattle and 15 buffaloes for breeding purposes and milk production. The commercial coconut nursery and the demonstration block were maintained.

Total income received from different activities was as follows;

Income:

Coconut	=	Rs.	6,121,395.00
Copra	=	Rs.	73,747.00
Milk & milk products	=	Rs.	513.282.00
Banana	=	Rs.	14,630.00
Total	=	Rs.	6,723,054.00

Cost of production (COP) for 1000 nuts was Rs. 7,353.01 and Net Sale Average (NSA): for 1000 nuts was Rs. 11,658.04. This has recorded a Rs. 4.35 profit margin per nut..

2.6. Pallama Genetic Resource Centre (PGRC) Pallama

Officer In Charge	:	Mr. T.M.P.A.K.Thilakarathna
District	:	Puttlam
Agro climatic Zone	:	Dry Zone
Extent	:	252 ha

This estate is in the development stages as a seed garden for the mass (production of CRISL 98) seed nuts. It consists of mature and immature plantations. From the old mature plantation it was producing 586,816 nuts. Maintenance of under plantation was done successfully and infilling was done for the existing vacancies. Agronomic practices such as fertilizing, weeding, and mulching have successfully completed. Hybridization program of the Genetic and Plant Breeding Division was commenced. Two ponds were conducted for the rain water harvesting. The total rainfall received during the year was 1,174.5mm and 73 wet days.
A herd of cattle comprising 38 and 15 buffaloes were maintained.

Total income from sale of coconut and sundries were Rs 9,191,771.00 and Rs. 725,698.00 respectively .

Cost of production (COP) for 1000 nuts was Rs. 15,062.70 and Net Sale Average (NSA): for 1000 nuts was Rs. 15,663.80. This has recorded a profit of Rs. 0.60 per nuts.

2.7. Poththukkulama Research Station (PRS) - Pallama

Officer In Charge	:	Mr. D.L.I.Neththasinghe
District	:	Puttlam
Agro climatic Zone	:	Intermediate Dry Zone
Extent	:	81.73 ha

The coconut production at PRS was 962,834 nuts and it was a 12.68% increase compared to the previous year yield. This estate is used only for research activities and a collection of dwarf varieties maintained in a separate block. Routine activities were continued in this

centre successfully. All the palms of the estate have been mulched. The total rain fall of 1,288.3mm in 81 wet days was received in this year.

A herd of Goats and cattle were maintained in the estate. Goat project was conducted by the Agronomy Division and estate staff assisted for these activities. PRS was conducting cattle fattening program collecting male animals from CRI estates and 37 cattle and 05 buffaloes were maintained in this year. Two ponds were constructed for the rain water harvesting

Income:

Coconut & copra	=	Rs.	15,095,491.00
Sundry	=	Rs.	725,698.00
Total	=	Rs.	15,821,189.00

Cost of production (COP) for 1000 nuts was Rs. 9,180.23 and Net Sale Average (NSA): for 1000 nuts was Rs. 15,678.18. This has recorded a profit of Rs. 6,497.95 per 1000 nuts.

2.8. Rathmalagara Research Station (RRS)- Panirendawa

Officer In Charge	:	Mr. G.B.A.Wijesekara
District	:	Puttlam
Agro climatic Zone	:	Intermediate Dry Zone
Extent	:	110.48 ha

Rathmalagara gave an annual crop of 705,595nuts for this year. Out of the above nut production 16,770 seed nuts have been issued which were separately collected from plus palms. Total rainfall of 1,450.77mm in 112 wet days was received in this year.

A cattle project was carried out in this estate and it maintained 64 animals. This contributed to earn an income of Rs.272,396.00 by selling milk products and live animals.

A commercial coconut nursery also maintained successfully and it has contributed an income of Rs.1,173,930.00 by selling of coconut seedlings. The income from coconut and copra was Rs.11,261,233.00. Including sundry income of 124,131.00 it has recorded a total income of Rs.12,831,690.00

Cost of Production (COP) for 1000 nuts was Rs. 11,278.80 and Net Sale Average (NSA) for 1000 nuts was 15,959.91. This has recorded a profit of Rs. 4,681.11 for 1000 nuts

2.9. Walpita Research Station (WRS)-Walpita

Officer In Charge	:	Mr. Harold Upali
District	:	Gampaha
Agro climatic Zone	:	Wet Intermediate
Extent	:	17.8 ha

This research station is maintained specifically for the demonstration purpose of intercrops within a coconut plantation. All the intercrops suitable for intermediate climate conditions have been grown in this station. The existing coconut stand is 58 years old and yield is now

in declining trend. Coconut palms in 10 acre extent were uprooted and replanted by the Genetic & Plant Breeding Division for a research purpose.

The yield recorded in 2007 was 100,886 nuts and it was a 26.89% decrease when compared to previous year. This decrease yield is mainly due to aging condition of the palms. The estates received 1,960.5mm of rainfall in 95 wet days.

A herd of cattle comprising 17 animals were maintained for milking, controlling weeds and collection of cow dung. A cattle shed was constructed having stall facilities for 12 cows with waterers and feederers.

Income:

Coconut	=	Rs.	1,425,198.68
Seedlings	=	Rs.	299,440.00
Fruit & spices	=	Rs.	132,574.31
Milk	=	Rs.	105,750.00
Other	=	Rs.	86,285.00
Total	=	Rs.	2,330,135.00

Cost of Production (COP) for 1000 nuts was Rs. 16732.40 and Net Sale Average (NSA) for 1000 nuts was 14126.81. This has recorded a loss of Rs. 2605.59 for 1000 nuts

2.10. Middeniya Research Station (MRS)-Middeniya

Planting of 2333 seedlings was completed for five different research trials and 112 of seedling were planted by estates Management Division. Young palms initially established in this estate came up to flowering.

Construction of OIC quarters and circuit bungalow were completed. A water pump was installed for the deep well. The construction of the water storage tank (Ferro cement type) having the capacity of 100,000liters was completed. Construction of medium size tank for rain water harvesting was successfully completed.

Training program which was started last year was continued this year also. .

Table 01: Nut production, Expenditure & Income of all Genetic Resource Centres & Research Stations

Criteria	2006		2007	
	Estimated	Actual	Estimated	Actual
Total Nut Production	5,042,750	5,778,281	5,645,00	5,561,296
Total Expenditure for coconut	52,280,000	54,447,144	66,924,526	66,193,659
Total Income from Coconut	57,224,000	56,429,968	79,541,090	86,418,494

Table 02: Performance Indicators

Indicator	Performance	
	2006	2007
Cost Of Production Rs. (COP)	Rs 9.42	Rs 11.90
Net Sale Average Rs. (NSA)	Rs 9.76	Rs 15.53
Yeild Per Palm (Nos.)	79	76
Yeild Per Acre (Nos.)	4,917	4,068

Table 03: Land extent of each category (acres)

Category	AGRC	MOGRC	PGRC	MGRC	BRS	PRS	WRS	DRS	RRS
Coconut plantation	329.25	195.13	431.83	133.38	193.90	187.72	38.29	20.65	240.33
Nursery extent	2.47	-	-	-	3.71	-	-	-	-
Bare land	-	2.47	81.51	4.45	103.74	-	-	1.28	83.98
Roads and buildings	9.88	1.24	10.87	4.94	61.75	6.18	4.45	0.99	4.99
Jungle	780.52	11.12			1.24				96.95
Reservoirs	4.94		2.47	0.99	2.47	5.51	1.24	1.98	
Jungle barrier	-	-	96.82	-	-	-	-	-	-
Other crops	-	-	-	-	-	-	-	-	2.57
Total	1127.06	209.95	623.50	143.75	366.80	199.40	43.97	24.90	428.82

Table 04: Number of palms in each category

Category	AGRC	MOGRC	PGRC	MGRC	BRS	PRS	WRS	DRS	RRS	Total
Bearing palms	17,749	5,139	10,764	5,858	10,049	9,982	1,406	324	11,857	73,128
Young palms	17	3,059	9,284	0	897	143	33	974	958	15365
Dud palms	173	140	1,419	131	1,460	825	31	0	743	4922
Vacancies	752	1,834	3,383	1,253	6,031	2,525	990	80	156	17004
Total	**18,691**	**10,172**	**24,850**	**7,242**	**18,437**	**13,475**	**2,460**	**1,378**	**13,714**	**110,419**

Table 05 Rain fall (mm) and Number of wet days 2007

Estate		Month												Total
		Jan	Feb	Mar	App	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ambakelle GRC	Rain fall mm)	20.5	4.5	18.1	114.8	218.7	54.5	44.2	42.6	92.0	302.4	71.7	214.2	1198.2
	Wet days	4	2	2	12	5	6	4	8	10	15	9	11	88
Pallama GRC	Rain fall mm)	19.8	6.0	23.0	96.7	101.0	52.8	67.8	59.6	102.4	349.5	119.7	176.2	1174.5
	Wet days	3	0	3	7	4	5	2	7	8	18	8	8	73
Poththukkulama RS	Rain fall mm)	18	0	42.7	117.0	144.3	50.6	49.7	37.1	141.0	359.2	137.2	191.5	1288.3
	Wet days	1	0	3	0	14	6	1	5	11	18	12	10	81
Rathmalagara RS	Rain fall mm)	8.3	5.1	69.6	157.7	175.7	92.4	72.0	85.5	146.1	337.3	151.47	149.6	1450.77
	Wet days	4	1	4	14	7	12	4	8	14	21	12	11	112
Bandirippuwa RS	Rain fall mm)	49.7	0	52.4	203.6	195.8	104.1	26.0	89.5	120.0	325.6	92.0	125.1	1383.8
	Wet days	3	0	2	14	11	10	3	8	15	19	10	9	104
Dunkannawa RS	Rain fall mm)	7.8	3.0	50.2	236.7	155.5	104.0	48.1	123.4	125.5	264.1	17.6	168.8	1304.7
	Wet days	2	1	3	15	5	8	7	8	16	20	5	12	102
Makandura RS	Rain fall mm)	0	0	115.6	159.9	84.5	47.5	27.2	73.8	160.2	251.2	21.6	30.7	972.2
	Wet days	0	0	2	8	3	4	1	3	10	7	2	4	44
Walpita RS	Rain fall mm)	32.9	0	27	358.4	126.2	147.6	112.8	112.0	361.7	403.3	115.3	163.3	1960.5
	Wet days	4	0	3	12	7	11	3	8	17	15	6	9	95
Maduruoya GRC	Rain fall mm)	80.6	116.5	0	300.0	84.7	39.9	42.3	27.6	82.4	261.6	153.3	579.1	1768
	Wet days	10	3	0	12	3	4	1	3	3	16	12	19	86

Table 06: Centre Wise Estimated & Actual Nut Production

Estate	Estimated Nuts (Nos.)			Actual Nut Production					
				2006			2007		
	2006	2007	2008	Picked	Fallen	Total	Picked	Fallen	Total
Ambakelle GRC	1,325,000	1,350,000	1,392,830	1,390,702	129,794	1,520,496	1,218,716	197,423	1,416,139
Pallama GRC	700,000	900,000	575,180	449,428	77,083	526,511	506,185	80,631	586,816
Poththukkulama RS	800,000	825,000	708,601	659,591	194,867	854,458	721,739	241,095	962,834
Rathmalagara RS	700,000	840,000	715,051	700,253	54,949	755,202	628,904	76,691	705,595
Bandirippuwa RS	700,000	833,000	487,377	745,027	67,307	812,334	621,499	68,825	690,324
Dunkannawa RS	12,750	13,000	16,772	20,939	2,284	23,223	19,628	2,791	22,419
Makandura RS	230,000	300,000	305,734	566,763	66,894	633,657	439,689	91,716	531,405
Walpita RS	150,000	135,000	123,347	105,127	32,871	137,998	81,932	18,954	100,886
Maduruoya GRC	425,000	440,000	253,632	474,374	39,998	514,372	490,049	54,829	544,878
Total	**5,042,750**	**5,645,000**	**4,578,524**	**5,112,204**	**666,047**	**5,778,251**	**4,728,341**	**832,955**	**5,561,296**

Table 07: Centre Wise Budgeted & Actual Expenditure & Income

Estate	Expenditure (Rs.)				Income (Rs.)			
	2006		2007		2006		2007	
	Budgeted	Actual	Budgeted	Actual	Budgeted	Actual	Budgeted	Actual
Ambakelle GRC	15,443,000	14,422,466	14,511,906	16,834,942	18,774,000	18,037,744	21,126,200	27,638,995
Pallama GRC	6,954,000	6,356,764	8,917,716	7,934,864	7,798,000	6,230,198	10,916,930	9,917,469
Poththukkulama RS	7,231,000	7,086,023	7,804,303	8,489,993	8,417,000	9,774,809	12,119,158	15,821,189
Rathmalagara RS	7,890,000	8,733,437	8,995,526	10,717,795	9,874,000	6,779,388	12,219,280	12,831,690
Bandirippuwa RS	7,427,000	9,613,633	11,643,475	11,917,643	8,855,000	7,937,580	10,017,538	13,279,278
Dunkannawa RS	1,085,000	1,842,199	1,522,947	1,652,155	562,000	834,922	1,018,000	1,257,814
Makandura RS	4,192,000	4,118,867	5,435,558	5,616,771	4,818,000	6,618,854	3,560,110	6,723,054
Walpita RS	1,866,000	2,148,959	2,560,661	2,603,364	2,103,000	2,762,760	2,290,800	2,330,135
Maduruoya GRC	4,466,000	4,748,129	5,532,434	4,986,639	5,483,000	5,117,650	6,273,074	8,016,093
Total	**56,554,000**	**59,070,477**	**66,924,526**	**70,754,166**	**66,684,000**	**64,093,905**	**79,541,090**	**97,815,717**

Table 08: ***Expenditure Statement of all Genetic Resource Centres & Research Stations***

Expenditure item	2006			2007		
	Budgeted (Rs.)	Actual (Rs)	Variance	Budgeted (Rs.)	Actual (Rs.)	Variance
General Charges						
Staff Salaries & wages	27,577,208	29,873,179	(2,295,971)	27,061,614	31,415,526	(4,353,912)
Transport/Vehicle	3,604,700	2,623,181	981,519	5,772,796	5,306,650	466,146
Estate Maintenance & Administration	7,530,453	7,677,884	(147,431	9,769,255	9,981,511	(212,256)
Agronomic Practices	3,787,300	3,857,208	(69,908)	4,474,863	4,276,612	198,251
Manuaring	6,050,100	6,603,961	(553,861)	6,313,733	8,506,688	(2,192,955)
Harvesting	3,373,800	3,927,155	(553,355)	4,098,494	4,770,104	(671,610)
Copr Manufacturing	357,177	425,250	(68,073)	2,873,000	721,504	2,151,496
Animal Husbandry	1,799,213	1,109,195	690,018	3,011,886	2,754,491	257,395
Nursery	1,806,980	2,235,931	(428,951)	2,599,792	2,054,591	545,201
Intercropping	443,000	725,134	(282,134)	652,593	686,068	(33,475)
Toddy tapping	225,000	238,736	(13,736)	296,500	280,421	16,079
Total	**56,554,931**	**59,296,814**	**(2,741,883)**	**66,924,526**	**70,754,166**	**(3,829,640)**

Table 09: ***Income statement of all Genetic Resource Centres & Research Stations***

Income Item	2006			2007		
	Budgeted (Rs.)	Actual (Rs)	Variance	Budgeted (Rs.)	Actual (Rs.)	Variance
Coconut						
Fresh Nut	33,684,954	37,996,988	4,312,034	50,777,975	58,518,055	7,740,080
Seed Nut	19,470,500	17,187,866	(2,282,634)	17,713,200	27,900,439	10,187,239
Copra	1,509,296	1,245,114	(264,182)	1,095,630	2,170,403	1,074,773
Animal husbandry						
Milk & Milk products	3,606,260	1,193,958	(2,412,302)	3,975,910	1,912,173	(2,063,737)
Sale of Animals	658,500	1,624,090	965,590	1,720,000	1,923,939	203,939
Intercrops	944,150	164,095	(780,055)	772,300	194,012	(578,288)
Toddy tapping	328,500	349,095	20,595	300,000	323,675	23,675
Other						
Coconut Logs	2,215,000	456,578	(1,758,422)	628,000	775,727	147,727
Coconut seedlings	3,324,000	2,406,303	(917,697)	2,103,075	3,394,399	1,291,324
Other	924,000	1,469,821	545,821	455,000	702,895	247,895
Total	**66,665,160**	**64,093,908**	**(2,571,252)**	**79,541,090**	**97,815,717**	**18,274,627**

REPORT OF THE ADMINISTRATION DIVISION

Deputy Director (Administration & Finance) - E P Gunapala
A.P.F.A., B. COM (SP), Diploma in Accountancy

1. ESTABLISHMENT UNIT

The unit continued to assist Research Divisions in routine administrative & financial matters and related affairs including maintenance work.

2. CADRE

The staff position of the Coconut Research Institute at the end of December 2007, is given in table 1.

Table 1: Staff position as at 31/12/2007

Grade	Upgraded	Sp C1	C1 I	C1 II	C1 III	C1 IV	Total	Total Approved Cadre
Executive	02	00	07	09	24	35	77	98
Technical	00	38	09	05	-	-	52	67
Intermediate	00	05	01	00	-	-	06	07
Clerical & Allied	00	25	03	03	-	-	31	42
Operative	00	27	06	06	-	-	39	54
Driver	00	20	04	03	-	-	27	30
Minor	00	44	11	7	-	-	62	95
Watcher	10	00	00	00	-	-	10	12
Grand Total	12	159	41	33	24	35	304	405

3. WELFARE

Welfare facilities extended towards the employees from the Board were continued. Financial assistance extended to the employees are given below:

3.1 Financial Aid

Provident Fund Loans:	Granted for 67 employees, amounting to	Rs.20,612,415.00
Distress Loans:	Granted for 25 employees amounting to	Rs. 3,878,401.00
Transport Loans:	Granted for 13 employees amounting to	Rs. 670,625.00
Refrigerator Loans :	Granted for 01 employee amounting to	Rs. 12,000.00
Loan Relief to Indebtedness Loans :	Granted for 01 employees amounting to	Rs. 7,500.00
Medical Aid:	Rs.3,983,655.00 was reimbursed by the Medical Aid Scheme during the year 2007, and an amount of Rs.943,206.00 was distributed to 341 Savings Accounts of Members.	

The following medical clinics were conducted during the year 2007

- Eye Clinic
- Blood Donation Programme
- Medical Check up for members & their families conducted by Asha Central Hospital (Pvt.) Ltd and Sri Lanka Diabetic Centre.
- Checking of Blood Sugar of members of Medical Aid Scheme

3.2 Other facilities to employees

(a) Financial assistance was also granted to the Multi-purpose Co-operative Society, Art Circle, Day Care Centre, Seva Vanitha Movement, Death Donation Society and the Recreation Club during the year 2007.

STAFF MATTERS

4. APPOINTMENTS

No appointments were given during the year 2007.

5. RESIGNATIONS, RETIREMENTS, VACATION OF POSTS & TERMINATIONS OF SERVICES & DEATHS

The details are given in Table 2:

Table 2:

Name	Designation	Division/Unit	Date
Resignations:			
Miss. D Paramasiwam	Assistant Research Officer	Soils & Plant Nutrition Division	01.03.07
Dr.(Mrs.) W C Fernando	Senior Research Officer	Soils & Plant Nutrition Division	11.05.07
Dr. T S G Peiris	Principal Research Officer	Biometry Division	15.08.07
Miss. H P I N M Gunawardena	Technical Assistant	Plant Physiology Division	13.09.07
Mr. W A D R Abeysekara	Assistant Research Officer	Agriculture Economics Division	17.09.07
Mr. W W F N Fernando	Senior Lab/Field Assistant	Crop Protection Division	01.10.07
Mr. K L N Pradeepa	Manager(Estates)	Estates Management Division	11.10.07
Retirements:			
Mr. H A G Perera	Senior Office Attendant	Plant Physiology Division	04.01.07
Mr. I J Antony	Senior Vehicle Attendant	Establishment Unit	23.01.07
Mr. W M L G Fernando	Senior Lab/Field Assistant	Biometry Division	27.02.07
Mr. A Sugathadasa	Senior Supervisor	Estates Management Division	28.02.07
Mr. A H Norman	Senior Technical Officer	Estates Management Division	12.04.07
Mr. G M R Karunasekara	Experimental Officer	Estates Management Division	28.07.07
Mr. A N Eknaligoda	Estates Superintendent	Estates Management Division	18.11.07
Mr. J H Somaratne	Senior Lab/Field Attendant	Genetics & Plant Breeding Division	22.11.07
Mr. H M Tikiribanda	Senior Driver	Estates Management Division	15.12.07
Deaths			
Mrs. A R S Hettiarachchi	Senior Clerk/Typist	Establishment Unit	24.03.07
Mr. K R E M Fernando	Senior Lab/Field Assistant	Soils & Plant Nutrition Division	06.11.07

6. PROMOTIONS

6.1 PROMOTIONS IN NON-EXECUTIVE GRADES

Following Internal Promotions in Non-Executive Grades were implemented during the year 2007, as shown in Table 3. The effective date of these promotions was 01/01/2007.

Table 3: Promotions in Non-Executive Grades during the year 2007

Name	Designation	Division/Unit
CLASS 1 TO SPECIAL CLASS		
Technical Grade		
Mr. S S Rajapaksha	Senior Technical Officer	Biometry Division
Mr. H M N B Herath	Senior Technical Officer	Genetics & Plant Breeding Division
Mr. R Vithanage	Senior Foreman(Mechanical)	Engineering Unit
Mr. R B Attanayaka	Senior Technical Officer	Genetics & Plant Breeding Division
Clerical & Allied Grade		
Mr. N M H Wijewardena	Senior Clerk/Typist	Establishment Unit
Mr. K T G N W Perera	Senior Clerk/Typist	Engineering Unit
Operative Grade		
Mr. H B Perera	Senior Lab/Field Assistant	Agronomy Division
Mr. K D D Appuhamy	Senior Lab/Field Assistant	Agronomy Division
Drivers Grade		
Mr. R P Somasiri	Senior Driver	Establishment Unit
Mr. K P S Dissanayake	Senior Tractor Driver	Estates Management Division
Minor Grade		
Mr. K A S C N Fernando	Senior Office Attendant	Technology Transfer Division
Mrs. B A D Kusumawathie	Senior Lab/Field Attendant	Plant Physiology Division
Mr. M M N Jayatissa	Senior Lab/Field Attendant	Plant Physiology Division
Mr. E A Chandradasa	Senior Lab/Field Attendant	Soils & Plant Nutrition Division
Mrs. I B Dayawathie	Senior Office Attendant	Establishment Unit
CLASS II TO CLASS I		
Technical Grade		
Mr. W A S Wickramarachchi	Technical Officer	Biometry Division
Mr. G P N Chandrasiri	Field Officer	Estates Management Division
Mr. W A H Upali	Field Officer	Estates Management Division
Clerical Grade		
Mrs. W A N K Wijesinghe	Accounts Clerk	Accounts Unit

Operative Grade		
Mr. H A P B Fernando	Lab/Field Assistant	Genetics & Plant Breeding Division
Mr. R S P Jayamanna	Linesman	Engineering Unit
Drivers Grade		
Mr. J A D B D Appuhamy	Driver	Establishment Unit
Minor Grade		
Mr. G D Asitha Milroy	Lab/Field Attendant	Coconut Processing Research Division
Mr. R P S L Abeyratne	Office Attendant	Library
Mr. R K S Wimalasiri	Office Attendant	Accounts Unit

6.2 PROMOTIONS IN EXECUTIVE GRADES

Following Promotions in Executive Grades were implemented during the year 2007, as shown in Table 4 & 5.

Table 4: Promotions in Executive Grades during the year 2007

Executive Grade Class II to Class I

Name	Designation	Division	Effective Date
Dr. N P A D Nainanayake	Principal Research Officer	Plant Physiology Division	14.12.2006

Table 5:

Executive Grade Class III to Class II

Name	Designation	Division	Effective Date
Mr. R P B S H Senaratne	Senior Research Officer	Agronomy Division	21.04.2006
Mr. A M A P G Gunawardena	Senior Extension Officer	Technology Transfer Division	02.11.2006
Mr. I M S K Idirisinghe	Senior Research Officer	Agriculture Economics Division	02.11.2006
Mrs. L L W C Yalegama	Senior Research Officer	Coconut Processing Research Division	03.11.2006
Dr.(Mrs.) N S Aratchige	Senior Research Offcer	Crop Protection Division	25.01.2007

7. TRANSFERS

1. Mr. W M D R Wijesinghe, Supervisor from Ratmalagara Research Center to Middeniya Research Center – On January 01

2. Mr. E M A Tilakaratne Banda, Senior Technical Officer from Ratmalagara Research Center to Soils & Plant Nutrition Division – On January 01

3. Mr. A M N Kularatne, Watcher from Genetics Resource Center Ambakelle to Poththukulama Research Center– On January 01

4. Mr. H B S Herath, Assistant Superintendent from Bandirippuwa Research Station to Ratmalagara Research Center – On February 01

5. Miss S A Sumanawathie, Lab/Field Attendant from Poththukulama Research Center to Ratmalagara Research Center. – On Aprirl 01

8. LOCAL TRAININGS (More than 7 days)

1. Mr. E M Gnanaratne/Internal Auditor and Mr. R M U Chandranath/Accountant followed a Diploma in English for Professionals at Sri Lanka Institute of Development Administration from 07 April (One year, Every Saturdays)

2. Mr. M G M K Meegahakumbura/Research Officr followed a Postgraduate Diploma Course in applied Statistics at Postgraduate Institute of 15 May (15 Weeks, Weekends)

3. Miss. M K F Nadheesha/Research Officer, Mrs. N I Suwandaratne/Assistant Research Officer, Mr. B A S Manjula/Assistant Research Officer, Mr. L R M C Liyanage/Assistant Research Officer, Mrs. H M I K Herath/Research Officer followed a Diploma in English for Professionals at Sri Lanka Institute of Development Administration from 18 August (One year, Every Saturdays)

4. Mr. M G M K Meegahakumbura/Research Officr followed a Advance Course in PCR Technology at GENETECH from 18 October to 09 November.

5. Mr. K P A Pathirana/Senior Technical Officer followed a short course on GIS & IT Applications at Postgraduate Institute of Science from 26 November to 01 December.

6. Miss S C Somasiri, Research Officer following a postgraduate studies leading to a MPhill. at the Post Graduate Institute of Agriculture, Peradeniya, Sri Lanka

7. Mrs. L L W C Yalegama commenced her postgraduate training leading to PhD at the Post Graduate Institute of Agriculture, Peradeniya from september 2007 to 2009

9. OVERSEAS VISITS

1. Dr.(Mrs) L C P Fernando/Head, Crop Protection Division participated as an examiner for Ph.D. defense of Mrs. N S Aratchige and attended mite workshop in Netherlands from 21 – 27 January.

2. Dr.(Mrs) N S Aratchige/Senior Research Officer participated at the thesis defense examination and mite workshop in Netherlands from 21 January to 08 February.

3. Dr.(Mrs) L C P Fernando/Head, Crop Protection Division attended annual cum final review meeting of the CFC/DFID/APCC/FAO project on integrated pest Management of Coconut Pests in India from 01 – 07 May.

4. Dr.(Mrs.) C Jayasekara/ Director, Coconut Research Institute participated at the Coconut Summit 2007 in Kerala, India from 07 – 11 May.

5. Mr. K D P P Gunathilaka/Research Officer participated at the International Conference on Biotechnology Engineering in Kuala Lumpur, Malaysia from 08 to 10 May.

6. Dr. D B T Wijeratne/Chairman, Coconut Research Board visited to Cuba with Hon. Minister of Coconut Development, to support and advice the Cuban Government on their Coconut Industry as requested by HE the President of Sri Lanka from 26 May to 05 Jnne.

7. Dr A A F L K Perera/Head, Genetics & Plant Breeding Division Visited to National Institie of Agricultural Botany(NIAB) Cambridge, UK to submit a joint project proposal to the Generation Challenge Program of the IPGRI in UK from 01 to 16 June.

8. Dr.(Mrs.) W N I S C Fernando/Principal Research Officer participated to present a paper at the Asia Pacific Conference on plant Tissue Culture and Agribiotechnology 2007 in Kuala Lumpur, Malaysia from 17 to 22 June.

9. Mrs. P I P Perera/Research Officer participated to present a paper at the Asia Pacific Conference on plant Tissue Culture and Agribiotechnology 2007 in Kuala Lumpur, Malaysia from 17 to 22 June..

10. Mrs. H D D Bandupriya/Research Officer participated to present a paper at the Asia Pacific Conference on plant Tissue Culture and Agribiotechnology 2007 in Kuala Lumpur, Malaysia from 17 to 22 June..

11. Dr. D B T Wijeratne/Chairman, Coconut Research Board accompanied the Hon. Minister of Coconut Development on a delegation to South China- Hainan Island to negotiate introduction of cold tolerant coconut variety "Hainan Tall" to Sri Lanka in Hainan Island, China form 02 to 07 August.

12. Mr. P A H N Appuhany/Head, Technology Transfer Division participated at the Study Meeting on knowledge management tools for strengthening Agricultural Research and Extension Systems Tehran Islamic Republic of Iran in Iran from 03 to 10 August

13. Mr. C S Herath/Extension Officer, participated at the Study Meeting on knowledge management tools for strengthening Agricultural Research and Extension Systems Tehran Islamic Republic of Iran in Iran from 03 to 10 August

14. Dr.(Mrs.) C Jayasekara/Director, Coconut Research Institute participated the International Coconut Gene Bank(ICG) workshop and Steering Committee Meeting of the COGENT, and visit the Coconut Development Board of the Philippines in Los Banos, Philippines form 09 to 16 December

10. OVERSEAS TRAININGS

1. Miss. H D M A Dissanayaka/Research Officer attended 7th FAO/IAEA Interregional Training Course on Mutant Germplasm characterization using Molecular Markets in Australia, from 18 May to 24 June

2. Dr. H T R Wijesekara/Senior Research Officer participated short term training on the methods of identification of phytoplasma associated with root-wilt disease in coconut in India from 17 to 29 June

3. Mr. I M S K Idirisinghe/Senior Research Officer attended Postgraduate training, leading to a Ph.D (Agriculture Economics) in Tomas Bata University in Zlin, Czech Republic from 17 September 2007 to 15 July 2010.

4. Mr. C S Herath/Extension Officer attended Postgraduate training, leading to a Ph.D (Mass Communication and motivation of farmers) in Tomas Bata University in Zlin, Czech Republic from 17 September 2007 to 15 July 2010.

5. Mrs. H D D Bandupriya/Research Officer attended Postgraduate training leading to Ph.D in Plant Biotechnology at the University of Reading, UK from 28 September 2007 to 29 September 2010.

11. NO-PAY LEAVE

1. Mr. K D P P Gunathilake/Research Officer was granted no-pay leave in order to search for postgraduate scholarship opportunities in UK from 28 September 2007 to 24 September 2008.

2. Mr. S A D K Antony/Senior Driver was granted no-pay leave for employment in Italy from 14 May 2007 to 13 May 2009.

12. TRANSPORT UNIT

Administration of the staff of the unit including drivers and maintenance of the following fleet of vehicles were done by the Transport Unit during the year 2007.

Buses	-	03
Lorries	-	02
Vans	-	08
Cars	-	02
Cabs	-	14
Jeeps	-	05
Motor bicycles	-	61
Three Wheelers	-	03
		98

13. DEBTORS DUE TO VIOLATORS OF BONDS

Name	Bond Value
1. Dr. K.B.Dasanayaka	Rs. 2,039,715.00
2. Mr. H.P.S.Jayasundara	Rs. 2,078,905.33
3. Mrs. M.G.F.S.Jayasundara	Rs. 3,345,424.66
4. Mr. R.A.J.R.Perera	Rs. 1,068,165.00
5. Mr. M.A.Thilakasiri	Rs. 927,906.52
6. Mrs. P.G.P.Hewawitharanage	Rs. 2,993,945.18
7. Dr.(Mrs) C.K.Banadaranayake	Rs. 3,371,612.63
8. Mr. N.A.K. De Silva	Rs. 3,204,297.60

14. FINANCE UNIT

Total budgetary allocation for this year is 178.755 million and out of which 136.855 million under recurrent and 41.9 million under capital expenditure. Therefore the government grant was 170.8 million.

Preparing Institutional Budget cash flow and the final accounts are main functions of the Unit in addition to preparing monthly salaries and making routine payments.

15. ENGINEERING UNIT

Engineering Unit carried out maintenance work of buildings, electricity, vehicles, and machineries and attended to the following construction and rehabilitation works during the year 2007.

- Construction of Glass House for Plant Physiology Division.
- Construction of Two Storey Laboratory Building for Soils & Plant Nutrition Division.
- Consultancy Services for Two Storey Laboratory Building for Soils & Plant Nutrition Division.
- Relaying to the Glazed Sheets to Glass House.
- Renovation of Crop Protection Division Laboratory Building at Bandirippuwa Estate.
- Providing Pipelines for Water Supplying Works to Coconut Plants at Middeniya Research Station.
- Construction of Room for Heat Recovery Unit of Coconut Processing Research Division.

STAFF PUBLICATIONS /ACADEMIC AND PROFESSIONAL ACTIVITIES/ COMMUNICATIONS AT SCIENTIFIC MEETINGS / PARTICIPATION OF CRI STAFF IN OTHER STATUTORY BODIES AND COMMITTEES

1. STAFF PUBLICATIONS

Aratchige, N.S. (2007). Predators and the accessibility of herbivore refuges in plants. PhD thesis. University of Amsterdam, the Netherlands. ISBN: 978-90-76894-70-6.

Bandupriya HDD, Malaurie B, Fernando SC, Verdeil JL (2007). Cryopreservation of encapsulated plumules of coconut. Effect of transport / store conditions. In: Books of abstracts; Asia Pacific conference on Plant tissue culture and Biotechnology (APaCPA), June 17-21, 2007, Kuala Lumpure, Malaysia, pp 83.

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Ekanayake, G K (2007) Un-revealed Coconut Biodiversity from the Southern Coast of Sri Lanka. Coconut Technology Update CRI (2) pp 3-4.

Ekanayake, G K., Perera, S A C N., Dassanayake, P N and Everard J M D T (2007) " Identification, Characterization and Conservation of new Coconut Phenotypes from Southern Sri Lanka" Proceeding of the 12th International Forestry and Environment Symposium 2007. pp 76-77.

Fernando S C, Vidhanaarachchi V R M, Weerakoon L K and Santha E S (2007). What makes clonal propagation of coconut difficult? Book of Abstract, asia Pacific Conference on Plant Tissue Culture and Agribiotehnology 2007, 17-21 June 2007, Kuala Lumpur, Malaysia, pp.73.

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Herath, H.M.I.K., Ranasinghe, K.L., Pathirana, K.P.A. and Tennakoon, N.A. 2007. Characteristics and occurrence of soil series in Dandagamuwa topographic area (one inch sheet), Soils & Plant Nutrition Division, Coconut Research Institute, Lunuwila.

Herath, H.M.I.K., Saumyakumara, A.P.A., Tennakoon, N.A. 2007. Soil fertility status of common coconut growing soil series in Sri Lanka. *Journal of the Soil Science Society of Sri Lanka*, Volume 18. INPRESS.

Jayakody, J.A.D.S.S., Tennakoon, N.A. and Fernandopulle, M.N.D. 2007. Assessment of the available phosphorus in two soil series under different fertilizer used for coconut *(Cocos nucifera)* in Gampaha District. *Cocos*, Vol 18. INPRESS.

Jayasekara, C. and Gunathilake, K D P P. Processing Technologies for virgin coconut oil and coconut based Confectionaries and beverages, International Coconut Summit 2007, Kochin, India.

Jayasinghe, J.A.A.K., Marikkar, J.M.N., Jayasundra, J.M.M.A and Gajanayake, K.G.M.C.P.B. Exploring constraints and motivations of HACCP adoption in the virgin coconut oil and white edible copra industries of Sri Lanka. In Proceeding of the 7th *Agricultural Research Symposium of the Wayamba University of Sri Lanka,* 23-24 October, 2007.

Kumara, P M U S., Perera, S A C N., and Fernandopulle, M N D (2007) "Evaluation of Morphological differences between Green Dwarf x Sri Lanka Tall and Yellow Dwarf x Sri Lanka Tall Hybrids of Coconut. Proceedings of the 7th Agricultural Research Symposium, Faculty of Agriculture and Plantation Management . University of Wayamba. Pp. 136-138.

Madurapperuma, W S., Dayaratne, K K S R., De Costa, W A J M (2007). Evaluation of physiological and biochemical changes of two coconut genotypes grown under different moisture regimes. *Proceedings Part I, International Forestry and Environment Symposium. P 81.*

Madurapperuma, W S., Mendis, H., Ranasinghe, C S., Premasiri, N and Gunawardena, M (2007). Comparative study of water movement in leaf Scorch Decline affected and healthy coconut palms using Li as a non-radio active tracer. *Cocos,* 18, 74-82.

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Marikkar, J.M.N., Jayasundera, J.M.M.A., Rupangali, A.P.D and Fernandopulle, M. Effect of different levels of fortification of wheat flour with defatted coconut flour on the quality of fibre-enriched biscuits. *Int. J. Coco Res. Dev.*, 23(2) 16-27 (2007).

Nadheesha, M.K.F. 2007. Monthly pattern of nutrient removal by the coconut palm. Technology Update, August, Coconut Research Institute, Lunuwila

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Nainanayake, A D (2007). Use of Chlorophyll fluorescence parameters to assess drought tolerance of coconut varieties. *Cocos,* 18: 10-35.

Nainanayake, A D and Morison, J I L (2007). A case study on physiology-based drought screening of coconut with selected accessions. *Cocos,* 18: 6-73.

Jayalath, K V N N, Jayasinghe, U. K. and Fernando, M. T. N (2007). Price and production risk in coconut industry in Sri Lanka: A comparison with the leaders in the world market. In First Annual Research Forum of Sri Lanka Agricultural Economics Association. 21st September, 2007. Faculty of Agriculture,University of Peradeniya, Peradeniya.

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Pathiraja, P.M.E.K., Idirisinghe,I.M.S.K., Vithanaarachchi,V.A.R.P., Priyankara,G.G.D.S., Subasinghe,S.D.J.N., (2006). Evaluation of Samurdhi Coconut Development Programme 2005. Report submitted to the Coconut Cultivation Board of Sri Lanka after conducting a survey in 2006. Abstract published in 63rd Research Forum of Sri Lanka Association for the Advancement of Science, 2007.

Pathiraja, P.M.E.K., Fernando, M.T.N., Idirisinghe, I.M.S.K., Subasinghe, S.D.J.N., (2007). "Exploring the Potential for Home-gardening of Coconuts in Urban and Semi-urban areas of Sri Lanka – A case study" - In Sri Lanka Agricultural Economics Association 1st Research Forum held on 2007 September. Faculty of Agriculture, University of Peradeniya, Peradeniya.

Abeysekera,A.W.A.D.R, (2007). Enviromentally friendly products from coconut. Published on "Pol Withthi" Bimonthly Magazine of Coconut Cultivation Board, Sri Lanka, Section 3, Volume 5, 2007 March –April, ISSN 1800-0355.

Pathiraja,P.M.E.K.,(2007). Profitability of different coconut kernel products – Published on "Pol- Withthi" Bimonthly Magazine of Coconut Cultivation Board, Sri Lanka, Section 3, Volume 5, 2007 March –April, ISSN 1800-0355.

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M G M K Meegahakumbura, L Perera, M H L Padmasiri and S.A.S Chandrasiri (2007) New Dimensions of Coconut Breeding in Sri Lanka for the 21st Century. Coconut Technology Update, CRI (2): p8

R Jayathilake and L Perera (2006) Coconut seedling certification: A move from CRI to ensure growers good quality coconut seedlings. Coconut Technology Update 3: 1-2 (released in 2007)

L Perera, W B S F Fernando and A Fernando (2006). A reliable method establish at CRI for testing coconut hybrids using DNA technology. Coconut Technology Update, 3: 3 (released in 2007)

Wickramananda, I R, Peiris, T S G, Neil Fernando, L C P and Edgington, S (2007). Impact of the coconut mite (*Acerria guerreronis Keifer*) on the coconut industry in Sri Lanka. *International J of Coconut R & D (CORD)*, Indonesia, 23 (1), 1-16.

Peiris, T S G, Hansen, J W amd Lareef, Zubair (2007). Use of seasonal climate information to predict coconut production in Sri Lanka. *International J of Climatology* (in press)

Peiris, T S G, K P Waidyarathne, Samitha S and R O Thattil (2007). Control of spatial effect due to neighboring palms in coconut (*Cocos Nucifera*) experiments. *Cord 23 (2)*: 46 - 57.

Senarathne, S.H.S. and Sangakkara, U.R. (2007). Influence of Selected Environmental Factors on Germination and Emergence of *Hyptis suaveolens* of Coconut Plantations in Sri Lanka, *Published in 21st Asian Pacific Weed Science Society (APWSS) Conference, Colombo (2007), Sri Lanka, Proceeding, 625-630.*

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Senarathne, S.H.S. (2007). Vermicompost production in coconut lands. Lankadeepa News Paper (2007.08.11), Vijaya Publication.

Senarathne, S.H.S. (2007). Wild sunflower use as a organic fertilizer in coconut plantations. Lankadeepa News Paper (2007.12.03), Vijaya Publication.

Senarathne, S.H.S. (2007). Importance of worms in Agriculture field. Polwitthi, Vol: 4:1 Coconut Cultivation Board, Sri Lanka, Publication.

Senarathne, S.H.S. (2007). Vermicompost production in coconut lands. Polwitthi, Vol: 4:4 Coconut Cultivation Board, Sri Lanka, Publication.

Ranasinghe, C S and Silva, L. R. S. (2007). Photosynthetic assimilation, carbohydrates in vegetative organs and carbon removal in nut-producing and sap-producing coconut palms. Cocos, 18: 45-57.

Fernando M T N, Zubair L, Peiris T S G, Ranasinghe C S and Ratnasiri, J (2007) Economic value of climate variability impacts on coconut production in Sri Lanka, AIACC working paper No. 45, START Secretariat, USA.

R A M K Ramanayaka, V Wijerathne, L L W C Yalegam (2007) Biochemical study on germinated coconuts Proceedings of the 63rd Annual sessions of Sri Lanka Association for Advancement of Science.

2. ACADEMIC AND PROFESSIONAL ACTIVITIES

Mr.I M S K Idirisinghe supervised B.Sc. Agriculture final year student research project of U.H.R.Uhanovita from University of Wayamba. The topic was 'Identification of Inefficiencies in Marketing Channels of Coconut'.

Dr. N.A. Tennakoon and Mrs. H.M.I. K. Herath supervised B.Sc (Agric) final year research project of Mr. W.T.U. Perera in University of Ruhuna. The title of the project was "Alternative sources capable of supplying potassium for coconut".

Dr. N.A. Tennakoon, Mr. L.R.M.C. Liyanage and Mr. D.P. Panditharatne supervised a B.Sc (Agric) final year research project of Mr. Y. Purusothaman in University of Jaffna. The title of the project was "Design and Evaluation of Girdle Sprinkler Irrigation System for Coconut Plantations".

Dr (Miss) S A C N Perera served as a reviewer for the Agricultural Symposium of the Department of Agriculture (ASDA) 2007.

Dr. (Miss) S A C N Perera and Mr. M G M K Meegahakumbura served as judges at the Biotechnology session in the 7th Agricultural Research Symposium of the Faculty of Agriculture and Plantation Management, Wayamba University, Makandura, 23 October 2007.

Dr. (Miss) S A C N Perera served as a visiting lecturer at the University of Colombo for the Course on Genetics and Molecular Biology

Dr. (Miss) S A C N Perera served as the research supervisor for Mr. G K Ekanayake, M.Phi student of the University of Sri Jayawardanapura, Nugegoda.

Dr. (Miss) S A C N Perera served as the research supervisor for Ms. Priyanka Molligoda MSc student at the Post Graduate Institute of Science, Peradeniya.

Dr. (Miss) S A C N Perera supervised the final year research project of Mr. P. M.U. S. Kumara of the Faculty of Agriculture and Plantation Management of the University of Wayamba.

Dr. L Perera and Dr (Miss) S A C N Perera served as reviewers for Peradeniya University Research Session (PURSE) 2007.

Dr. L Perera served as a reviewer for the Aries Kovoor Symposium on "Innovations in Plant Sciences through Multidisciplinary Research" organized by the Institute of Fundamental Studies and the National Research Council.

Dr. L Perera served as the reviewer for the on line review journal of the CAB reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources

Lecturer in Statistics at the Post Graduate Institute of Agriculture (PGIA) and Post Graduate Institute of Science (PGIS), University of Peradeniya and University of Sri Jayawardanapura.

3. COMMUNICATIONS AND PARTICIPATIONS AT SCIENTIFIC MEETINGS, WORK SHOPS AND SEMINAR

Mrs. P M E K Pathiraja made a presentation to the Director Board of the CCB on 16th March, 2007 under the topic of 'Evaluation of Samurdhi Coconut Cultivation Programme-2005".

Dr. L Perera and Dr. (Miss) S A C N Perera participated in the workshop organized by the National Science Foundation for developing the National Policy on Biotechnology on 24th August 2007

Waidyarathna Pramuditha K. (2007). Has Pattern on onset of monsoon rains changed? A statistical approach. Invited presentation at Applied Statistics Association Sri Lanka held on 27 October, 2007

Tennakoon, N.A. 2007. 'Soil Fertility and its Improvement in Coconut Lands' Paper presented at the seminar conducted by Coconut Research Institute at the four day exhibition held in Coconut Research Institute, 26th – 29th January, 2007.

Tennakoon, N.A. 2007. 'Organics, Organic & Inorganic Mixtures for Nutrient Supply of Coconut'. Paper presented at the seminar conducted by Coconut Growers Association Sri Lanka, 24th march 2007.

Tennakoon, N.A. 2007. 'Organic and Inorganic Fertilizer for Coconut'. Paper presented at the seminar conducted by coconut Growers Association to the Coconut Growers Task Force, 03rd November, 207.

Tennakoon, N.A. 2007. Quality Test for Fertilizers'. Paper presented at the seminar conducted by Coconut Cultivation Board to the Regional Managers and Coconut Development Officers, 04th April, 2007.

Tennakoon, N.A. 2007. 'Formulation of Fertilizer Mixtures Using Straight Fertilizer for Coconut'. Paper presented at the seminar conducted by Coconut Cultivation Board, 13th June, 2007.

Dr. L Perera delivered a special public lecture on "Performance of Improved Coconut Cultivars" for the general public at the Coconut Day Exhibition, 29 January 2007

Mr. M G M K Meegahakumbura made a presentation on "Utilization of Global Coconut Germplasm for the breeding programmes of CRI" to CRI research and technical staff under the CRI in-house seminar series, CRI Auditorium.

Miss H D M A C Dissanayake made a presentation on "Mutation breeding: Prospects for coconut" to CRI research and technical staff under the CRI in-house seminar series, CRI Auditorium.

4. PARTICIPATION OF CRI STAFF IN OTHER STATUTORY BODIES AND COMMITTEES

Mr. I.M.S.K. Idirisinghe

Member of the Advisory Committee on the Desiccated Coconut, Ministry of Coconut Development

Dr.N.A. Tennakoon

Member of the working group for Standardization of Organic Fertilizer of Sri Lanka Standard Institution.

Member of the Advisory Committee on Fertilizer appointed by the Honorable Minister of Agriculture

Member of the National Committee on Organic Fertilizer, Ministry of Agriculture, Battaramulla.

Member of the National Organic Certification Body and Development of Organic Production Base in Sri Lanka for domestic Consumption and Export, Govijana Mandiraya, Battaramulla.

Chairman of eight (14) Technical Evaluation Committees in Coconut Research Institute and Coconut Cultivation Board.

Dr. (Miss) S A C N Perera

Committee member for the National Committee of CARP on Plant Breeding and Biotechnology

Dr T S G Peiris

Member of the Board of Study in Applied Statistics at the Post Graduate Institute of Agriculture (PGIA), University of Peradeniya, Sri Lanka.

Mr J D J S Kularatna

Coordinator of INFORM database of Council of Agricultural Research Policy (CARP)

REPORT OF THE ACCOUNT UNIT
FINANCIAL PERFORMANCE REPORT
Accountant -R M U Chandranath, BSc Mgt., FCBA

The Coconut Research Institute receives funds for its maintenance from the Treasury and other incomes generated from four Genetic Resource Centres, five Research Centres, CESS grant , Divisional income through services and, Donor Funded Projects Grants etc.. Table 1 shows the funds received from the treasury, income generated through self-financing units, CESS grants and donor funded projects grant for the last four years.

Due to financial limitations, allocation and utilization of available resources were made more effectively and efficiently to achieve organizational objectives. Planning and organizing the institute so as to maintain the financial strength and stability, investment plan was established to generate additional funds and to monitor the institute's resources.

Table 1 : Grants from Treasury, income from self-finance units, CESS and donor projects

Sources	Rs. Million			
	2004	**2005**	**2006**	**2007**
Treasury Grant – Recurrent	60.27	77.00	99.80	122.10
Treasury Grant – Capital	22.26	24.60	17.40	26.97
Income Self-finance Units	55.00	58.62	68.77	106.41
CRI Own Income	4.98	5.76	6.57	10.51
CESS Grant	20.67	57.48	55.00	56.50
Donor Funded Projects	8.45	7.29	8.18	0.93
Total	171.63	230.75	255.72	323.42

As shown in Table 1, the recurrent grant has increased by 18 % in the year 2007 compared to year 2006. The income generated by self-financing unit operations for the year increased by 38% to reach Rs, 106.40 Millions.

Table 2 : Financial progress of recurrent expenditure

Description	Rs. Million		(Decrease) %
	2006	**2007**	**Increase**
Personnel Emoluments	78.14	92.90	16%
Travelling Expenses	1.63	1.86	12%
Supplies and Requisites	10.48	15.75	33%
Maintenance Expenses	16.76	15.22	(10%)
Contractual Expenses	5.40	6.22	13%
Other Recurrent Expenses	2.81	3.75	25%
Depreciation & Amortization	26.68	30.80	13%
Gratuity provision	18.27	9.35	(95%)
Total Recurrent Expenses	**160.17**	**175.85**	**09%**

The staff position of the CRI was 754 employees during the year 2007. Out of them 304 were permanent employees and 450 were daily paid workers in research substations and genetic resources centres . As indicated in Table 2, 53% of the total recurrent expenditure was on personnel emoluments and the next highest expenditure was on maintenance such as buildings, vehicles, electricity, infrastructure development etc. Fuel and lubricant were included under supply expenditure and telephone, Internet, insurance, security charges, legal fees etc. included under contractual services.

Table 3 : Financial progress of capital expenditure

Description	**Rs. Million**	
	2006	**2007**
Vehicle	-	4.49
Office Furniture & Equipment	1.27	1.15
Machinery & laboratory Equt.	4.58	6.44
Building & Structure	0.86	-
R/D. Expenses	12.27	15.34
Other Capital Expenditure	2.14	2.30
Total Capital Expenses	**21.12**	**29.72**

Table 4: Financial Progress of Self-financing Units

Seed Gardens/ Research Centers	**Year 2007**		**Surplus/ (Deficit)**
	Income Rs. Million	**Expenditure Rs. Million**	
Ambekela Genetic Resources Center	27.92	16.83	11.09
Pallama Genetic Resources Center	11.78	7.93	3.85
Makandura Genetic Resources Center	9.50	5.62	3.88
Maduruoya Genetic Resources Center	8.82	4.99	3.83
Bandirippwa Research Staton	14.75	11.92	2.83
Rathmalagara Research Center	13.20	10.72	2.48
Walpita Research Center	2.33	2.60	0.28
Pottukulama Research Center	16.30	8.49	7.81
Dunkannawa Research Center	1.67	1.65	0.02
Estates Management Division	2.40	0.15	(2.25)
Total	**106.41**	**73.15**	**33.25**

Pallama Genetic Resource Center and Dunkannawa Research Center had been vested recently and therefore these two estates are in an improvement stage.

COCONUT RESEARCH INSTITUTE
ESTABLISED UNDER COCONUT DEVELOPMENT ACT NO. 46 OF 1971
BALANCE SHEET AS AT 31 st DECEMBER 2007

		YEAR 2007 Rs.	YEAR 2007 Rs.	YEAR 2006 Rs.
ASSETS				
PROPERTY,PLANT & EQUIPMENT	NOTE-01	1,812,909,589.67		**1,794,842,389.36**
RESEARCH & DEVELOPMENT	NOTE-01.1	42,703,354.50		17,382,635.10
LIBRARY BOOKS		6,988,345.18		
			1,862,601,289.35	
CURRENT ASSETS				
STOCKS	NOTE-02	49,302,159.92		39,518,963.30
DEBTORS LESS PROVISION	NOTE-03	5,414,698.69		1,207,801.40
PURCHASE ADVANCES	NOTE-04	12,282,727.45		10,579,265.39
LOANS AND ADVANCES TO EMPLOYEES	NOTE-05	15,598,621.72		15,687,866.64
DEPOSITS RECEIVABLE		1,703,927.00		1,703,927.00
SAVING DIPOSIT	NOTE-06	6,000.00		1,006,000.00
PREPAYMENTS		366,720.84		627,751.46
I.A.E.A. PROJECT		5,513.29		5,513.29
CASH -IN -TRANSIT		73,253.20		13,442.58
CASH & CASH EQUIVALANTS	NOTE-07	51,061,451.62		41,620,391.71
			135,815,073.73	**111,970,922.77**
TOTAL ASSETS			**1,998,416,363.08**	**1,924,195,947.23**
LIABILITIES				
CURRENT LIABILITIES				
SUNDRY CREDITORS	NOTE-08	718,477.76		954,473.00
ACCRUED EXPENSES		20,618,837.85		20,723,786.82
EXPENCE CREDITORS		3,465,144.94		2,568,737.70
DEPOSITS PAYABLE	NOTE-09	2,654,264.39		1,857,856.88
ON GOING PROJECTS	NOTE-10	616,723.47		758,148.65
WORKING CAPITAL			**28,073,448.41**	**26,863,003.05**
NON CURRENT LIABILITIES				
PROVISION FOR GRATUTY			75,848,148.35	72,370,784.24
TOTAL NET ASSETS			103,921,596.76	99,233,787.29
			1,894,494,766.32	**1,824,962,159.94**
NET ASSETS/EQUITY				
AUTHORISED CAPITAL			18,000,000.00	18,000,000.00
CONTRIBUTED CAPITAL - CF	NOTE-11	342,804,619.10		311,334,619.10
CONTRIBUTED CAPITAL - CESS	NOTE-12	91,798,707.67		35,298,707.67
COTRIBUTED CAPITAL-PROJECT		5,449,869.85		5,210,258.35
FOREIGN AID		634,078.78		634,078.78
LOCAL AID		6,242,969.57		5,925,796.19
REVALUATON RESERVE		1,709,930,959.14		1,709,930,959.14
REVENUE RESERVE	NOTE-13	262,366,437.79		243,372,259.29
			1,894,494,766.32	1,824,962,159.94
			1,894,494,766.32	**1,824,962,159.94**

COCONUT RESEARCH INSTITUTE

STATEMENT OF FINANCIAL PERFORMANCE FOR THE YEAR ENDED 31st December 2007

ILLUSTRATION THE CLASSIFICATION OF EXPENSES BY NATURE

	YEAR2007 Rs.	YEAR2006 Rs.
OPERATING REVENUE		
RECURRENT GRANT	122,100,000.00	99,800,000.00
ADMINISTRATION COST - ESTATE	5,000,000.00	4,000,000.00
ADMINISTRATION COST - CESS	0.00	10,700,000.00
ESTATE INCOME	106,407,114.84	68,765,578.84
INTEREST ON LOAN & INVESTMENT	598,114.23	615,723.00
INCOME FROM MORTOR VEHICLES	3,868,233.96	1,884,866.63
SUNDRY INCOME	5,753,589.68	3,722,923.30
SALES OF PHEROMONE	180,600.00	264,450.00
SALES OF MONOCROTOPHOSE	115,220.00	81,400.00
INCOME PROJECTS	928,376.60	8,177,885.99
INCOME CESS	1,242,007.90	51,389,472.20
	246,193,257.21	**249,402,299.96**
OPERATING EXPENSES		
SALARIES ALLOWANCES & OVER TIME	70,999,445.43	64,494,769.51
BOARDS CONTRIBUTION TO ETF/EPF	15,444,037.46	9,513,171.73
BOARDS CONTRIBUTION TO MEDICAL AID	6,075,990.49	3,802,006.49
COCONUT ALLOWANCES	273,951.90	285,122.51
ESTATE GENERAL CHARGES/UPKEEP/CULTIVATION & HARV.	81,296,762.78	63,296,814.85
TRAVELLING	1,857,596.70	1,630,229.03
SUPPLIERS & CONSUMABLE	15,748,069.65	10,483,679.17
MAINTAINNANCE	15,220,576.08	16,756,178.70
CONTRACTUAL SERVICES	6,222,936.32	5,395,516.17
DEPRECIATION & AMORTISATION EXPENSES	30,802,164.04	26,680,391.20
EXPENSES - PROJECTS	2,930,500.38	4,441,452.37
EXPENSES - CESS	9,646,451.42	31,088,256.49
BOARD MEMBERS FEES	111,320.00	104,336.05
GRATUITY	9,353,316.79	18,265,084.05
OTHER OPERATING EXPENSES	3,745,097.23	2,814,884.35
TOTAL OPERATING EXPENSES:	**269,728,216.67**	**259,051,892.67**
SURPLUS/(DEFICET) FROM OPERATING ACTIVITIES	**(23,534,959.46)**	**(9,649,592.71)**
GAIN ON SALES OF PROPERTY PLANT & EQUIPMENTS	0.00	0.00
TOTAL NON OPERATING REVENUE (EXPENSES)	**(23,534,959.46)**	**(9,649,592.71)**

COCONUT RESEARCH INSTITUTE

GENETIC RESOURCE CENTRES & RESEARCH SUBSTATIONS

ITEM	BANDIRIPP--UWA RESEA. CEN. Rs.	RATHMALA--GARA RESEA. CEN. Rs.	AMBAKELLE GNENATIC RESEO. CEN. Rs.	POTTHUKU-AMA RESEARC STATION Rs.	WALPITA RESEA. CEN. Rs.	MAKANDURA GNENATIC RESEO. CEN. Rs.	MADURUOYA GNENATIC RESEO. CEN. Rs.	PALLAMA GNENATIC RESEO. CEN. Rs.	DUNKANNAWA RESEA. CEN. Rs.	ESTATE MANA. DIV. & MRC Rs.	TOTAL 2007 Rs.	CUMULATIVE 2006 Rs.
GENERAL CHARGES	2,927,440.50	3,295,898.63	5,088,737.81	2,683,251.90	629,864.69	1,574,406.92	2,224,668.16	3,521,540.04	549,655.61	113,939.04	22,609,403.30	19,290,877.11
SUPERINTENDENT & STAFF	4,023,451.24	3,917,125.13	4,688,306.11	2,814,748.91	850,735.52	1,899,534.58	814,409.91	1,920,040.35	504,519.40	2,285,422.98	21,545,958.68	16,827,982.37
UPKEEP	1,943,709.54	1,076,757.12	2,888,644.96	834,354.12	534,388.53	687,212.01	1,139,136.02	478,130.12	399,178.84		9,981,511.26	7,677,884.74
CUTIVATION	1,505,187.09	1,284,431.41	2,703,224.48	1,188,956.96	194,173.29	336,761.64	385,216.60	948,335.42	51,937.05		8,598,223.94	6,723,244.53
HARVESTING	862,444.53	533,022.07	1,061,154.86	663,927.79	150,144.98	346,772.06	405,721.47	725,142.73	21,773.52		4,770,104.01	3,927,155.49
TOTAL COST OF PRODUCT.	**11,262,232.90**	**10,107,234.36**	**16,430,068.22**	**8,185,239.68**	**2,359,307.01**	**4,844,687.21**	**4,969,152.16**	**7,593,188.66**	**1,527,064.42**	**2,399,362.02**	**69,677,536.64**	**54,447,144.24**
CURING INTO COPRA/DISPOSE	118,601.40	194,397.73	16,067.78	171,230.73	12,476.51	96,831.61	5,413.15	102,185.42	4,299.85		721,504.18	725,134.83
ANIMAL HUSBANDRY	536,808.90	416,163.02	388,806.62	133,523.39	231,581.09	675,252.28	12,074.18	239,490.36	120,791.63		2,754,491.47	1,109,195.78
TOTAL EXPENDITURE	**11,917,643.20**	**10,717,795.11**	**16,834,942.62**	**8,489,993.80**	**2,603,364.61**	**5,616,771.10**	**4,986,639.49**	**7,934,864.44**	**1,652,155.90**	**2,399,362.02**	**73,153,532.29**	**56,281,474.85**
SALES OF COPRA	850,684.15	356,974.60		369,617.12	20,150.00	139,217.00	43,166.00	386,545.95	4,048.40		2,170,403.22	1,245,115.85
SALES OF COCONUT	10,495,807.35	11,080,334.60	26,346,268.18	14,390,078.27	2,045,122.76	5,624,947.20	7,356,495.76	8,677,596.62	401,843.57		86,418,494.31	54,170,069.35
SALES OF SEEDLING	187,820.00	635,565.00	751,890.00		150,720.00	202,755.00	610,010.00	93,450.00	762,189.00		3,394,399.00	2,406,304.56
SALES OF SUNDRIES	518,134.69	309,941.83	66,106.48	156,134.75	98,274.27	151,353.48	6,421.50	686,718.42	3,223.97		1,996,309.39	3,454,367.15
SALE OF ANIMALS PRODUCE & ANI	1,226,831.90	448,874.84	474,731.00	905,359.25	15,868.75	604,782.00		73,158.88	86,509.75		3,836,116.37	2,818,051.80
	13,279,278.09	**12,831,690.87**	**27,638,995.66**	**15,821,189.39**	**2,330,135.78**	**6,723,054.68**	**8,016,093.26**	**9,917,469.87**	**1,257,814.69**		**97,815,722.29**	**64,093,908.71**
STOCK VARIANCES	1,472,729.10	369,492.50	282,284.00	474,427.25	3,941.60	2,768,495.00	804,341.00	1,863,163.30	413,042.00	147,360.00	8,591,392.55	4,671,670.13
ADJUSTED INCOME	**14,752,007.19**	**13,201,183.37**	**27,921,279.66**	**16,295,616.64**	**2,326,194.18**	**9,491,549.68**	**8,820,434.26**	**11,780,633.17**	**1,670,856.69**	**147,360.00**	**106,407,114.84**	**68,765,578.84**
SURPLUS/(DEFICIT)	2,834,363.99	2,483,388.26	11,086,337.04	7,805,622.84	277,170.43	3,874,778.58	3,833,794.77	3,845,768.73	18,700.79	2,252,002.02	33,253,582.55	8,484,103.99
LESS - AMORTIZATION &DEPRICIA	393,497.14	413,886.43	847,095.97	378,284.00	97,532.48	237,292.45	400,598.24	251,434.40	123,609.38		3,143,230.49	3,015,340.00
NET SURPLUS/(DEFICIT)	**2,440,866.85**	**2,069,501.83**	**10,239,241.07**	**7,427,338.84**	**(374,702.91)**	**3,637,486.13**	**3,433,196.53**	**3,594,334.33**	**(104,908.59)**	**(2,252,002.02)**	**30,110,352.06**	**9,468,763.99**
TRANSFER TO HEAD OFFICE CHARGES											5,000,000.00	4,000,000.00
											25,110,352.06	**5,468,763.99**