

**COCONUT RESEARCH BOARD**

**COCONUT RESEARCH INSTITUTE  
OF SRI LANKA**

**REPORT FOR 2002**

**COCONUT RESEARCH INSTITUTE - REPORT FOR 2002**

*18/01/04*

# COCONUT RESEARCH BOARD



## REPORT OF THE COCONUT RESEARCH INSTITUTE FOR 2002

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**L L W Somasiri, Ph D (Aberdeen)**  
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**As at 31<sup>st</sup> December, 2002**

**1. Research Committee**

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Dr N A Tennakoon  
Dr H A J Gunathilake  
Dr M T N Fernando  
Mr I Wickramananda  
Mr F Jayasinghe (Manager Estate)

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# COCONUT RESEARCH INSTITUTE OF SRI LANKA

## THE STAFF

(as at 31 December 2002)

### DIRECTORATE

**Director** – Mrs. C Jayasekara, B.Sc.(Botany), Ph.D (Qld)

**Acting Deputy Director (Research)** – L L W Somasiri, B.Sc.(Chemistry),  
Ph.D.(Aberdeen), C. Chem. MI Chem C

**Deputy Director(Administration & Finance)** – E P Gunapala, A.P.F.A; B.Com (SP)  
Diploma in Accountancy

### RESEARCH DIVISIONS

#### Agronomy Division

##### *Head*

H A J Gunathilaka, B.Sc.(Agric); Ph.D (Wales)

##### *Agronomists*

A D Samarajeewa, B.Sc.(Agric)  
M.Sc.(Wageningen)  
R P B S H Senaratne, B.Sc.(Agric);  
M.Sc. (Peradeniya)  
N A K de Silva, B.Sc.(Agric)\*\*

##### *Technical Assistants*

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H G Wasantha

##### *Senior Agricultural Economists*

M T N Fernando, B.Sc.(Agric) ;  
Ph.D (Aberdeen)

##### *Senior Clerk/Typist*

A A D N Athauda

##### *Agricultural Economists*

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B.Sc (Agric); M Phil

##### *Senior Lab/Field Assistants*

E M Gunarathne Banda  
M D V Saparamadu

##### *Senior Technical Officers*

H A Abeysoma  
M J I Costa  
R Marasinghe, B.Sc.  
Mrs. K C P Perera, B.Sc.S  
D J N Subasibghe, Dip Agric.

##### *Lab/Field Assistants*

H B Perera  
K D D Appuhamy  
R A Swarnathilaka  
W R O Fernando  
W P Fernando

## Genetics and Plant Breeding Division

### *Head*

J M D T Everard, B.Sc.; M.Sc. (New English) M.Sc. (Jayawardenapura)

### *Senior Geneticists/Plant Breeders*

A A L F K Perera,  
B.Sc. (Agric); Ph.D. (Dundee)  
Mrs. C K Bandaranayake,  
B.Sc. (Agric); Ph.D. (Birmingham)

### *Technical Assistants*

R B Attanayake  
H M N B Herath

### *Geneticists/Plant Breeders*

Miss S A C N Perera,  
B.Sc. (Agric)\*\*

### *Senior Clerk/Typist*

Mrs. I N Jayawardena

### *Senior Technical Officers*

Mrs. W B S Fernando  
M H L Padmasiri  
L M S R Jayathilake, B.Sc.

### *Senior Lab/Field Assistants*

U V M Fernando  
W T H C Fernando  
T M W Peiris  
M Victor

### *Technical Officers*

G K Ekanayake, B.Sc.  
Miss. S M Mallawaarachchi, B.Sc.

### *Lab/Field Assistants*

P A D M Appuhamy  
M A Hemachandra

## Soils and Plant Nutrition Division

### *Acting Head*

N A Tennakoon, B.Sc (Agric); M Phil (Kelaniya) Ph.D (Aberdeen); M I Biol

### *Soil Scientists*

Mrs. D M D I Wijebandara B.Sc.;  
M Phil (Peradeniya); M I Biol  
Mrs. U G M B K Tennakoon  
B.Sc.(Chem)

### *Senior Technical Officers*

G D George  
Mrs. S Sabharatnem. N D S  
Mrs. H H R M de Silva, B.Sc.  
U S S Perera  
A H Norman  
D P Panditharatne  
E M A T Banda

### *Technical Officer*

Mrs. C P A Kurundukumbura,  
B.Sc. (Agric)

***Technical Assistants***

K P A Pathirana, Dip Agric  
B S V J Perera, Dip Agric  
M R D Perera  
Mrs. H L A Padmini, Dip Agric

***Senior Stenographer***

Mrs. H M A Herath

***Lab and Field Assistants***

N M D Chandrasoma  
K R E M Fernando  
W Gunasena  
K L Ranasinghe  
K J S Perera  
K S A J Fernando  
F H A J R Silva

**Crop Protection Division**

***Head***

Mrs. L C P Fernando, B.Sc. (Agric), Ph.D. (Qld)

***Senior Entomologist***

I R Wickramananda, B.Sc. (Agric);  
M Phil (Aberdeen)

***Plant Pathologist***

H T R Wijesekara, B.Sc. (Agric);  
M.Sc.(Peradeniya)\*\*

***Entomologist***

Mrs. N S Aratchige, B.Sc. (Agric)

***Senior Technical Officer***

K A S Chandrasiri  
K F G Perera  
Mrs. D C L Hapuarachchi  
Miss. P H A P Siriwardena,  
B.Sc. (Agric)

***Technical Officer***

S Prabhath Manoj  
P H P R de Silva, B.Sc.(Agric)

***Technical Assistant***

Y M W G S Bandara, B.Sc.

***Senior Clerk***

Mrs. A A de Zoysa

***Lab/Field Assistant***

W W F N Fernando  
N G Premasiri  
D E V R Wijetunga  
P A D R G Caldera

## Biometry Division

### *Head*

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

### *Principal Biometrician*

T S G Peiris, B.Sc.; M.Sc.(Stat.  
Canterbery, NZ),  
F. R. S (UK); Ph.D(Colombo)

### *Technical Assistant*

W A S Wickramaarachchi

### *Senior Technical Officer*

J D J S Kularatne, B. Sc.

### *Senior Clerk/Typist*

Mrs. U I Abeysinghe

### *Technical Officer*

S S Rajapakse,  
Dip.Agric. (Aquinas)

### *Senior Lab/Field Assistant*

W B P Fernando  
W E R C Fernando  
W M L G Fernando  
W K M K Herath

## Tissue Culture Division

### *Head*

Mrs. L K Weerakoon, B.Sc.(Botany); M.Sc.(Illinois State); Ph.D (Illinois State)

### *Senior Botanist*

Mrs. W N I S C Fernando,  
B.Sc.(Russia); M Phil (UK);  
Ph.D (Colombo)

### *Senior Technical Officer*

E S Santha

### *Botanists*

Mrs. V R M Vidanaarachchi, B.Sc.  
(Agric) \*\*  
Mrs. P I P Perera, B. Sc. (Agric.)  
Mrs. H D D Bandupriya  
B. Sc. (Botany)

### *Technical Officers*

K P I E Ambagala, Dip Agric.  
Miss T R Gunathilaka

## Plant Physiology Division

### *Head*

Miss C S Ranasinghe, B.Sc., Ph. D. (Sussex)

### *Senior Plant Physiologist*

N P A D Nainanayake, B.Sc.;  
M.Phil (Peradeniya)\*\*

### *Senior Technical Officers*

Mrs. W P K K Fernando, B.Sc.  
R D N Premasiri  
Mrs. P S A de Seram, B.Sc.  
L R S Silva

### *Plant Physiologist*

Mrs. M A D W S Madurapperuma,  
B.Sc. (Agric),  
M Phil(Peradeniya)

### *Technical Assistant*

Miss H P I N M Gunawardena

### *Senior Lab/Field Assistant*

A Jayathilake

## Coconut Processing Research Division

### *Officer -in-Charge*

Mrs. C Jayasekara, B.Sc., Ph.D (Qld)

### *Biochemist*

Mrs. P G P Hewavitharanage,  
B.Sc. (Botany),  
M.Phil (Peradeniya)\*\*

### *Food Microbiologist*

Miss. F F Faruk, B.Sc. (Madras), M.Biol

### *Food Technologist*

J M M N Marikkar,  
B.Sc.(Chemistry)\*\*  
Mrs. L L W C Yalagama,  
B Sc. (Chem)  
Miss. J M M A Jayasundara,  
C. Chem.,  
M.Sc.(Chem)(Peradeniya)  
K D P P Gunathilake, B.Sc.(Agric),  
M.Sc.(Peradeniya)

### *Technical Officer*

G R A Dharmasena, B.Sc.

### *Technical Assistant*

A R Kulathunga, Dip (Agric)  
A R A N Kumara

## Extension Services Division

### *Head*

P A H N Appuhamy, B.Sc.(Agric); M.Sc.(Reading)

### *Extension Officers*

I M S K Idirisinghe, B.Sc.(Agric),  
M.Sc.(Peradeniya)  
A M A P G Gunawardena,  
B.Sc.(Agric)  
C S Herath, B.Sc.(Agric)

### *Senior Machine Operator*

W G L Rodrigo

### *Assistant Extension Officer*

Mrs. H D N H Fonseka,  
B.Sc.(Agric)  
J K J P Jayawardena, B.Sc.(Agric)

### *Senior Clerk/Typist*

R A L C Fernando  
Mrs. K A P Chandani

### *Technical Officer (Audio-Visual)*

Premisiri Silva

### *Lab and Field Assistant (Photography)*

H P Asoka Kumara

## Library Service Division

### *Acting Librarian*

P A H N Appuhamy, B.Sc.(Agric); M.Sc.(Reading)

### *Assistant Librarian*

Mrs. P D U C Dharmapala

### *Senior Clerk/Typist*

Mrs. S N Gunathilake

### *Library Assistant*

Mrs. A P Illangakoon

## **Administration**

### ***Deputy Director (Administration & Finance)***

E P Gunapala, A.P.F.A., B.Com (Sp); Dip. (Accountancy)

### **Establishment Unit**

#### ***Acting Administrative Officer***

Miss. H D Mangalika, B A, LLB

#### ***Administrative Assistants***

Miss. H D Mangalika, B A, LLB  
Mrs. P C A Fernando  
A I F Fernando

#### ***Senior Telephone Operator***

I H Nelson

#### ***Supplies Officer***

P Premaratne Fernando, B.A.;  
Dip. (Purchasing & Material  
Management)

#### ***Stenographers (English)***

Mrs. M M S P Fernando

#### ***Secretary to the Chairman***

Mrs. S Z Suhair

#### ***Supplies Assistant***

W F T Fernando

#### ***Chief Clerk***

B M D Bandara

#### ***Senior Clerk/Typists***

Mrs. A R S Hettiarachchi  
Mrs. W S R Fernando  
Mrs. K P S Jayathilake

#### ***Senior Stenographer (English)***

Mrs. M P Premaratne  
Mrs. H M W S Athauda

#### ***Clerk/Typists***

Mrs. M G Karunawathi  
Y H Wijesena  
N M H Wijewardena  
M A D M F Appuhamy

## Internal Audit Unit

### *Internal Auditor*

N M K S Ranjith, B.Com. (Sp); ICA Part II

### *Senior Internal Audit Clerks*

Mrs. M M J R Fernando  
Mrs. R D I Somasiri

### *Senior Typist (English)*

Mrs. W J M D M A Fernando

## Accounts Unit

### *Accountant*

R M U Chandranath, B.Sc. Management (Public)

### *Senior Accounting Assistant*

A S Nanayakkara

### *Accounts Clerk*

S A D Richard

### *Senior Book Keeper*

B M Jayathilake Banda

### *Senior Clerk/Typist*

Mrs. C M B I Salwathura

### *Book Keepers*

N M R Sarathchandra  
S M Sirisoma  
R D Sumanasiri, H N D  
(Accountancy)  
W A C Fernando, B. Ph.

### *Clerk/Typist*

Mrs. A A N P Kanthi  
M Somasiri

### *Senior Shroff*

M C H N Fernando

### *Senior Audit Clerk*

M R U Attanayake

### *Senior Store Keeper*

M B Upali

### *Senior Accounts Clerks*

W P C Fernando  
Mrs. A S M S Abeywickrama

## Engineering Unit

### *Resident Engineer*

K N A S Perera, Dip (Mech Eng.)

### *Works Superintendent*

A L D K Amarasinghe,  
Dip (Eng.Science)

### *Foreman (Building)*

J M P K Jayasekara

### *Foreman (Electrical)*

D W J Jayakody

### *Foreman (Mechanical)*

R Vithanage

### *Senior Draughtsperson*

Mrs. R M S Ratnayake

### *Senior Clerk/Typist*

Mrs. N R Ayagama

### *Clerk/Typist*

K T J N W Perera  
M A M Perera

### *Motor Mechanic*

R M S G Ratnayake

### *Senior Mason*

W M Dhanpala

### *Senior Carpenter*

A A K Amarasinghe

### *Linesman*

R S P Jayamanna

## Estate Management Division

### *Manager (Estates)*

Mr. F Jayasinghe, B.Sc. (Agric)

### *Clerk/Typist*

W A L R Fernando

### *Senior Clerk/Typist*

Mrs. C Munasinghe  
W P R R Fernando

## **Bandirippuwa Estate**

### ***Superintendent***

Mr. G B A Wijesekara

### ***Supervisor***

A G B G Silva  
S Alahakoon

### ***Field Officer***

G P N Chandrasiri

### ***Senior Clerk***

H H J E Appuhamy  
K P W Perera

### ***Senior Supervisor***

M P W Fernando

## **Ratmalagara Estate**

### ***Superintendent***

A N Eknaligoda

### ***Senior Supervisor***

T M Keerthiratne

## **Isolated Seed Garden**

### ***Superintendent***

U W B A Weragoda, B.Sc.(Agric.)

### ***Clerk/Typist***

H M Podiratne

### ***Supervisor***

Piyal Ranjith Fernando  
A Sugathadasa

### ***Lab/Field Assistant***

H A P B Fernando

## **Maduruoya Seed Garden**

### ***Superintendent***

W M U Ratnayaka

### ***Lab/Field Assistant***

M G D Placidez

### ***Supervisor***

M A S Fernando  
W M D R Wijesinghe

**Dunkannawa Estate**

***Officer-in-charge***

N Gamage

***Superintendent***

D P S K Hettiarachchi,  
Dip (Agric. & EM)

**Walpita Estate**

***Officer-in-charge***

W A H Upali

**Pottukulama Research Station**

***Officer-in-charge***

D L J Neththasinghe

***Clerk/Typist***

D M Jayawardena

***Supervisor***

W M N G Wijethunga

**Makandura Seed Garden**

***Superintendent***

I A N Hemasiri

***Senior Lab/Field Assistant***

M Victor

***Supervisors***

A P C Pradeep, Dip. (Agric)

**Pallama Seed Garden**

***Superintendent***

W S M A Fernando

***Clerk/Typist***

J A R Reginold

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

# **THE COCONUT RESEARCH INSTITUTE OF SRI LANKA**

## **INTRODUCTION**

The Coconut Research Institute was established in 1929, as Coconut Research Scheme under the Coconut Research Ordinance No 29 of 1928. The scheme established its head quarters at Bandirippuwa Estate, Lunuwila (NWP). With the enactment of coconut research Act No.37 in 1950, the Coconut Research Scheme was renamed as 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.

## **VISION OF THE CRI**

To be the Center of Excellence in Coconut Research,  
Technology Development and Technology Transfer.

## **MISSION OF THE CRI**

Our Mission is to generate knowledge and technology through excellence in research towards increasing productivity and profitability of coconut. In the pursuit of this mission we endeavor to nurture motivate our staff to excel.

## **OBJECTIVES, GOALS AND SERVICES OF THE INSTITUTE**

As stated in the mission to achieve its specific objectives of increasing productivity profitability, and competitiveness of the coconut industry, CRI is expected to engage in research and service functions, efficiently and effectively in the next five years as given below.

### **1. To undertake research on:**

- Genetics of the coconut palm, coconut breeding and crop improvement
- Cultivation and management of the crop
- Physiology of the coconut palm in relation to growth, yield and other functions
- Development of coconut based farming systems
- Pest and disease control
- Quality control, value addition, and product diversification of coconut

For the generation of technology and knowledge for the benefit of the coconut industry.

2. To disseminate technologies and information on coconut and associated production systems and coconut processing to end-users through extension service of the Institute, Coconut Cultivation Board, and the Coconut Development Authority to achieve national yield of over 3000 million coconuts in three years.
3. To supply improved seed nuts for the national replanting programme to meet 20000 acres replanting/under the planting target with improved seed nuts.

4. To provide specialized analytical service and certification for the exports and pest control services in outbreak situations.
5. To ensure committed and competent research staff and effective administration, technical and support staff by motivation and developing their capacity.
6. To recommend and advocate the formulation of policy.
7. To achieve excellence as a center for coconut research within five years.

**THE COCONUT RESEARCH INSTITUTE**  
**REPORT OF THE DIRECTOR**  
**FOR THE YEAR 2002**  
**C Jayasekara, Ph D (QLD)**

**1. GENERAL**

**1.1 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.

**1.2 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.

**1.3 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 7 members, appointed by the Minister in-Charge. One member is appointed as the Chairman of the Board. The members hold office for 3 years and are eligible for reappointment.

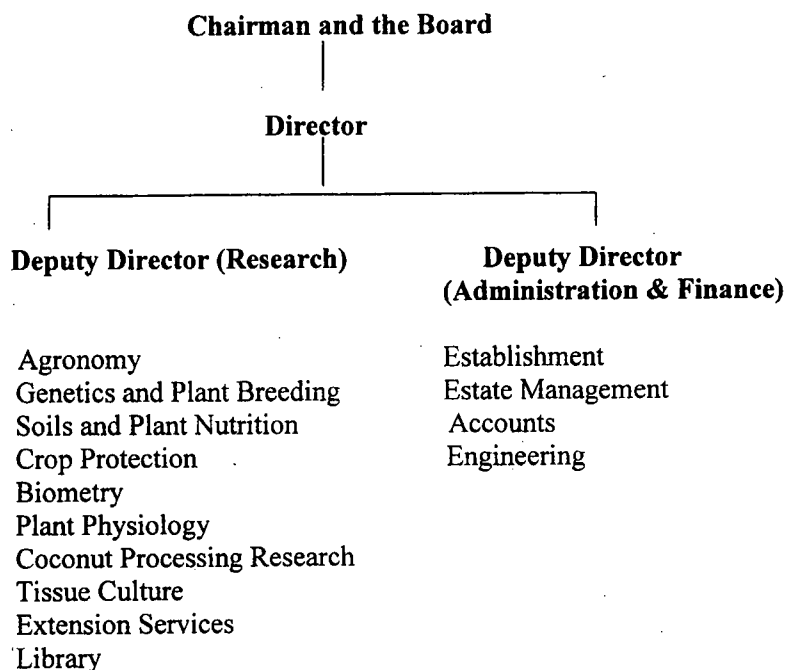
The members of the Board as at 31 December 2002 were:

Dr U P de S Waidyanatha	-	Chairman
Dr D Kirtisinghe	-	Member
Mr F Richie Fernandopulle	-	Member
Mr C D V Aponso	-	Member
Mr A Hettiarachchy	-	Member
Mrs I Sugathadasa	-	Member/ Representative of the Ministry
Dr R H S Samaratinga	-	Member/ Representative of the Treasury
Mr H A Tillekeratne	-	Observer/Chairman CDA
Mr Lincoln Fernando	-	Observer/Chairman CCB

#### 1.4 Management:

The Chairman is the Chief Executive of the Board. The Director is the Administrative Head of the Institute and functions under the general direction of the Chairman and the Board. He/she is responsible for the direction and supervision of all research and administrative functions of the Institute, and the implementation of all policies and programs laid down by the Board.

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

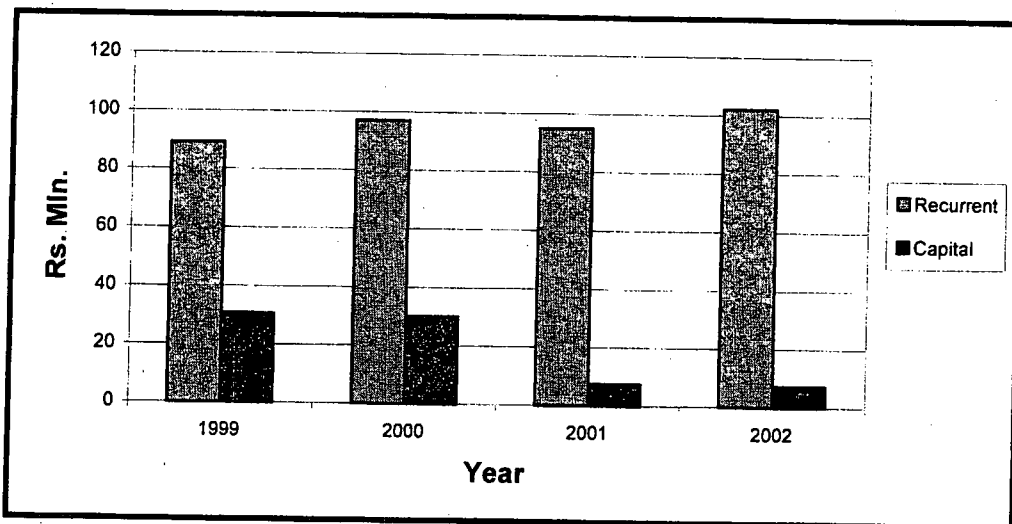


The Internal Auditor/Audit Unit is directly responsible to the Chairman.

#### 1.5 Funding

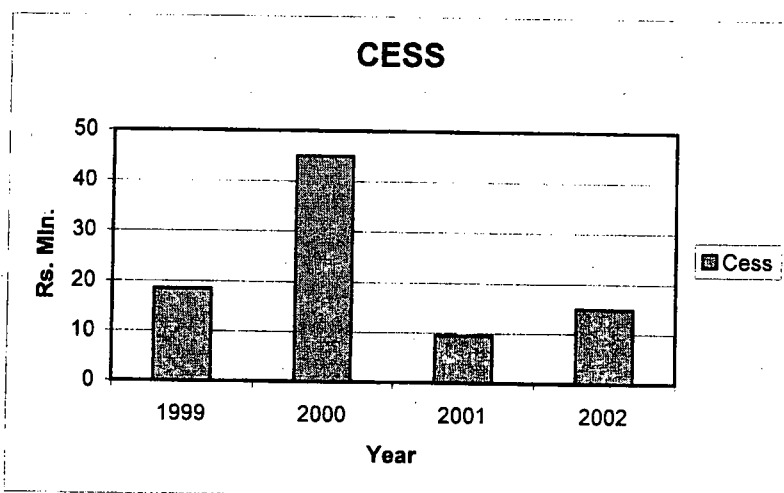
As a public sector organization, CRI is primarily dependent on government funding (Consolidated Fund). However, reduced spending for research and extension due to severe

budget cuts increasingly affect research and maintenance activities of the Institute. Government funding as capital and recurrent expenditure for the last three years is given below:



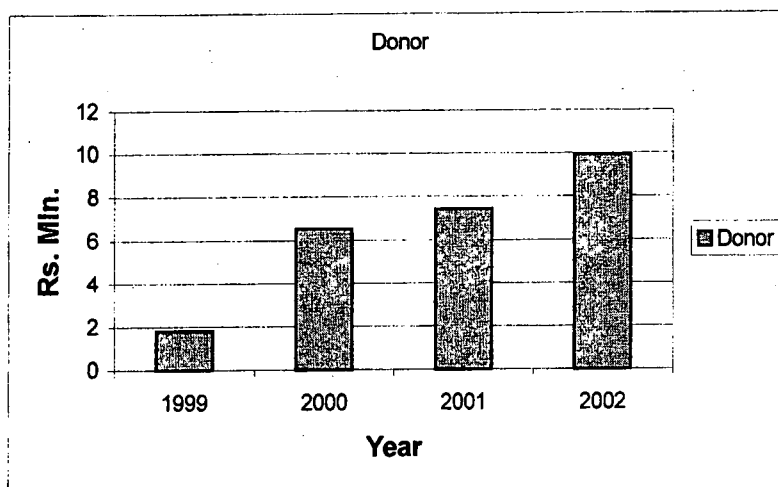
**Figure 1:** Recurrent and capital expenditure received from 1999 to 2003

The coconut Cess Fund also provides substantial contribution for special projects in situations where adequate funding is not available from the government. The total investment from the Cess Fund and number of projects assisted for the past three years are given below:



**Figure 2:** Total investments from CESS funds for the period of year 1999-2003

In addition to these funding, scientists at the CRI annually attract funding from various local and foreign funding sources as given below for the special projects:



**Figure 3:** Funding received for the special projects from local and foreign sources

## 2. ACHIEVEMENTS AND HIGHLIGHTS

### 2.1 Agronomy:

The Agronomy research program continued with 20 agronomic experiments and 8 socio-economic studies. The total research expenditure as capital and recurrent expenditure was Rs. 1.586 mln. and Rs. 0.648 mln. respectively.

All agronomic trials showed about 30% yield reduction in this year compared to 2001, due to the severe drought that prevailed during 2000/2001. In a field experiment investigating soil moisture conservation practices at five sites, only one site (at Bingiriya) showed improved nut yield due to husk burial and husk mulching.

About 45% of the total population of coconut seedlings planted in degraded shallow coconut soils ( $S_5/IL_1$ ) in 1.3 x 1.0 m trenches flowered during last year, while none of the seedlings planted in normal planting holes (1.0 x 1.0 x 1.0 m) have flowered yet. About 31% of the seedlings planted in 1.3 x 1.3 x 1.3 m planting holes also came into flower. Hence, in shallow degraded soils, there is an advantage in planting coconut either in large trenches or planting holes.

For the control of weeds in nurseries, use of glyphosate at a concentration of 4 l ha<sup>-1</sup> was found to be effective and economical over hand weeding. However, glyphosate has to be applied with a guard to prevent spraying on to the coconut seedlings. Hand weeding costs Rs 1.60 per seedling, while the use of glyphosate costs only Rs 0.61.

Intercropping bud-grafted cashew in a mature coconut plantation (45 years old) produced a yield of 5.2 kg tree<sup>-1</sup>yr<sup>-1</sup>, and seedling cashew 1.1 kg tree<sup>-1</sup>yr<sup>-1</sup> at six years after planting.

The on-farm adaptive research program funded by ADB is being continued at 112 sites in 15 administrative Districts. During the year pineapple, banana, rambutan, tea, papaya, and ginger had high market prices. A crop model were replanting coconut with pineapple and banana gave a net profit of Rs 27,000 per acre during the first year. Israel

Cavendish banana was introduced to 20 growers in the wet and intermediate zones. This banana variety performed well particularly in Kegalle and Galle Districts producing more than 30 kg/bunch in the first harvest.

Productivity and adaptability of 3 poultry breeds/strains (CPRS, Indigenous, CPRS x Indigenous) was tested in a semi-intensive system in coconut lands and the profitability of this system was found to be 1.5 times higher than the conventional commercial poultry production system.

During the year the following socio-economic studies were completed:

- i. Factors affecting the efficient functioning of a market for coir fiber as a raw material:  
This study revealed that the local coir fiber extraction system is unable to deliver the coir fiber that meets the quality requirements of the market. This study recommends that there must be practically feasible quality measurement methods and devices to be developed or introduced to the coir sector to enhance the competitiveness of the industry.
- ii. Present trend in fresh nut export from Sri Lanka:  
The analysis of export trends of fresh coconuts from 1997 to 2001 has revealed that the annual exports of fresh nuts from Sri Lanka has been less than 1% of the total coconut production. Thus the fresh coconut exports have not made any significant effect on the local coconut industry during the analysed period.
- iii. Implications of trade liberalization in the edible oil market:  
A study carried out to determine the implications of trade liberalization in the edible oil market on coconut producers revealed that this policy extends its implications not only in the coconut oil market but also in the other coconut product markets. Returns to fresh coconut producers declined by Rs.13.71 mln. per year due to this policy. However there is an increase in the desiccated coconut supply.
- iv. Analysis of the consumer demand for coconut:  
This study revealed that the retail price of coconuts and per capita income of consumers are the significant variables that determine the coconut demand in Sri Lanka. There is a significant negative trend for coconut demand during the last two decades.
- v. Effect of fertilizer prices on the use of fertilizer by coconut growers:  
Analysis of the fertilizer consumption pattern in the coconut sector revealed that the price of fertilizer and the price of coconuts and rainfall in the coconut growing areas are the significant variables for the coconut growers to decide on fertilizer application. Hence, an attractive producer price for coconut will favour the use of more fertilizer on coconut cultivation.

Under the ADB funded Project on "Developing Sustainable Coconut-based Income Generating Technologies in Rural Communities of Sri Lanka" three coconut growing communities were selected from Wilpotha, Galle and Hettipola covering 1000 families. The Project will provide funds for machinery, equipment and other material for coconut processing, intercropping and livestock development.

## 2.2 Genetics and Plant Breeding:

The plant-breeding programme continued with 14 field evaluations of progeny arising from various crosses and 2 molecular marker based studies. The total research and maintenance expenditure for the plant breeding research programme as capital and recurrent expenditure was Rs.0.592 mln. and Rs.0.749 mln. respectively.

Year 2002 marks a milestone in coconut breeding research in Sri Lanka. The much debated, discussed and solicited germplasm importation became a reality through mediation of Coconut Genetic Resources Network (COGENT), a MOA between Indian Council of Agriculture (ICAR) and Council for Agriculture Research Policy in Sri Lanka (CARP) with the financial assistance of the Cess Fund. Four promising Indian coconut varieties namely West Coast Tall, Laccadive Ordinary Tall, Andaman Tall and Banawali Round Dwarf were brought to Sri Lanka as *in-vitro* cultured embryos under direct supervision of a Plant Breeder from the Institute and meeting appropriate quarantine requirements. The embryos brought are now being raised at the tissue culture laboratory for subsequent establishment in the field with necessary precautions. The enrichment of coconut germplasm by these exotic introductions would strengthen the capacity of coconut breeding in CRI.

The inter-varietal hybrids continued to outperform pure tall cultivars in all sites even with relatively low yields resulted from drought. Nine year averages of yield for *dwarf green x tall* were significantly higher than for the other cultivars. The respective nine year averages of the five cultivars, *dwarf green x tall*, *dwarf yellow x tall*, *tall x tall*, *Moorock tall* and *plus palm tall* were 14,067, 12,889, 9,556, 8,300, 9,289 nuts ha<sup>-1</sup> yr<sup>-1</sup>. The drought also affected the copra out turn not only as a consequence of reduction of nut number but also as a reduction in nut size in all cultivars.

The performance of the hybrids of *dwarf green x san ramon* at the Daisy Valley estate, Mawathagama to date has been remarkable. As a hybrid it possesses both high yielding character as well as high copra per nut. The average yield of *dwarf green x san ramon*, *dwarf green x tall*, *tall x tall*, and *tall x san ramon* were 9,441, 10,080, 6,240, 7480 nuts ha<sup>-1</sup> respectively during the year at this site. The average copra out turn per nut in *dwarf green x san ramon* was 304 g nut<sup>-1</sup> which is an extremely high value compared to *tall x tall* (270 g nut<sup>-1</sup>) and *dwarf green x tall* (259 g nut<sup>-1</sup>). This was only second to *tall x san ramon*, which recorded 329 g nut<sup>-1</sup>. This promising performance of *dwarf green x san ramon* lead to initiate a pollination programme to produce *dwarf green x san ramon* in sufficient quantities to establish evaluation trials in farmers fields for further evaluation of this variety before releasing as an improved cultivar.

The demand for the new release CRISL 98 (*tall x san ramon*) was increasing, hence the programme for production of seeds by hand pollination was continued at Isolated Seed Garden (ISG). A total of 2803 seedlings were issued for planting in farmer's plots.

Establishment of Pallama Seed Garden (PSG) for mass production of CRISL 98 was continued and during the year 1,317 *tall x tall* and 1,459 *san ramon* seedlings were planted. About 50 seedlings came into flower in the fourth year.

Eleven more new accessions, Nipuni, Gannoruwa, Kalgedihena, Nittambuwa, Rambukkana, Yakkala, Amparai, Bogamuwa, Bathigama, Diddenipotha and Aparakka were planted in the gene bank at Pallama Seed Garden. Two phenotypically distinct palms, one an

exceptionally high yielding bodiri-like palm at Thuwakkugalawatta temple (Galle district) and the other palm Characteristic of large nuts in a home garden at Pilimathalawa, Kandy were identified for obtaining selfed progenies for conservation.

Investigation of the presence of phytoplasma in Coconut Rapid Decline (CRD) affected palms was continued with the consultative assistance of Professor John Randles from University of Adelaide. Phytoplasma specific signals for nested polymerase chain reaction (PCR) were obtained for root DNA from two diseased palms and two healthy palms while DNA from heart tissues gave positive signals for two out of five palms. These PCR products were sent to the University of Adelaide for further verification. There is no evidence yet that the syndrome is caused by phytoplasma.

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

The Soils and Plant Nutrition Division continued 16 on going field experiments and commenced a new field experiments recently. The on going deep ground water survey in the Kurunegala District was continued with Cess Fund assistance. The total research and maintenance expenditure for the Division from recurrent and capital budget was Rs.1.271mln and Rs.0.431mln respectively.

An experiment carried out at Rathmalagara Estate with different sources of Phosphate fertilizers i.e. Eppawela Rock Phosphate (ERP), Imported Rock Phosphate (IRP), or as Triple Super Phosphate (TSP) on young palms revealed no significant difference in phosphorous levels in the 14<sup>th</sup> leaf. Therefore, it is possible to recommend ERP for young coconut palms grown in the Wet and Wet Intermediate Zones. This recommendation will lead to substantial foreign exchange saving.

Two experiments were conducted at Walpita and Marandawila to formulate suitable fertilizer recommendations for king coconut palms. A significant yield increase ( $p < 0.05$ ) against the control (no fertilizer) was observed when the palms were receiving NPK and Mg fertilizers equivalent to 75% removal by nuts or 1 ½ the dose of Adult Palm Mixture (APM) was applied. Until the experiment is completed a tentative fertilizer recommendation for king coconut palms, was given as 600g Urea, 325g IRP, 1000 g Muriate of potash and 600 g Dolomite to be applied once in 6 months.

Comparison of efficiency of 3 organic manures, a green manure and 3 kg of Adult Palm Mixture (APM) at the end of fifth year showed 55%, 35%, 18%, 15%, and 33% yield improvement for poultry manure, gliricidia, cow dung, goat dung and APM respectively.

A drip irrigation experiment conducted at Rathmalagara Estate showed 47% increase in yield compared to control (no irrigation) when 600 l of water was given at every 5-day interval.

### **2.4 Crop Protection:**

The Crop Protection research program consists of 18 laboratory and field experiments. The research and maintenance expenditures were Rs.0.835 mln. and Rs.0.418 mln respectively. A total of Rs 774,173.00 was spent from the Coconut Cess Fund for the research and extension activities on coconut mite (*Aceria guerreronis*).

The coconut mite continued to spread in some parts of Anuradhapura, Kurunegala, Gampaha Districts. It has also been reported for the first time in Batticaloa District during the year.

The research on management of coconut mite received the highest priority. The research was mainly focused on chemical and biological control methods. Bagging of infested young coconut bunches with polythene bags each containing 10g of wettable sulphur for 10 days reduced the pest population by 95% and the damage considerably.

Testing efficacy of neem-based botanical, Neemarin, substitution of garlic with sulphur in the margosa mixture and chemicals, chlorpyrifos, carbosulfan and 0.2 % wettable sulphur were commenced. Chemicals reduce pest populations only temporarily and sustained chemical management of the pest will require regular spraying.

Biological control agents seem to be the sustainable method for managing the coconut mite. Already a predator mite (*Neoseiulus* nr sp. *paspalivorus*) has been identified as the most effective biological control agent. Therefore, mass culture of this predator is now being investigated. The two spotted spider mite, *Tetranychus urticae* has been identified as an alternative prey for the breeding of predatory mite, *Neoseiulus* nr sp. *paspalivorous* in the laboratory. Development of methods of mass breeding of the predator and the prey was received the highest priority.

A collaborative project funded by the Department for International Development, UK was initiated with CABI bioscience, UK to develop an integrated management programme for coconut mite using an entomopathogenic fungus *Hirsutella thompsonii*. Preliminary studies conducted in the field to investigate the effectiveness of the fungus indicated that the fungus sprayed on to infested bunches could cause mortality of coconut mites on the nuts, but the infection rate was very low. Studies commenced to improve the efficacy of the fungus.

As a solution to the difficulty in finding toddy and sugarcane to be used in the traps for red weevil, readily available sugar and yeast solution was recommended as an alternative. It was found that 15% sucrose solution with 0.2% yeast attracted 30% more weevils than toddy.

A pilot trial to confirm the effectiveness of a single release of the parasitoids, *Brachymeria nephantidis* and *Eriborou trochanteratus* at the ratios of 300:1 and 75:1 of pest: parasitoid respectively showed that the coconut caterpillar was completely controlled in 3 months after the release. A single release of the parasitoids could be recommended in order to reduce the cost of repeated releases practiced so far.

The causal agents for the leaf rot disease of coconut in the Southern Province were identified as *Ceratocystis paradoxa*, *Colletotrichum* sp. and *Fusarium solani*. Their pathogenicity in the laboratory was confirmed and proving the pathogenicity in the field was initiated. This study will lead to determine effective chemicals to destroy these fungi and manage the disease in the field.

## 2.5 Plant Physiology:

The total allocation for Plant Physiology Research as recurrent expenditure was Rs.1,000,000/-. This research programme continued with 13 lab and field experiments during the year giving more emphasis on Coconut Rapid Decline (CRD) syndrome of coconut palm.

The vegetative, reproductive and physiological parameters of CRD affected palms were quantified and results show a reduction of total number of fronds by 32%, girth of the trunk by 24%, chlorophyll content by 12%, and three fold increase in stomatal diffusive resistance, when compared with apparently healthy palms. There was also a concomitant reduction in the size of the inflorescences (35%), number of female flowers produced (71%), nut yield (54%) and copra weight (44%).

The Food and Agriculture Organization (FAO) continued to assist financially and with expert knowledge to test the causative agent for CRD syndrome.

A plant house experiment conducted for screening coconut palms for drought tolerance revealed that *san ramon* as a reasonable candidate for tolerance to drought compared to ordinary *tall*, *tall x tall*, and *tall x dwarf*.

Application of 3.0 ml of 2.5% ethrel at the axis of the tapping spadix increased the annual toddy yield per palm consistently for a period of five years. The yield increase was 31%, 44%, 13%, 30% and 25% during the respective years. This finding is ready for the recommendation to the toddy tapping industry.

The protocol for quality preservation of tender king coconuts for a period of one month was obtained by 18 growers/exporters during the year. This technology is being now used to export king coconuts to Europe, Middle East, and Japan. Further refinements to the existing protocol are being tested to enhance the shelf-life of king coconuts up to six weeks.

## 2.6 Tissue Culture:

The Tissue culture research program comprised 9 laboratory studies. The total investment for tissue culture research as recurrent and capital funds were Rs.0.768 mln. and Rs.0.150 mln respectively.

During the year twenty-seven tissue-cultured plants raised from plumule cultures were planted at Bandirippuwa Estate and Pallama Seed Garden to evaluate their performance in the field. The growth of the tissue-cultured plants established previously at Bandirippuwa Estate was satisfactory and flowering was observed in two of the palms. Fifteen more tissue-cultured plants were fully acclimatized and ready for field planting.

Investigations on pollen and ovule culture for the production of double haploid plants were continued. The most suitable development stage of ovule culture was identified and suitable culture conditions for callogenesis were defined.

A total of 233 dikiri embryos were cultured using an upgraded embryo-culture protocol. With the new protocol, the germination rate of embryos was found to be satisfactory and a considerable number of ungerminated embryos could also be recovered by the application of gibberellic acid ( $GA_3$ ). The growth of *in vitro*-raised dikiri plants was

found to be satisfactory. About 20 dikiri plants are ready for field planting, whereas 33 plants are at the final stage of acclimatization.

*In vitro* culture of coconut embryos brought to Sri Lanka from India under the germplasm exchange program was initiated using the protocol already developed for embryo culture in the laboratory.

High frequency of plant regeneration from *Paulownia fortunei* (a fast-growing timber crop) was achieved by culture of nodal segments on MS medium (Murashige and Skoog medium) with appropriate supplementation of growth regulators. More than 75 *in-vitro* raised *Paulownia* plants were successfully acclimatized using a hydroponic technique.

## **2.7 Biometry:**

The total allocation for, Biometry research and statistical services and maintenance was Rs. 192,000/- and Rs.137,000/- respectively.

The Biometry staff assisted to Research Divisions in designing experiments, analysis of data, and lay out of field trials.

The Division maintained experiments on monthly harvesting at several locations to study the benefits of harvesting at monthly intervals. The results indicated an overall average increase of 15% yield for monthly harvesting when compared to two monthly harvesting. This practice will increase yields, income to growers, and year round availability of nuts.

In socio-economic surveys, it is common that policies are implemented at the farm level by aggregating results at different levels, such as Districts, land extents and population sector. The effect of such aggregation was studied using past survey data related to coconut cultivation. The results show that unless the data set is reduced in size the aggregation of data by major grouping factors has little influence on yield variables. Therefore, there is a need to identify correctly different grouping factors and their interactions before appropriate policies are formulated.

## **2.8 Coconut Processing Research:**

The Coconut Processing Research program continued with 13 ongoing experiments and new experiments on product development and quality improvement of existing products. The total recurrent expenditure for the experiments was Rs.94,208/- and capital investment for equipment procurement was Rs.465,693/-.

During the early part of the year, high priority was given to develop a suitable method to utilize coconut kernel efficiently in domestic use. A coconut paste was developed which has zero waste of kernel, and storage studies were also conducted at ambient and refrigerated conditions. It was found that this paste could be kept for at least two weeks at room temperature and one month at refrigerated condition without changing taste and colour. The process is being popularised through advertisements.

A processing method was developed to preserve scraped fresh coconut for about one month at refrigerated temperature without affecting its organoleptic properties by incorporating permitted preservatives at mild levels. Further experiments are being carried

out to extend its shelf-life in both ambient and refrigerated temperatures. Once this method is perfected, scraped coconut could be sold under cold storage or exported for Sri Lankan communities living in the Middle East and Europe. For expatriate Sri Lankans and modern society looking for convenience food bottling method was developed for candied coconut (Pani pol). This product is organoleptically acceptable and which could be kept for about an year.

A tender coconut water drink was developed with its kernel. This beverage contains 10% kernel and natural limejuice or artificial citric acid. Pectin at 0.4% was identified as a suitable stabilizer to get a stable product without separation of the kernel and water. It was observed that homogenisation at 11,000 rpm is sufficient to get a physically stable product and pasturization at 100 °C for 5 minutes is sufficient to get a microbiologically safe product.

In order to increase alcohol percentage in toddy high alcohol producing yeast strains were isolated from wild yeast strains. A laboratory scale mass cultivator was designed for mass culturing of high alcohol producing yeast strains. Cultivated yeast was then coated on boiled rice and dried to bring it to a ready-to-use form. This work is being continued to commercialise this product in order to improve alcohol content and quality of toddy supplied to distilleries.

In order to enhance retting process a series of experiments were conducted to compare microbial communities in fresh, brackish water and saline water retting pits. The most dominating organism in all three types of water was found to be a spore-forming bacillus.

The Ceylon Copra Kiln was modified for the use of charcoal powder, taking into account heat generation and heat distribution patterns in the kiln. Based on the trials, the most suitable firing chamber height was found to be either 3 feet or 4 feet. The firing chamber of 4 feet height was selected for further studies. In this redesigned kiln the moisture percentage of copra was reduced to  $7 \pm 1$  with 3 firings. Even after the 3<sup>rd</sup> firing, on storage, copra gets contaminated in 2-3 days. Further experiments are being continued. This redesigned copra kiln has higher energy efficiency than the conventional one, and it will be quantified later.

## **2.9 Extension Services:**

At the beginning of the year, the extension staff of CRI were involved heavily in conducting several field programs for the Extension and Field Staff of the Coconut Cultivation Board (CCB) under the 100 Day Program introduced by the government. Four field programs were conducted for the Field Extension Staff of CCB at Weeraketiya, Dummalasuriya, Anuradapura and Matale to update and refresh their knowledge on new technologies in coconut cultivation. Nearly 195 CCB officials participated at these four programs. Field demonstrations on specific recommended practices were arranged with each of these programs. Concerning the needs of specific areas, four booklets as special publications were issued for each field program. Nearly 1000 copies of each issue were distributed to CCB Regional Offices to be used in field programs organized by them for coconut growers.

Several television and radio programs were conducted to educate the public on the rehabilitation of drought- affected coconut plantations. Four television programs on tapering

of coconut palms, mite control activities, irrigation and coconut paste were produced and telecasted over Rupavahini, ITN and Sirasa TV channels.

The Persuasive Extension Program (PEP) was continued successfully to promote the adoption of new technologies in the coconut estate sector. Based on observations and discussions with landowners, 63 estate development plans were submitted. The total extent covered was 12,275 ac.

To meet the increasing demand for educated youth as Managers in the coconut estate sector, a two and a half months practical training was conducted for a batch of 25 educated youth. All these trainees are presently employed in private sector estates and their progress is being assessed.

One-day training program is the most popular practical training for the coconut growers. It was conducted this year too with seven individual programs on seven specific technical areas in coconut cultivation and estate management. This program mainly focused on the improvement of technical knowledge and skill of coconut growers. Over hundred growers participated in each of these programs conducted at different sub-stations of the Institute.

Several field days, demonstrations and trainings were conducted for officials of government and private sector Institutions on coconut cultivation and management. Numerous field inspections were also made on request of coconut growers to solve their specific field problems.

A significant increase in the number of visits of school children and students from various educational institutions to the Institute for educational purposes was witnessed. Based on their requirements several educational programs were conducted. During the year 4550 school children participated from 56 schools and 475 students and undergraduates from Agricultural Schools and Universities.

During the year the following publications were printed at the Institute and issued:

Coco News-Newsletter-December, 2001, Pol Puwath-Newsletter-March, 2002, CRI Annual Report-2000, CRI Annual Reports for 1996-2001 in three languages for the Parliament 1996, International Service for National Agriculture Research(ISNAR) - Organizational Performance Assessment (OPAS) report, Seven booklets for the one day training participants, and several advisory circulars.

Two colour posters in Sinhala and Tamil and several colour leaflets on mite control activities were printed and issued to CCB and growers.

## **2.10 Library Services:**

Routine services of the Library were conducted satisfactorily throughout the year. The number of printed books added to the collection was 44 out of which 9 were donated by ADB. The total number of books was 5666 as at 31 December 2002. Literature searches were made on the coconut database to cater the information needs of staff as well as outsiders. Adequacy of access to Internet is still remains a problem for the staff.

## 2.11 Estate Management:

The Estate Management Division of the institute manages four Seed Gardens and four Research Sub Stations, and the total extent of the lands is about 1197 ha. The Pallama Seed Garden which was acquired in 1997, hundred acres are being replanted as a seed garden and is expected to issue *tall x san ramon* (CRISL 98) seed nuts in the future for the National Replanting Program. During this year 50 seedlings planted in the seed garden area came into flower.

The total yield of the eight estates was 2,550,880 nuts from 74,552 bearing palms and 3,898 partially bearing palms from January to October 2002. This yield decrease could be attributed to the prolonged drought that prevailed during the last year throughout the country, and confinement of application of fertilizer to only 50% of the extent due to heavy financial constraints experienced by the Institute for two consecutive years.

The total seed nut production for the National Replanting Program from the Ambakelle and Maduru Oya seed gardens was 803,965 seed nuts. Further plus palm nuts were issued from identified blocks of CRI estates. Seed nut production during the past five years is given below. Ambakelle seed garden showed 50% reduction in yield compared to previous years due to the drought.

### Seed nut production during the past five years:

Estate	1998	1999	2000	2001	2002
Isolated Seed Garden	902,541	1,032,875	972,824	1,007,000	548,719
Maduru Oya Seed Garden	126,623	153,930	199,000	252,718	255,246

During this year all the estates received sufficient rainfall with good distribution pattern, compared to the last year.

Replanting program was carried out at Pallama Seed Garden, Maduru Oya Seed Garden and Rathmalagara Estate as scheduled and were able to complete 32.8 ha as given below:

Estate	Extent Planted (ha)
Pallama Seed Garden	20.0
Maduru Oya Seed Garden	10.0
Rathmalagara Estate	2.8
<b>Total</b>	<b>32.8</b>

To generate additional income in research sub-stations an intercropping program was initiated and the following intercrops were planted in those estates:

<u>Variety</u>	<u>No. of plants planted</u>
Banana	10150
Pineapple	4000
Cinnamon	2400

The Estate Management Division employed 67 monthly paid and 410 daily paid workers for all seed gardens and research sub-stations. Out of the total workforce, 80

workers served as estate security staff and another 15 as emasculation labourers. Labour wages were increased by Rs 33.80 from January this year, which involve additional expenditure of Rs 3.5 mln per annum.

### 2.11.1 Estate Expenditure:

Annual allocations for the Estates Management Division for year 2002 and the details of expenditure against allocations are given below:

Type of Funds	Amount allocated (Rs)	Total expenditure (Rs)	Total expenditure as a percentage
1. Recurrent Funds	18,724,000	17,464,278	93%
2. Capital Funds			
a. For young plantation management	2,145,000	2,182,299	102%
b. For purchase of capital items	749,000	314,129	42%

### 2.11.2 Estate Income:

The total gross income from seed gardens and research substations was Rs.34.58 mln. during this period by sale of coconut, copra, trees, animals and other by products as mentioned below:

Coconut Income	32,124,151.10
Copra Income	829,202.30
Sundry Income	1,448,120.80
Milk	95,548.13
Sale of Seedlings	87,230.00
<b>Total</b>	<b><u>34,584,252.33</u></b>

### 2.11.3 Estate Development Activities:

#### a. Irrigation:

Two major irrigation development programs were launched at Maduru Oya seed garden and Pallama seed garden by utilizing Cess Funds. The estimated cost for Maduru Oya seed garden irrigation expansion scheme was Rs.2.70 mln., and 70% of the work was completed before the end of the year.

The establishment of drip irrigation system for 100 acres at Pallama seed garden with an anticipated cost of Rs.6.5 mln. is already underway. Cess money will be utilized for the installation of a drip irrigation system at this place.

**b. Infrastructure Development:**

Capital funds for building construction work was not allocated this year due to shortage of funds. Only few repairs were carried out at Pallama Seed garden using Cess Funds.

Also 42200 meters of new fencing was completed at Pallama seed garden, Bandirippuwa estate, and Dunkannawa estate by using capital and Cess Funds.

**c. Electrification:**

Three-phase electricity supply for the Pallama seed garden was installed in the early part of this year. The total expenditure for this program was Rs.2.5 mln.

**d. Agronomic practices:**

Weeding of all estates were managed by an integrated system using animals and other control measures (manual, mechanical, chemical control methods).

The fertilizer application was limited to 50% of the total extent and organic fertilizer application program has to be suspended due to shortage of funds.

**e. Procurement of vehicles & farm machinery:**

One two-wheel tractor with trailer was purchased for Dunkannawa Estate and no other farm machinery was purchased during the year.

**2.12 Administration:**

The Staff strength of the CRI as at 31 December 2002 was 351 and almost 400 check roll labourers were working in 05 Research Stations and 03 Seed Gardens. Except one vacancy was filled during the year and no new recruitments were made. In order to achieve the Physical and Financial targets set in the institute action plan, regular monitoring meetings were held with Heads of Divisions and other relevant staff.

Total budgetary allocation for 2002 was 111 mln, out of which 102 mln under recurrent and 9 mln. under capital expenditure. The gross income forecast of the institute for the year was 45 mln. and the balance 66 mln. was government grants for the expenditure. The details of expenditure including salaries and major expenses are given below:

a) For staff salaries, labour wages, overtime & Board contribution for Medical Aid, Provident Fund, ETF	Rs.	57,683 mln.
b) Gratuity for 18 members who left the services of the Institute	Rs.	2,217 mln.
c) Grants for the Recreation Club, Art Circle, Seva Vanitha Unit, Co-operative Society & Day-care Centre of the Institute	Rs.	0.373 mln.
d) For local trainings grant for 26 officers	Rs.	0.150 mln.
e) For overseas trainings grant for 17 officers	Rs.	2.853 mln.

Expenditure incurred under the Engineering Unit during the year 2002 is given below. Following work had been completed during the year utilising allocation from the Consolidated fund and Cess Fund:

Nature of Work	Location	Cost Involved (Rs)	Source of funding
Renovation to staff quarters BE/GR111/04	BE	443,695.59	CF
Improvements to the dairy shed	BE	119,466.71	CF
Construction of 06 toilets	PSG	288,695.59	Cess
Construction of an agro-well	BE	469,214.74	CF
Construction of a tractor garage	BE	298,299.38	CF
Construction of a labour rest room	MOSG	212,870.20	Cess
Construction of a tractor garage	MOSG	269,006.60	Cess
Repairs to pavements of the Superintendent's Bungalow	PSG	99,006.00	CF
Supply, Installation and commissioning of a water pump	BE	134,462.84	CF
Repairs to the OIC bungalow	DE	194,470.79	Cess
Construction of a goat shed	PRS	154,220.00	Cess
Water distribution system	BE	115,930.00	Cess

The work to be completed in early 2003:

Nature of work	Location	Cost involved (Rs)	Source of funding
Supply, Installation and commissioning of 300 KVA Generator	BE	3,352,366.10	CF
Irrigation development works	MOSG	3,143,266.87	Cess
Supply of furniture to the new laboratory	BE	1,433,120.00	Cess
Repair works to Male's hostel	BE	394,378.97	CF

(BE - Bandirippuwa Estate, PRS - Pottukulama Research Station, MOSG - Maduru-Oya Seed Garden, PSG - Pallama Seed Garden, DE - Dunkannawa Estate)

Utilization of recurrent expenditure for the maintenance activities of buildings, roads, vehicles, machinery, electricity and water supply during the year is given below:

Upkeep Vote	Utilization (Rs)
Building/Laboratories and roads	1,797,132.00
A total of 33 vehicles including buses, lorries, motor coaches, dual purpose vehicles, jeeps, and a car and 45 motor cycles	1,416,982.00
Machineries	238,444.00
Water supply, electricity and telephones	4,228,170.00

## 2.13 Services provided by Research Divisions

### a. Genetics and Plant Breeding Division:

The following training programs were conducted by the staff of Genetics and Plant Breeding Division:

- i. One-day training program on planting material of coconut, planting techniques and early care of seedlings for coconut growers.

- ii. A training program on the "Use of DNA technique for assessment of genetic diversity in plants" conducted for scientists from Universities and research organizations.
- iii. One-day demonstration on DNA isolation from plant tissues for undergraduate students in the Faculty of Agriculture and Plantation Management, Wayamba University.

**b. Soils and Plant Nutrition Division:**

The main service functions of the Division were analysis of leaf, soil and fertilizer samples and advisory visits as given below:

<b>Activity</b>	<b>No. of samples</b>
Differential fertilizer recommendations	102 growers
Inorganic fertilizer analysis	132
Organic Fertilizer Analysis	17
Analysis of coir pith samples	15
Soil surveys	123 ha
Advisory visits	24
Participation at training programs	07

**c. Crop Protection Division:**

The staff of the Crop Protection Division continued to serve the coconut growers by providing advice on management of pests and diseases. Field inspections were made in case of instances where specialized advice was required. All reported infestations of coconut caterpillar were successfully managed by releasing nearly 430,000 laboratory-bred parasitoids. A total of 3690 pheromone vials were sold and 240 l of monochrotophos was issued to growers to manage red weevil.

**d. Coconut Processing Research Division:**

The staff of coconut processing division conducted demonstrations on preparation of coconut paste to reduce domestic wastage of coconut. These demonstrations were held in schools and at AGA offices for women's organizations.

Preparation of quality treacle, jaggary, golden syrup and coconut oil as small industries also demonstrated on request of people for such services.

**3. DONOR FUNDED AND CESS ASSISTED PROJECTS**

**3.1 Donor funded projects**

**a. ADB funded projects:**

**1) Science & Technology Personnel Development Project:**

The total allocation for five years was US\$ 228,256. The project is funded for three thrust areas, namely Food Technology, Biotechnology and Library improvement. Ms P Hewavitharanage, Mr J M M N Marikkar, Ms C

Bandaranayake and Ms S C N Fernando continued their postgraduate studies leading to Ph D in Oleochemistry, Food Technology, and Molecular Biology respectively. Ms C Bandaranayake successfully completed her Ph D program and reported back to the Institute in October. Ms C Yalegama of Coconut Processing Research Division received a short-term training in Germany. Almost all the equipment requested for Molecular Biology Research was received during the year. Mr Werner Baensch, Consultant in Food Technology completed his first consultancy mission and Prof. U Samarajeewa, local Consultant completed his program. These two consultancies became very useful to develop new value added products out of coconut kernel. Project activities are continuing with good progress.

## 2) On-farm Adaptive Research Program:

The allocation for 2002 was Rs.2 mln. Under this project 112 on-farm adaptive trials are being continued in 15 administrative Districts. During the year pineapple, banana, rambutan, tea, papaya and ginger were the crops that received high farmer preference.

## 3) Developing sustainable coconut-based income generating technologies in rural communities in Sri Lanka:

Total allocation is US\$ 50,000. Three coconut-growing communities were selected from Wilpotha, Hettipola and Galle. These three communities cover about 1000 families. The project is aimed at funding for all machineries, equipment and other material for coconut processing, intercropping and livestock development. Several training programs, equipment and other necessary assistance were provided to these communities to start coconut based small industries. Project is progressing satisfactorily, but is hampered by lack of staff support. The government has not allowed to recruitment even casual staff (community coordinators).

### b. IPGRI/DFID funded projects:

- i. Development of an effective technology for the production of coconut seedlings from the high-value soft-endosperm coconut variety "Dikiri Pol"

Under this project, under the aegis of the Coconut Genetic Resource Net work (COGENT), upgraded coconut embryo culture protocol was used to mass propagate dikiri plants. With this protocol, germination rate of embryos was found to be satisfactory. One hundred and seventy eight plants have already been transferred to soil out of which 112 survived. Over 200 embryos are still growing in culture media.

### c. National Research Council (NRC) grants:

- i. Culture of immature inflorescence explants of coconut (*Cocos nucifera L.*) with a view to clonal propagation. (Funds awarded: Rs.2,086,700/-)

The analysis of proline, total sugar and starch in inflorescence tissues at different developmental stages was continued with a view to develop a suitable marker for selecting the most responsive developmental stage of immature inflorescence for *in vitro* culture. Protein profiles in the inflorescence tissues at different developmental stages and immature inflorescence derived callus was analysed for the same purpose.

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

Funds awarded: Rs.2.337,500/-. Viable protoplasts were isolated from the immature inflorescence tissues and immature embryo-derived callus. A suitable protocol was developed for protoplast isolation.

d. **Food and Agriculture Organization of the United Nations (FAO):**

The FAO continued funding for the multidisciplinary project on "Assistance to identify the causal agent of Coconut Rapid Decline and initiate a practical control strategy. Under this project investigation of the presence of phytoplasma in Coconut Rapid Decline (CRD) affected palms was continued with the consultative assistance of Professor John Randles from University of Adelaide, using nested polymerase chain reaction. Phytoplasma specific signals were obtained for root DNA from two diseased palms and two healthy palms while DNA from heart tissues gave positive signals for two out of five diseased palms. DNA samples of these palms were sent to Adelaide University for further verification.

e. **Global Environment Facility (GEF) funding through Assessments of Impacts & Adaptations to Climate Change (AIACC):**

The AIACC commenced funding a three-year project on "Assessment of the Impacts & Adaptation to Climate Change in the Plantation Sector with Particular Reference to Coconut in Sri Lanka". Preliminary data collection is being continued for various climatic regions. Meanwhile two short-term trainings were received on modelling and socio-economic impact assessment through the project.

3.2 **Cess Assisted Projects**

1) **Persuasive Extension Program:**

Total approved allocation	:	Rs. 824,000.00
Available balance for project	:	Rs. 104,000.00

Expenditure in 2002

Recurrent	:	Rs. 44,851.00
Capital	:	Rs. -

Balance available for 2003	:	Rs. 59,149.00
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### **Physical Progress:**

Under this program, 400 estates were visited during the year covering 25,121 acres. Development plans for all those estates were provided. About 60% of these were re-visited for monitoring the progress of the activities.

#### **2) Construction of bio-technology laboratory:**

Total approved allocation	:	Rs. 12,865,665.00
Available balance for project	:	Rs. 231,000.00
Expenditure in 2002		
Recurrent	:	-
Capital	:	Rs. 188,631.20
Balance of 2002 allocation	:	Rs. 42,368.80

### **Physical Progress:**

Construction of the laboratory completed and building was handed over to the Institute. Coconut Processing Research Division shifted to the new building.

#### **3) Application of bio-technology in coconut breeding:**

Total approved allocation	:	Rs. 14,650,000.00
Available balance for project	:	Rs. 2,485,000.00
Expenditure in 2002		
Recurrent	:	Rs. 1,530,554.00
Capital	:	Rs. -
Balance of 2002 allocation	:	Rs. 954,445.00

### **Physical Progress:**

Training of one Researcher at the Ph D level for coconut genome mapping was successfully completed. Few equipments required for mapping work were purchased. Chemicals and Biochemical reagents too were purchased.

#### **4) Pilot study on deep ground water availability:**

Total approved allocation	:	Rs. 7,211,100.00
Available balance for project	:	Rs. 2,500,000.00
Expenditure in 2002		
Recurrent	:	Rs. 1,967,872.00
Capital	:	Rs. -
Balance of 2002 allocation	:	Rs. 532,128.00

**Physical Progress:**

Three tube wells were done in Dambadeniya, Wariyapola and Kurunegala. Sites were selected by field survey for another 9 tube wells and drilling of wells in these sites are in progress.

**5) Establishment of Fuel Wood Plantation and Dendrothermal Power Plant:**

Total approved allocation	:	Rs.	935,000.00
Available balance for project	:	Rs.	184,000.00
Expenditure in 2002			
Recurrent	:	Rs.	61,957.00
Capital	:	Rs.	-
Balance of 2002 allocation	:	Rs.	122,043.00

**Physical Progress:**

Gliricidia and acacia plantations in 22 acres were maintained at Pallama Seed Garden and pruning was done at appropriate time intervals. Fuel wood was sold to Heycarb. Negotiations are taking place with NERD to install 100 kv gasifer at Pallama Seed Garden.

**6) Training for Estate Managers:**

Total approved allocation	:	Rs.	988,000.00
Available balance for project	:	Rs.	200,000.00
Expenditure in 2002			
Recurrent	:	Rs.	24,463.50
Capital	:	Rs.	7,060.00
Balance of 2002 allocation	:	Rs.	168,476.00

**Physical Progress:**

Batch of 25 Estate Supervisors were trained successfully on the coconut estate management. Some furniture required for improving facilities for training was also purchased.

**7) Strengthening analytical facilities for DFR:**

Total approved allocation	:	Rs.	7,370,000.00
Available balance for project	:	Rs.	3,819,464.00
Expenditure in 2002			
Recurrent	:	Rs.	-
Capital	:	Rs.	2,657,400.00
Balance in 2002	:	Rs.	1,162,064.00

**Physical Progress:**

An auto-analyser was purchased for nitrogen and phosphorus analysis. Quotations were called to purchase a digestion block and digestion tubes, which are used for plant material analysis.

**8) Controlling mite damage:**

Total approved allocation	:	Rs.	25,949,480.00
Available balance for project	:	Rs.	7,778,720.00
Expenditure in 2002			
Recurrent	:	Rs.	670,287.27
Capital	:	Rs.	219,957.08
Balance in 2002	:	Rs.	6,888,475.65

**Physical Progress:**

**Research:** Testing of 4 different chemicals against coconut mite was initiated. The alternate prey, *Tetranychus urticae* for the rearing of predatory mite was identified. Initiated developing techniques, for mass rearing the predatory mite. Evaluation of pathogenicity of the pathogen fungus of coconut mite initiated in the field. A modified knapsack sprayer to spray chemicals on palms and bagging of immature bunches with sulphur to reduce pest damage were introduced.

**Other:** Awareness programs conducted.

**9) Red Weevil Pheromones:**

Total approved allocation	:	Rs.	3,000,000.00
Available balance for project	:	Rs.	400,000.00
Expenditure in 2002			
Recurrent	:	Rs.	81,866.00
Capital	:	Rs.	-
Balance in 2002	:	Rs.	318,134.00

**Physical Progress:**

Purchased glassware and chemicals for synthesis of pheromone. Method of synthesis of black beetle aggregation pheromone was studied. A suitable method has been identified, but needs further improvement to increase yield of the pheromone.

**10) Development of Pallama Seed Garden:**

Total approved allocation	:	Rs.	20,348,000.00
Available balance for project	:	Rs.	11,110,380.00
Expenditure in 2002			
Recurrent	:	Rs.	193,698.00
Capital	:	Rs.	846,276.81
Available balance	:	Rs.	10,070,408.18

**Physical Progress:**

- \* Completed fencing 2400 meters
- \* Construction of electricity meter room
- \* Production of seedlings from Pallama Seed Garden (3,400 Nos.)
- \* Preparation of estimate for Drip Irrigation Systems

Fencing around the Pallama Seed Garden (2,400 meters) was completed. Electricity meter room was constructed and electricity supply was connected to the Seed Garden. Planting of seed garden is being continued. Preparation of design and estimate for drip irrigation system was completed and tenders were called.

**11) Development of Maduru-Oya Seed Garden:**

Total approved allocation	:	Rs.	7,890,000.00
Available balance for project	:	Rs.	3,560,000.00
Expenditure in 2002			
Recurrent	:	Rs.	-
Capital	:	Rs.	1,453,845.10
Balance in 2002	:	Rs.	2,106,154.90

**Physical Progress:**

- \* Completed 60% from the Irrigation Development Projects at Maduru Oya Seed Garden
- \* Construction of a road at newly planted area is in progress.

**12) Development of Dunkannawa Estate:**

Total approved allocation	:	Rs.	1,199,500.00
Available balance for project	:	Rs.	1,199,500.00
Expenditure in 2002			
Recurrent	:	Rs.	11,509.40
Capital	:	Rs.	233,229.17
Balance in 2002	:	Rs.	954,761.43

**Physical Progress:**

Superintendent's bungalow and office building were renovated. Office and field equipments were purchased. Two wheel tractor and trailer were purchased for the estate. Land preparation work was completed and planted with coconut seedlings.

**13) Enhancement of fibre retting:**

Total approved allocation	:	Rs.	660,000.00
Available balance for project	:	Rs.	599,324.00
Expenditure in 2002			
Recurrent	:	Rs.	226,929.10
Capital	:	Rs.	13,800.00
Balance in 2002	:	Rs.	358,594.90

**Physical Progress:**

Pectin decomposing and Tannin degrading micro-organisms were isolated. Formulation of a microbial consortium is in progress to expedite the retting process.

**14) Development of solar dryer for copra:**

Total approved allocation	:	Rs.	278,530.00
Available balance for project	:	Rs.	278,530.00
Expenditure in 2002			
Recurrent	:	Rs.	36,000.00
Capital	:	Rs.	-
Balance in 2002	:	Rs.	242,530.00

**Physical Progress:**

Rs.36,000/- was used to purchase coconut for the hybrid dryer as part of the money for the project was received from Sarvodaya.

**15) Coconut germplasm exchange between Sri Lanka & Ivory Coast:**

Total approved allocation	:	Rs.	1,762,313.00
Available balance for project	:	Rs.	1,762,313.00
Expenditure in 2002			
Recurrent	:	Rs.	605,402.00
Capital	:	Rs.	166,459.75
Balance in 2002	:	Rs.	990,451.25

**Physical Progress:**

Due to civil unrest in the Ivory Coast during 2002 the proposed germplasm exchange between Sri Lanka and Ivory Coast was postponed. Instead germplasm exchange was happened between Sri Lanka and India. One Plant Breeder and Technical Assistant from the Tissue Culture Division were visited India and brought total of 773 coconut embryos from four promising Indian varieties namely Laccadive Ordinary, West Coast Tall, Banawali Green Round and Andiman Ordinary Tall, embryo cultures were initiated with these materials in order to propagate these varieties under *in vitro* conditions.

**16) Purchase of furniture for the new bio-technology laboratory:**

Total approved allocation	:	Rs.	6,987,307.94
Available balance for project	:	Rs.	6,190,108.00
Expenditure in 2002			
Recurrent	:	Rs.	-
Capital	:	Rs.	10,500.00
Balance in 2002	:	Rs.	6,179,608.00

**Physical Progress:**

Some furniture was received and the balance yet to be received. The contractor was instructed to complete the contract at earliest possible.

**17) Hundred-day Program:**

Total approved allocation	:	Rs.	1,247,661.00
Available balance for project	:	Rs.	1,247,661.00
Expenditure in 2002			
Recurrent	:	Rs.	977,435.92
Capital	:	Rs.	-
Balance in 2002	:	Rs.	270,225.08

**Physical Progress:**

Six field demonstration programs were held by the CRI to improve awareness of extension staff of the CCB and coconut growers. The demonstrations were aimed at addressing problems existing in different coconut growing areas. Anuradhapura, Matara, Hambantota and Puttalam Districts were selected for those field programs. Each program consisted of about 100 participants.

**Summary of financial progress:**

Total available balance for projects :	Rs.	44,000,000.00
Total cash received in 2002 :	Rs.	14,884,000.00
Expenditure in 2002 :	Rs.	12,229,984,71
<b>Balance of funds released in 2002Rs.</b>		<b>2,656,015.29</b>

#### 4. ACKNOWLEDGEMENTS

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

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

Continued support given by the following organizations is also acknowledged:

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

# REPORT OF THE AGRONOMY DIVISION

## Head - H A J Gunathilake, Ph D

### 1. SUMMARY

The research programme was primarily aimed at increasing the production of coconut and productivity of coconut lands, the latter by intercropping, animal husbandry and fuel wood farming. In addition several socio-economic studies were also completed. Under the development programs, project on management of gliricidia plantations for dendro-thermal power generation, animal-breeding program and demonstration farm at Tabbowa continued successfully on self-financing basis.

All agronomic trials showed an average of 30 percent nut yield reduction in this year compared with the yield of year 2001 due to the prolonged drought prevailed in 2001/2002. During the period, studies on soil moisture conservation received high priority. In Bingiriya (IL<sub>1</sub>/S<sub>5</sub>), husk burial trial having coconut palms 2.5 m x 1.1 m x 1.0 m husk pits yielded 30 nuts/palm/year while palms without husk pits yielded only 15 nuts/palm/year. In addition palms mulched with coconut husks yielded 26 nuts/palm/yr showing benefits of husk mulch.

Experiment on rehabilitation of low yielding palms in sandy regosole soil, fertilizer application followed by harrowing increased the nut yield by 34% compared to only fertilizer application.

In intercropping trials, grafted cashew produced a yield of 5.9 kg/tree/yr and showed better performance compared with air-layered or normal seedlings.

The on-farm adaptive research programme funded by the ADB is being continued in 15 administrative districts (116 sites). During the year, pineapple, banana, rambutan, papaya and ginger received high market prices, giving high returns from crop models with these crops. Adaptability of several crops in non-traditional areas was also tested (eg. intercropping pineapple in Galle and Kegalle Districts)

Experiments on evaluation of three poultry breeds/strains for productivity and adaptability for semi-intensive systems in coconut plantations showed that CPRS breed adapted well with semi-intensive system with good egg production. The profitability of this system was found to be 1.5 times higher than the conventional commercial poultry systems.

Six socio-economic studies, namely: (1) factors affecting the efficient functioning of a market for Coir fiber as a raw material, (2) recent trends in fresh nut export from Sri Lanka, (3) improvement of the potentials of toddy tapping industry, (4) analysis of the consumer demand for coconut, (5) effect of domestic fertilizer prices on use of fertilizer by coconut growers, and (6) effect of tariffs for edible oil importation on profit of primary coconut producers, has been completed.

Under the ADB funded project of "Developing sustainable coconut-based income generating technologies in rural communities in Sri Lanka", three coconut growing communities (Wilpotha, Galle, Hettipola) has been selected covering 1000 families. The project is aimed at funding for all machinery's, equipment and other materials for coconut processing, intercropping and livestock development.

## 2. RESEAERCH PROJECTS

### PROJEECT 2: REHABILITATION OF LOW YIELDING PLANTATIONS

#### Experiment 2.3: Effect of root pruning and fertilizer application on yield of coconut palms with heavy root mat formation on Coastal Regosols. (DL<sub>4</sub>/S<sub>5</sub>), Palavi - 1996

The experiment has been laid on a Randomized Complete Block Design (RCBD) with three replicates containing nine effective palms per plot. The soil is 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 2002, 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 the treatments given in Table 1.

**Table 1.** *Effect of three different treatments on the nut yield of coconut at Palavi*

Treatments	Nuts/palm/year		
	1997-2001	2002	% Difference of nut yield over control
Control (no fertilizer + no harrowing)	27	27	-
Harrowing + Fertilizer	38	63	133
Harrowing only	34	42	56
Fertilizer only	40	47	74
Significance		**	
LSD (P=0.05)		12	

Results showed that harrowing as well as fertilizer application alone improved nut yield significantly over control (Table 1). Whereas fertilizer application followed by harrowing, increase yields resulting more than in the fertilizer alone. These results indicated harrowing alone was also beneficial on nut yield improvement comparing to fertilizer application.

The experiment is in progress.

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

#### Experiment 2.4.2: Effect of size of planting hole on the growth of T x T seedlings on the Andigama Soil Series (shallow phase); Rathmalagara Estate (IL<sub>1</sub>/S<sub>5</sub>) Madampe - 1997

The objective of this experiment is to determine whether the growth performance of T x T coconut seedlings could be improved by increasing the size of the planting hole and by changing the type of the soil used to fill the planting hole. Treatments given in Table 2 have been arranged in a Randomized Complete Block Design with three replicates. There are nine effective palms per plot.

Although results were statistically insignificant, coconut seedlings planted in T<sub>2</sub> - T<sub>5</sub> treatments showed more of number leaves than seedlings planted in T<sub>1</sub> (1 x 1 x 1 m hole). Visual observations also proved the same. However, there were no differences in growth or performance of seedlings planted among T<sub>2</sub> - T<sub>5</sub> treatments.

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

Treatments	Total Number of fronds/palm	Number of leaves produced
T <sub>1</sub> 1x1x1 m pit (standard planting hole)	11	9
T <sub>2</sub> 1.3x1.3x1.3 m pit (filled with husk/same soil)	14	11
T <sub>3</sub> 1.3x1.3x1.3 m pit (filled with husk/soils brought from out side)	14	11
T <sub>4</sub> 1.3 m wide x 1.3 m deep trench (filled with husk/same soil)	14	10
T <sub>5</sub> T <sub>4</sub> + 20% increased standard density of palms (156/ha)	14	11
Significance	n.s.	n.s.

The experiment is in progress.

*H A J Gunathilake, H A Abeysoma, I M Thilakarathne and W W Hemawardena*

**Experiment 2.4.4: Effects of deep loosening of lateritic soils on the performance of coconuts grown on Andigama Soil Series (Shallow phase) at Ratmalagara Estate (IL1/S4), Madampe - 1997**

The study was aimed at deep loosening of shallow lateritic soil by mechanical and biological means in order to facilitate better growth of coconut roots thereby increasing growth and yield of coconut. The treatments given in Table 3 were arranged in a Randomized Complete Block Design with three replicates and nine effective palms per plot.

Although the nut yield differences among treatments were not significant from 1999-2001, the yield of this year showed that inter-cultivation of *Gliricidia* and *Accacia* reduced nut yield significantly over control (Table 3). Those two NFT's were allowed to grow with less/no pruning aiming to obtain a vigorous root system to penetrate into shallow soils of this site as an objective of this trial. So, reduction of nut yield is explained as below-ground competition between roots of coconut and NFT's. Hence, it could be concluded that less/unmanaged *Gliricidia* and *Accacia* do not facilitate to grow coconut roots to deep soil layers by loosening of shallow lateritic soil or this benefit overcome by competition of such trees with coconut.

Further loosening of soils as described in T<sub>2</sub>-T<sub>4</sub> did not increased nut yields. So, efforts to rehabilitate coconut palms in shallow lateritic soil by adopting techniques given in T<sub>2</sub>-T<sub>6</sub> were ineffective and not recommended for such soil.

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

Treatments	Nut yield (nuts/palm)			
	1999	2000	2001	2002
T <sub>1</sub> - Control (General estate practice)	47	70	65	38
T <sub>2</sub> - 1.3 x 1.3 m trench cut along coconut rows (and filled with same soil)	46	70	60	31
T <sub>3</sub> - 1.3 x 1.3 m trench cut along coconut rows (and filled with soils from out side)	45	63	71	34
T <sub>4</sub> - 1/3 circular trench cut around the manure circle (and filled with same soil)	50	60	60	28
T <sub>5</sub> - Inter-cultivation of <i>Gliricidia</i>	51	65	68	16
T <sub>6</sub> - Inter-cultivation of <i>Accacia</i>	51	63	67	18
Significance	n.s.	n.s.	n.s.	*
LSD (P=0.05)				15
CV%	45	32	16	17

The experiment was terminated.

*H A J Gunathilake, H A Abeysome, I M Thilakarathne and W A Hemawardane*

**Experiment 2.4.5: Rehabilitation of degraded coconut soils through short-term forestry in Andigama Soil Series (Shallow phase) at Ratmalagara Estate (IL<sub>1</sub>/S<sub>5</sub>), 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 economical productivity of coconut. The forest tree species used in this experiment has been planted in a Randomized Complete Block Design with three replicates (Table 4).

Among the tree species under study, two provenance's of *Acacia mangium* and *Macaranga palata* (Kenda) showed a high growth rate as in previous years (Table 4). The growth rates of *Calophyllum eletum* (Domba) and *Grewia tilifolia* (Damminna) and *Swietenia macrophylla* (Mahogani) were low.

The presence of weeds underneath each tree species was measured (g/m<sup>2</sup> - dry weight basis), the low values recorded with *M. paltata* and *G. sepium* while weeds were not comparatively suppressed under trees of *C. elatum*, *S. macrophylla* and *T. grandis*. Except *C. elatum* and *S. macrophylla*, other tree species covered the ground, hence light transmission at the ground level was low. There was a direct relationship between presence of weeds and sunlight availability under different tree species (eg. *M. paltata*), however, several tree species behaved differently (eg. *B. mooni* and *G. sepium*). This indicates that weeds suppression is controlled not only by sunlight availability but also with other factors too (e.g. rate of leaf litter decomposition, competition for moisture etc.).

**Table 4:** Growth, sunlight transmission and weed undergrowth of selected forest tree species

Treatments	Stem girth (cm) (at 30 cm above ground)	Underweight Weed biomass g/m <sup>2</sup>	Underneath light availability
T <sub>1</sub> <i>A. auriculiformis</i>	35	63	13
T <sub>2</sub> <i>A. mangium-1</i>	40	20	16
T <sub>3</sub> <i>A. mangium-2</i>	42	27	18
T <sub>4</sub> <i>Calophyllum elatum</i>	10	366	47
T <sub>5</sub> <i>Grewia tilifolia</i>	14	66	26
T <sub>6</sub> <i>Macaranga paltata</i>	40	13	6
T <sub>7</sub> <i>Gliricidia sepium</i>	22	16	3
T <sub>8</sub> <i>Teetonia grandis</i>	22	258	25
T <sub>9</sub> <i>Swieteria macrophylla</i>	16	282	44
T <sub>10</sub> <i>Bridella mooni</i>	25	197	10
Significant	***	*	***
LSD(P=0.05)	4	85	11
CV%	2	8	6

The experiment is in progress.

*H A J Gunathilake, H A Abeysona and I M Thilakerathne*

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

This experiment investigates the effects of different ground cover management systems on the performance of coconut palm and soil palm water relations on degraded shallow lateritic soils. The treatments given in Table 5 were arranged in a Randomized Complete Block Design with three replicates.

Although nut yield of coconut palms did not responded to treatments of T<sub>2</sub>-T<sub>5</sub> during previous three years might be due to either early stage of the experiment or experienced of well-distributed rainfall in years 1999 and 2000. Increased nut yield of this year clearly indicated that coir dust mulch (T<sub>5</sub>), *Pueraria* cover (T<sub>4</sub>) and controlled grass cover (T<sub>2</sub>) were beneficial over having a bare ground for coconut palms. Although no weeds/grasses under bare ground management (no other plant competition), there may be other disadvantages of it. Soil erosion, elevated soil temperature, less microbial activity are the probable disadvantages of managing a bare ground for coconut. The effect of these factors might be shown particularly during a bad year when drought is prevailed as in year 2002.

Based on these results it is recommended that coconut land would be managed grasses/weeds control by slashing or cover cropping with *Pueraria*. Application of coir dust as a dead mulch is the best for nut yield improvement.

**Table 5.** *Effects of ground covers on coconut yield*

Treatments	Number of nuts/palm/year			
	1999	2000	2001	2002
T <sub>1</sub> - Bare ground	60	70	66	33
T <sub>2</sub> - Controlled grass cover ( <i>B. brizantha</i> )	41	70	65	53
T <sub>3</sub> - Uncontrolled grass ( <i>B. brizantha</i> )	43	71	58	47
T <sub>4</sub> - <i>Pueraria</i> cover (live mulch)	50	85	67	62
T <sub>5</sub> - Coir dust to a 5.0 cm depth (dead mulch)	69	97	79	71
Significance	n.s.	*	n.s.	*
LSD (P=0.05)		8		18
CV%	33	25	22	20

The experiment is terminated.

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

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

The experiment was conducted at the following sites.

- 3.3.1 Minuwangoda (WL<sub>3</sub>/S<sub>4</sub>) - 1996
- 3.3.2 Hettipola (IL<sub>1</sub>/S<sub>3</sub>) - 1996
- 3.3.3 Pallama (IL<sub>1</sub>/S<sub>2</sub>) - 1996
- 3.3.4 Bingiriya (IL<sub>1</sub>/S<sub>4</sub>) - 1997

Effect of various methods of husk burials and mulching (Table 6) are being tested on a RCBD with three replicates with nine effective palms per plot. During the year, a severe drought prevailed in the coconut triangle, which resulted national coconut production declined by 29% over year 2001. Generally, the drought affect was severe in lands where having shallow soils depth. Up to the year 2002, nut yield of palms with different methods of husk burial and mulching did not show consistent differences. During year 2001, several methods of husk burial and particularly husk mulching showed significant improvement on nut yield in three sites except Pallama (S<sub>2</sub> soil classes). During this year, nut yield improvement with husk mulching (T<sub>5</sub>), husk burial in jumbo pits (T<sub>7</sub>) and 2.6 x 1.3 x 1.0 m pits (T<sub>8</sub>) was prominent in Minuwangoda, Hettipola and Bingiriya. Three were also indications that husk mulching is possibly more or equally beneficial for nut production.

The beneficial effect of several methods of husk burial and mulching (T<sub>2</sub>, T<sub>5</sub>, T<sub>6</sub>, T<sub>7</sub> & T<sub>8</sub>) was proved well at Bingiriya, where having shallow soil depth resulting severe yield loss. In this sites nut yield of palms mulched with husk has been increased by 73% over palms with no husk burial or mulching.

Husk burial in 2.6 x 1.3 x 1.0 m pits between two palms doubled the nut production over control. Further in these sites, visual observations also showed that nut production of palms without moisture conservation treatments has badly affected and will take several years to recover from the drought affect and reach to normality.

**Table 6.** *Coconut yields (nuts/palm/year) as affected by different methods of husk burial and mulching*

Treatments	Minuwangoda		Hettipola		Pallama		Bingiriya	
	97- 2001	2002	97- 2001	2002	97- 2001	2002	97- 2001	2001
T <sub>1</sub> - Control (Standard practices)	43	32	44	43	48	43	47	15
T <sub>2</sub> - Mulching with 12 fronds	50	35	50	53	47	41	51	21
T <sub>3</sub> -T <sub>1</sub> + 1/3 circle trench filled with same soils	48	28	41	48	44	46	46	14
T <sub>4</sub> -T <sub>1</sub> + 1/3 circle trench filled with husk	47	38	47	52	46	48	48	18
T <sub>5</sub> - Mulching with husk	54	41	40	59	48	54	55	26
T <sub>6</sub> -T <sub>4</sub> + T <sub>5</sub>	50	43	46	57	48	51	54	25
T <sub>7</sub> - 1.3 x 1.0 m trenches	51	39	44	59	43	54	54	25
T <sub>8</sub> -2.6 x 1.3 x 1.0 m husk pits between two palms	53	43	48	58	46	48	54	30
T <sub>9</sub> -1.3 x 1.3 x 1.0 m husk pits for every palm	47	39	45	51	44	45	45	19
Significant		***		*		***		**
LSD (P=0.005)		6		8		6		6

The experiments are in progress.

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## PROJECT 5: IMPORTANCE OF ORGANIC MATTER STATUS AND WATER HOLDING CAPACITY OF COCONUT SOILS

**Experiment 5.1:** Management of leguminous ground covers to improve productivity of coconut

**Experiment 5.1.1:** Pallama Seed Garden, Pallama – DL1- (Katukele Series)- 2000  
**5.1.2:** Melsiripura Farm, Melsiripura – IL1- (Melsiripura Series)-2000

The objectives of the experiment are to evaluate and quantify the effect of leguminous ground covers and their management methods on the productivity of coconut in long run. Treatments shown in (Table 7) were laid on a strip-split plot design with three replicates at each sites and nine effective palms per plot; sub plots covered either with Pueraria or natural vegetation. Sub plots are treated with two types of fertilizer mixtures with N and without N

(N, P, K, Mg and P, K, Mg) for coconut palms. Main plots are treated either harrowing or slashing twice a year.

**Table 7.** Effect of ground cover management on coconut yield (nuts/palm/year) at Pallama Seed Garden and Melsiripura estate

Treatment combinations	Melsiripura		Pallama	
	2001	2002	2001	2002
T1. Natural cover + P, K, Mg + Slashing	53	67	70	35
T2. Pueraria cover + P,K,Mg + Slashing	56	82	73	26
T3. Natural cover + N, P, K, Mg + Slashing	57	66	73	46
T4. Natural cover + P, K, Mg + Harrowing	49	76	71	32
T5. Pueraria cover + N,P,K,Mg + Slashing	59	66	78	39
T6. Pueraria cover + P,K,Mg + Harrowing	55	68	74	33
T7. Natural cover + N,P,K, Mg + Harrowing	54	78	62	34
T8. Pueraria cover + N,P,K,Mg + Harrowing	50	66	71	27
Significance	ns	ns	ns	ns

During the year, there was no significant difference on the yield among the treatments (cover types, fertilizer mixtures and management methods) (Table 7).

The experiment is in progress.

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**PROJECT 15: DEVELOPMENT OF LOW COST WEED MANAGEMENT SYSTEMS FOR COCONUT LANDS AND COCONUT NURSERIES**

**Experiment 15.1: Comparison of several recommended cultural practices for weed management in coconut lands**

**15.1.1 Pallama Seed Garden (IL<sub>1</sub>/S<sub>4</sub>)**

**15.1.2 Ussawa Division, Melsiripura Estate (IL<sub>1</sub>/S<sub>3</sub>)**

Treatments shown in (Table 8) were laid on RCBD with three replicates and nine effective palms per plot. Different weed management treatments were applied according to the schedule. During the year more frequent sampling was practiced to understand the dynamics of weed biomass in response to different cultural practices for weed management. The major weed species present in these sites were Illuk (*Imperata cylindrica*), Mana (*Panicum repens*), Getakola (*Hedyotis auricularia*), Podisinghomaran (*Chromolaena odorata*), Gadapana (*Lantana camara*) and Nidikumba (*Mimosa pudica*).

- T<sub>1</sub> - Control treatment (in which only the perennial shrubs are managed)
- T<sub>2</sub> - Cover cropping with Pueraria
- T<sub>3</sub> - Planting Gliricidia (in double rows in an avenue at 1m x 2m spacing)
- T<sub>4</sub> - Slashing (two times per year)
- T<sub>5</sub> - Application of Glyphosate (4lit/ha, two applications per year)
- T<sub>6</sub> - Grazing with cattle (6 rotations per year)

There was significant difference among treatments on weed biomass. The lowest weed biomass was in Glyphosate applied plots with the development of Pueraria cover was also equally effective to suppress weeds as in Glyphosate applied plots in Pallama (Table 8 & 9). Nut yield of coconut as affected by the application of different cultural practices did not show significant differences during the year in both experiments (Table 10).

**Table 8.** Weed biomass ( $\text{g/m}^2$ ) at different sampling times as affected by the application of different weed control practices at Pallama Seed Garden, Pallama

Treatments	Average 2001	Feb 2002	April 2002	June 2002	Aug 2002	Oct 2002	Dec 2002
T <sub>1</sub> - Un weeded	238	282	101	210	110	138	165
T <sub>2</sub> - Cover crop Pueraria)	193	121	107	222	167	138	53
T <sub>3</sub> - Gliricidia	216	131	88	177	145	117	117
T <sub>4</sub> - Slashing & mulching	168	81	86	216	88	100	182
T <sub>5</sub> - Chemical weeding	150	00	38	43	42	5	63
T <sub>6</sub> - Cattle grazing	227	136	83	173	190	142	156
Significance		***	*	***	*	**	**
LSD (P=0.05)		71	33	56	92	31	46
CV%							

Treatments were applied in June 01, December 01, June 02 and December 02.

**Table 9.** Weed biomass ( $\text{g/m}^2$ ) at different sampling times as affected by the application of different weed control practices at Melsiripura estate, Melsiripura

Treatments	Feb 02	April 02	June 02	Aug 02	Oct 02	Dec 02
T <sub>1</sub> - Unweeded	250	121	177	225	132	257
T <sub>2</sub> - Cover crop (Pueraria)	180	174	231	199	89	145
T <sub>3</sub> - Gliricidia	223	110	167	148	75	143
T <sub>4</sub> - Slashing & mulching	799	144	200	39	96	185
T <sub>5</sub> - Chemical weeding	78	123	179	15	43	88
T <sub>6</sub> - Cattle grazing	188	188	245	116	88	172
Significance	ns	ns	ns	**	ns	**
LSD (P=0.05)				66		73
CV%						

Treatments were applied in June 01, December 01, June 02 and December 02.

**Table 10.** Nut yield of coconut as affected by the application of different cultural practices to control weeds at Pallama Seed Garden and Melsiripura estate

Treatments	Nuts/palm/year			
	Pallama		Melsiripura	
	2001	2002	2001	2002
T <sub>1</sub> - Unweeded	72	26	46	56
T <sub>2</sub> - Cover crop (Pueraria)	88	38	45	52
T <sub>3</sub> - Gliricidia	77	38	59	49
T <sub>4</sub> - Slashing & mulching	78	27	54	50
T <sub>5</sub> - Chemical weeding	81	44	44	61
T <sub>6</sub> - Cattle grazing	83	36	58	46
Significance	ns	ns	ns	ns

The experiment is in progress.

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**Experiment 5.2. Application of different levels of Glyphosate on weed control in coconut nurseries**

**5.2.1. Coconut Cultivation Board Nursery - Wilpotha (IL<sub>1</sub>)**

**5.2.2. Coconut Cultivation Board Nursery - Wennoruwa (WL<sub>3</sub>)**

Treatments shown in Table 11 were laid on RCBD with three replicates. Forty seed nuts were established in each plot and 85% of seed nuts were germinated. The major weed species present in this site were Atawara (*Panicum repens*), Nidikumba (*Mimosa pudica*), Kuweni (*Cenchrus echinatus*), Kurunegala Desi (*Tridax procumbens*) and Landesi (*Amaranthus paniculatus*). Treatments were applied according to the schedule. Glyphosate controlled weeds successfully, hence weed biomass of those plots was the lowest (Table 11). There were no significant differences of weed biomass of among T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub>, & T<sub>5</sub> treatments. Growth of coconut seedling as expressed by the seedling girth (cm) and seedling height (cm). Both growth parameters were significantly difference at the end of nursery period. Coconut seedling in Glyphosate treated plots (T<sub>2</sub> & T<sub>3</sub>) showed higher growth rate than seedling in other treatments (Table 12 & 13)

**Table 11.** Weed biomass (g/m<sup>2</sup>) at different sampling times as affected by the application of different Glyphosate concentrations at Wilpotha

Treatments	Average	Jan	Feb	Mar	April	May
	2001	02	02	02	02	02
T1- Hand weeding	67	192	58	98	151	13
T2- Glyphosate 1400g/ha	85	52	3	5	21	0
T3- Glyphosate 1050g/ha	52	77	10	41	45	0
T4- Glyphosate 700 g/ha	39	100	5	54	96	0
T5- Glyphosate 350 g/ha	64	162	78	110	146	2
T6- Unweeded control	160	309	300	213	382	281
Significance		**	**	**	**	**
LSD(P=0.05)		125	105	60	91	43
CV%						

Treatments were applied in Nov 02, February 2002 and May 2002.

**Table 12.** Effect of different weed control treatments on the growth of coconut seedlings (expressed as the seedling girth (cm)) at Wilpotha

Treatments	Jan 02	Feb 02	Mar 02	April 02	May 02
T1- Hand weeding	6.7	7.7	8.8	9.90	11.2
T2- Glyphosate.1400g/ha	6.7	7.7	8.7	10.2	12.2
T3- Glyphosate 1050g/ha	6.7	8.0	9.1	10.7	13.3
T4- Glyphosate 700 g/ha	6.5	7.5	8.3	9.6	11.0
T5- Glyphosate 350 g/ha	7.0	8.4	9.4	10.6	11.1
T6- Unweeded control	6.7	7.5	8.5	9.6	10.5
Significance	ns	ns	*	ns	*
LSD (P=0.05)			0.7		1.1
CV%			4.0		5.0

**Table 13.** Effect of different weed control treatments on the growth of coconut seedlings (expressed as the seedling height (cm)) at Wilpotha

Treatments	Jan 02	Feb 02	Mar 02	April 02	May 02
T1- Hand weeding	60	77	88	100	109
T2- Glyphosate.1400g/ha	66	85	98	109	119
T3- Glyphosate 1050g/ha	59	81	94	114	129
T4- Glyphosate 700 g/ha	55	72	81	98	113
T5- Glyphosate 350 g/ha	62	85	96	109	114
T6- Unweeded control	57	74	84	96	108
Significance	ns	ns	ns	ns	**
LSD (P=0.05)					12
CV%					5.4

At Wennoruwa, dominant weeds were Kalanduru (*Cyperus rotundus*), Nidikumba (*Mimosa pudica*), Kurunegala Desi (*Tridax procumbens*) and Landesi (*Amaranthus paniculatus*). Forty seed nuts were established in each plot and 75% of seed nuts were germinated. There were significant differences between treatments on weed biomass (Table 14). Growth parameters (seedling girth and height) were measured and both values were significantly difference at the end of nursery period. Similar to results at Wilpotha, coconut seedlings in Glyosate applied plots showed higher growth rate than that of other treatments (Table 15 and 16).

**Table 14.** Weed biomass ( $g/m^2$ ) at different sampling times as affected by the application of different Glyphosate concentration at Wennoruwa

Treatments	Average 2001	Jan 02	Feb 02	Mar 02	April 02	May 02
T <sub>1</sub> - Hand weeding	73	72.3	124.3	123.5	76.7	116.9
T <sub>2</sub> - Glyphosate 1400g/ha	91	26.7	29.4	58.6	18.3	44.3
T <sub>3</sub> - Glyphosate 1050g/ha	69	47.4	63.7	123.3	41.4	85.9
T <sub>4</sub> - Glyphosate 700 g/ha	46	49.3	94.0	146.2	57.3	105.9
T <sub>5</sub> - Glyphosate 350 g/ha	84	85.7	141.7	180.4	112.5	158.1
T <sub>6</sub> - Unweeded control	108	316.6	275.4	220.5	255.9	287.6
Significance		**	**	ns	**	**
LSD(P=0.05)		45.4	98.5		42.5	43
CV%		25	21		25	18

Treatments were applied in December 2001 and March 2002.

**Table 15.** Effect of different weed control treatments on the growth of coconut seedlings (expressed as the seedling height (cm)) at Wennoruwa

Treatments	Feb	Mar	April	May	June
T <sub>1</sub> - Hand weeding	54	63	82	97	107
T <sub>2</sub> - Glyphosate 1400g/ha	60	68	92	112	118
T <sub>3</sub> - Glyphosate 1050g/ha	63	69	87	109	125
T <sub>4</sub> - Glyphosate 700 g/ha	55	65	87	107	115
T <sub>5</sub> - Glyphosate 350 g/ha	50	60	81	102	109
T <sub>6</sub> - Unweeded control	47	58	78	99	109
Significance	ns	**	**	**	**
LSD (P=0.05)		6	7	7	8
CV%		5	5	4	4

**Table 16.** Effect of different weed control treatments on the growth of coconut seedlings (expressed as the seedling girth (cm)) at Wennoruwa

Treatments	Mar 02	April 02	May 02	June 02
1- Hand weeding	7.3	9.1	11.1	13.1
2- Glyphosate 1400g/ha	7.6	9.3	12.2	12.7
3- Glyphosate 1050g/ha	7.6	9.3	12.5	14.8
4- Glyphosate 700 g/ha	7.8	9.6	12.2	13.8
5- Glyphosate 350 g/ha	7.2	8.8	10.9	13.1
6- Unweeded control	7.3	8.1	9.9	12.3
Significance	ns	**	**	**
LSD (P=0.05)		0.93	0.79	1.8
CV%		6	4	4

The experiments were terminated.

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

**Experiment 19.3: Evaluation of the performance of grafted cashew under coconut.**

a) **Rathmalagara Estate, Madampe (IL<sub>1</sub>/S<sub>4</sub>) - 1995**

The treatments given in Table 17 were tested on a RCBD with three replicates. Each plot consisted of nine effective coconut palms.

Grafted and air-layered cashew seedlings showed differences in their canopy form and also in their root distribution. Coconut yield was not affected by plant type of cashew (Table 17).

During the year, bud-grafted and air layered cashew yielded 5.9 and 4.6 kg/tree respectively while seedling cashew yielded only 2.6 kg/tree. The yield variation among trees within plots was high. The yield gap between air-layered and grafted cashew was gradually narrowed down with time. Growth parameters between two types also indicated a similar relationship. Further, air layered cashew showed high tendency for toppling compared with other two indicating the effect of no tap root of air layered plants.

None of the planting material types of cashew affected on nut yield of coconut (Table 17). However the nut yield difference between palms without cashew and palms with air-layered cashew was considerable in this year and this might be an early indication of root competition of shallow rooted cashew root system of air-layered plants with coconut root systems after seven years of establishment.

**Table 17.** *The effect of the plant type of cashew on coconut yield*

Treatments	Coconut yield (nuts/palm/year)	
	1996 - 2001	2002
Coconut monoculture	75	68
Bud grafted cashew	67	60
Air-layered cashew	70	54
Seedling cashew	69	68
Significance (P=0.05)		n.s

The experiment is in progress.

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**b) Pallama Seed Garden (IL<sub>1</sub>, S<sub>4</sub>) - 2000**

Among cashew planting material types, 100% of bud-grafted and air layered cashew flowered during the year. None of the seedling cashew did flower yet. Planting cashew did not show any effect on coconut yield as given in Table 18.

**Table 18.** *Coconut yield as affected by intercropping of different planting materials of Cashew*

Treatments	Coconut yield (nuts/palm/year)		Cashew yield kg/tree/year
	2000-2001	2002	
Coconut monoculture	53	43	-
Bud grafted cashew	56	56	1.9
Air-layered cashew	53	52	1.1
Seedling cashew	50	49	-
Significance (P=0.05)		n.s	

The experiments are in progress.

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**Experiment 19.4: Studying on a suitable density of grafted cashew in adult coconut plantations - 2001**

**9.4.1 Polontalawa Estate, Nikaweratiya (IL<sub>1</sub>/S<sub>5</sub>)**

**9.4.2 Galpola Estate, Kuliypitiya (IL<sub>1</sub>/S<sub>4</sub>)**

The objective of this experiment is to identify suitable planting density and layout of grafted cashew for intercropping adult coconut plantations. The treatments given in Table 19 were tested on a RCBD with three replicates. Each plot consisted with nine effective coconut palms.

In general, 30% of grafted cashew plants flowered during the year. So far, none of cashew plants in T<sub>2</sub>-T<sub>4</sub> treatments interfere each other. Coconut yield at Galpola site was also unaffected by treatments T<sub>2</sub>-T<sub>4</sub>.

**Table 19.** *Coconut yield as affected by intercropping of different densities and planting arrangements of grafted cashew in Galpola*

Treatments	Coconut yield (nuts/palm/year)
- Coconut monoculture	12
- Cashew trees per every coconut square (156 trees/ha)	13
- Cashew trees in alternative avenues of coconut (78 trees/ha)	12
- Cashew in alternative coconut square (78 trees/ha)	13
Significance	n.s.

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

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

This experiment is on a Complete Randomized Block Design (CRBD) with three replicates and 16 effective palms/plot. The site comprises clay loam soils. Three treatments were assigned to manage ground pasture and weed cover they are, (a) slashing by rotary-slasher attached to a four wheel tractor as necessary (about 3 round per year), (b) *Pueraria* cover cropping and (c) buffalo management (one animal for every 2.0 ha) with rotational grazing on one month cycle.

Table 20 shows that nut yield of buffalo grazed plots was higher than that of plots with cover crops or plots where weeds are slashed. This might be due to addition of nutrients to the soil by buffaloes and reduced competition between coconut and *Pueraria* or grasses.

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

Treatments	Coconut yield (nuts/palm/year)	
	1999-2001	2002
Slashing	81	65
Cover cropping	76	51
Buffalo gazing	86	69
Significance		*
LSD (P=0.05)		6

There was no difference in nut yield between slashing and buffalo grazing treatments.

During the year average milk yield was 4.0 l/day/head. The increased net profitability of a hectare is calculated as Rs. 6,200/- per year due to buffalo farming over monoculture coconut.

The experiment is in progress.

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

The growth and dry matter production of the pasture grasses in both Low Country intermediate Zone and Wet Zone showed similar trend as in the last year. *B. brizantha* & *B. ruziziensis* tend to be dominated in intermediate zone during dry period. But *B. miiliformis* showed a "compensatory growth" during wet months.

In Low Country Intermediate Zone, *B. brizantha* showed enhanced DM production in comparison to *B. ruziziensis* (Fig.01). However, farmers prefer *B. miiliformis* and *B. ruziziensis* to *B. brizantha* as higher rate of wastage of feed due to hard stems in case of *B. brizantha*.

Therefore results confirmed that a mixture of *B. ruziziensis* & *B. miiliformis* (in the same field but separately) ensures a sustainable feed supply for small holders in the Intermediate zone.

Of the three varieties, *B. miiliformis* performed well in smallholdings in Low Country Wet Zone (Fig.02) although there was suppression in growth even during short dry period. Results suggest that the combination of *B. miiliformis* & *B. ruziziensis* can be recommended for smallholder dairy farmers in the Wet zone.

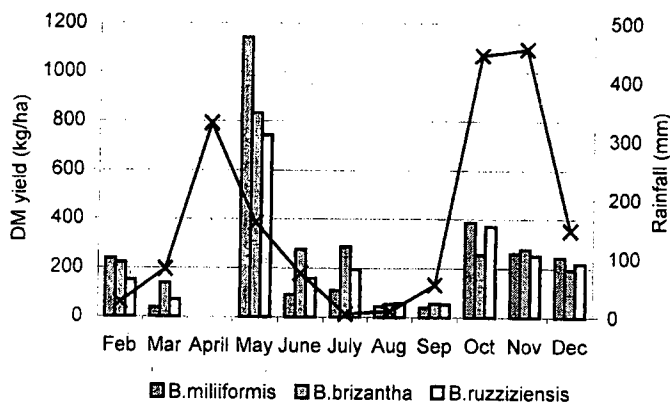


Fig. 01. On farm performance of pasture varieties in (Low Country) Intermediate zone

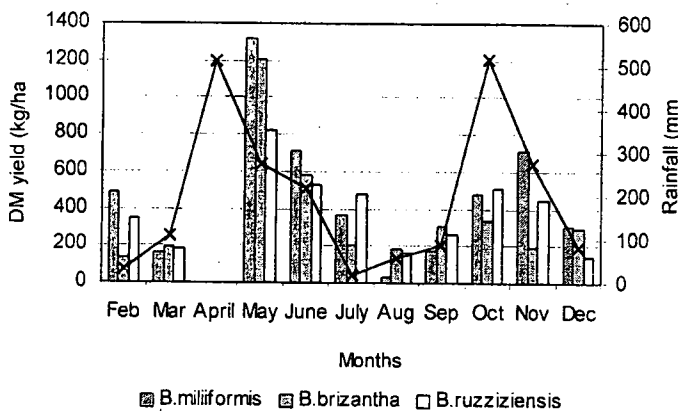


Fig. 02. On farm performance of pasture varieties in Wet zone

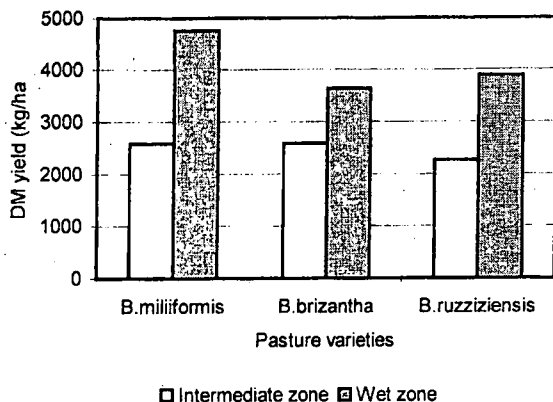


Fig.03 Annual DM yield of pasture grasses in different agro-eco zones.

The experiment is in progress.

*A.D.Samarajeewa and M.D.V. Saparamadu*

### Experiment 21.5.3: Development of low cost poultry production system under coconut

This experiment was designed to assess the feasibility, profitability and sustainability of semi intensive systems under coconut and to assess the nutrients balance of the coconut-poultry system under restricted scavenging systems. Three chicken crosses/strains were evaluated for the production and adaptability for restricted scavenging system in coconut lands with the supplementation of formulated ration by half the rate of the requirement. One-month-old chicks were introduced to the system.

#### Nutrient balance of the coconut –poultry system

Nutrient balance of the coconut poultry system (average of the three strains) is given in Fig. 04. The system shows positive balance of nitrogen (83 kg/year/ac) Phosphorous (34.5 kg/year/ac) while Potassium is in negative balance of 2.98 kg/year/ac. (Initially, 1.1 kg of MOP per palm per year was supplemented).

The total Nitrogen and Phosphorus requirement (Nut production- 90 nuts/year/palm) are provided through the inputs from the poultry and 67% of the Potassium requirement per acre of coconut is supplied by the poultry dung indicating that supplementation is needed at the rate of 750 g of Muriate of Potash (MOP) per palm per year. Therefore total N & P requirement for coconut could be met within the system itself where as the 750g of MOP per palm per year has to be supplemented externally.

## Comparison of the productivity of different poultry strains / breeds

**Table 21.** Performance of different breeds/strains of poultry

Breed/Strains	Egg Production (eggs/year/ replicate*)	% egg production	FCR**	Egg weight (g)
CPRS	4172	46%	2.17	53.8
CPRS x Indigenous	3516	39%	2.91	48.9
Indigenous	3839	42%	2.51	45.9
Significance	NS	-	-	-
CV (%)	9.8	-	-	-

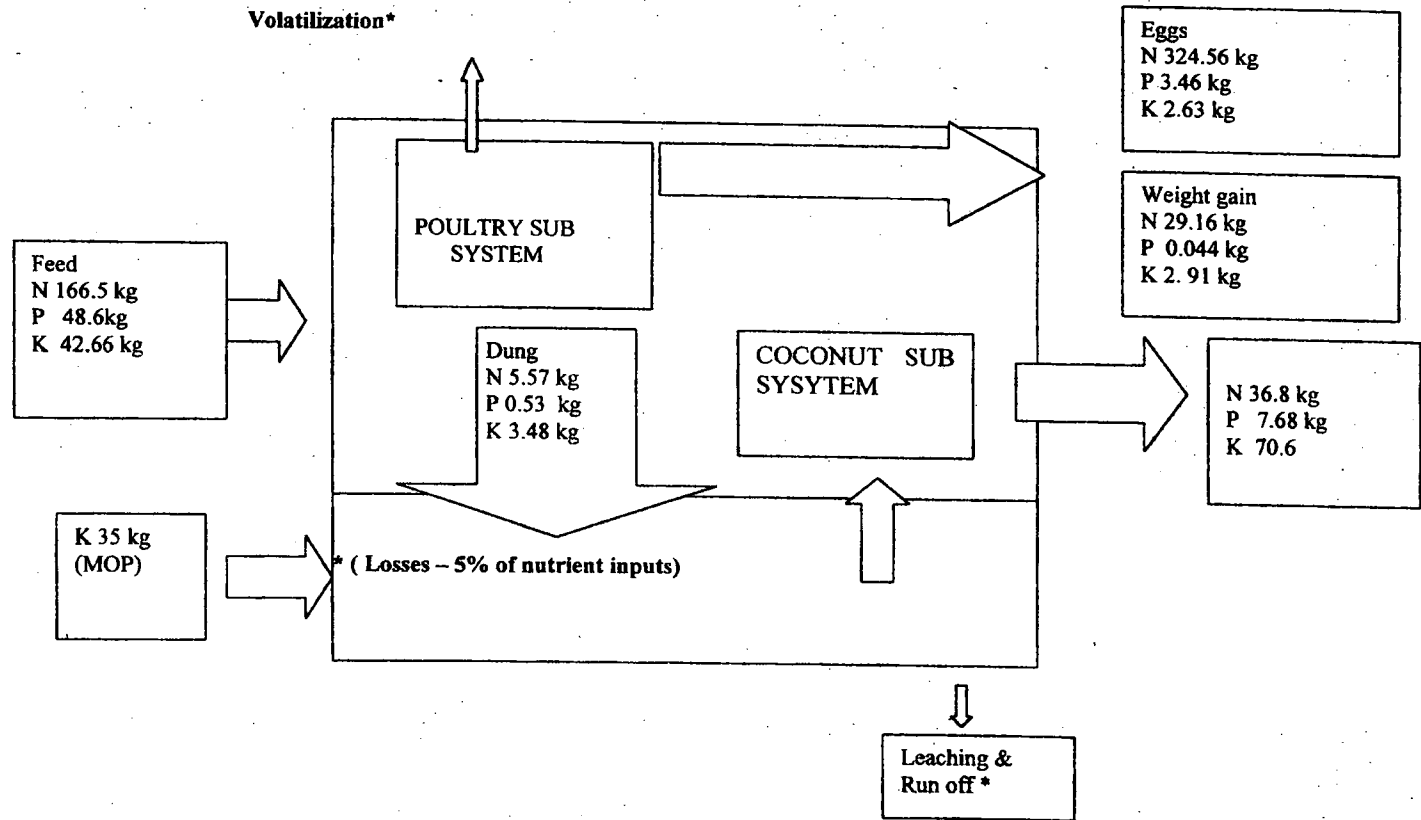
\* Replicate- 25 birds

\*\* FCR- Feed Conversion Rate (Feed requirement for 12 eggs)

Breed CPRS was found to be better adapted to the coconut – poultry systems (Table 21). Parameters such as egg production, FCR and egg weight were shown improvement in CPRS compared to the other strains, CPRS x Indigenous and Indigenous. The profitability of the system is yet to be estimated.

The experiment is in progress.

*A. D. Samarajeewa and M. D. V. Saparamadu*



**Fig. 04. Nutrient flow diagram of the coconut – poultry system**

**PROJECT 27: ECONOMIC STUDIES ON CURRENT ECONOMIC ISSUES AND TO ENHANCE THE PRODUCTIVITY OF COCONUT LANDS**

**Study 27.1: Analysis of export trends of fresh coconuts from Sri Lanka**

This study analyzed the trends of fresh coconut exports from Sri Lanka from 1997 to 2001, based on secondary data.

Fresh coconut exports have steadily increased from 17.71 million nuts in 1997 to 27 million nuts in 2001, representing a 52% increase. However, the fresh coconut exports is still less than 1 % of the national production (Table 22).

**Table 22 :** *Exports of fresh nuts as a percentage of national production*

Year	National Production (million nuts)	Fresh nut exports (million nuts)	Fresh nut exports as a % of national production
1997	2631	17.71	0.67
1998	2522	17.54	0.70
1999	2828	22.99	0.81
2000	3096	29.02	0.94
2001	2796*	27*.0	0.97

Note: \* Provisional.

Source: Sri Lanka Coconut Statistics (1997-2000). Coconut Development Authority.  
Annual Report of Central Bank of Sri Lanka (2001).

Middle east constitutes the major destination of fresh coconut exports, followed by Asia, EU and Africa. UAE, Pakistan, Netherlands and Mauritius are the major importing countries respectively of each of the above broader regions.

***Trends in monthly average FOB prices of fresh coconuts***

Monthly average FOB prices (in US\$ and Rs) from January 1997 to April 2002 were analyzed under four scenarios.

*Scenario 1: in US\$ (nominal)* Double-log model which was best fitted has shown a declining trend in the nominal FOB price (in US\$) of fresh nut exports.

*Scenario 2: in US\$ (real):* Smoother trend line fitted using 12-point moving average shows that the monthly average real FOB prices (in US\$) are steadily declining with a greater rate than the nominal counterpart.

*Scenario 3: In Rs. (nominal):* The direction of the coefficient of time variable of the double log model, which best explained the time trend, showed a marginal increase in nominal price (Rs.) of fresh coconuts. This marginal increase while the FOB in US\$ is declining, is largely due to continuous depreciation of Rupee against dollar.

*Scenario 4: In Rs. (real):* An insignificant decrease in real price (Rs.) was observed.

The study concluded that although the exports of fresh coconuts have steadily increased by 52% from 1997 to 2001, the exports as a percentage of national nut production are still less than 1 % of total nut production. So, the contention that increasing export tax on fresh coconuts can be used as a strategy to make nuts abundant to the local industries is not realistic. However, the more pertinent concern may be the price considerations. First, the FOB price in Dollars (both nominal and real) is declining indicating world price for our fresh coconuts during the analyzed period is declining. Second, the FOB price in Rs. (nominal) is increasing only marginally despite the continuous depreciation of the Rupee against the dollar while the FOB price in Rs. (real) has shown a declining trend, albeit small. These raise the issue whether it worthwhile to export fresh coconuts at the prevailed prices.

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### **Study 27.2 : The tariff policy liberalization in the edible oil market and its implications on the welfare of primary coconut producers**

The trade liberalization in the edible oil market in Sri Lanka was introduced in the early eighties by granting of tariff concessions and thereby permitting the importers to import different edible oils in large quantities. When these edible oils are present in the market at a relatively cheaper rate, which are known to be free from cholesterol formation, the consumers may substitute such edible oils to coconut oil leading a lower demand for coconut oil. This can adversely influence the domestic coconut oil milling industry, which has been badly affected due to various other reasons, such as low export demand for coconut oil, views associated with cholesterol formation etc.

The coconut industry as a whole forms related markets, where there are direct and indirect linkages in production and consumption. Once the coconut oil industry has lost its competitiveness, it directly influences the fresh coconut production sector as the input demand created by the coconut oil industry declines. This is evidenced by the proportion of fresh coconut utilization in the coconut oil milling industry during the past decades. It has utilized 32% of the total annual fresh coconut production in 1978, whilst in 1998 it has only utilized around 13% of the production, whereas the total coconut production remain more or less similar in quantity (Coconut Statistics, 1978,1998).

Conversely, the coconut growing industry comprises a large number of small-scale resource poor growers who earn their living by coconut cultivation and related activities. Therefore, many of the development programs in the domestic coconut sector have been focused on the welfare improvement of the primary producer. However, the profits gain by these development programs can be outweighed if any adverse implication occurred in any of the related coconut market is transmitted to the primary coconut producer. This study attempted to investigate the repercussions of the trade liberalization in edible oil market on coconut producer sectors focusing mainly on the welfare change of the fresh coconut producers.

The objective of the study was achieved using a coconut market simulation model, which consists of 13 endogenous variables including supply, demand, producer price and consumer price for fresh coconut, desiccated coconut and coconut oil markets. The model is validated using standard criteria and accepted as satisfactory for policy analysis purpose. The values of endogenous variables were predicted treating import tariff on palm kernel oil was

zero, over the period from 1978 to 1999. The palm kernel oil was specifically selected, since it has similar uses as coconut oil and has been imported in large quantities during the past two decades. According to the results of the policy simulation and the producer surplus calculation, it is clear that the tariff concessions given in the edible oil market has notable implications on coconut producer sectors.

**Table 23.** Results of the zero tariff policy simulation on production, and producer prices of the coconut markets at the mean of the sample (1978-1999)

Market	Variable	Unit	Mean at the base simulation	Predicted change for Zero tariff policy shock
Fresh Coconut	Supply	Mill. Nuts	2456.04	2439.03 (-0.6)
	Producer Price	Rs/'000 nuts	2.597	2.591 (-0.23)
Coconut oil	Supply	Metric tons	67667.30	62321.60 (-7.9)
	Producer Price	Rs/MT	19.31	16.76 (-13.2)
Desiccated coconut	Supply	Metric tons	50850.70	50895.30 (+0.1)
	Producer price	Rs/MT	18.83	18.5 (-1.8)

Figures in the parenthesis are the percentage changes from the mean base value.

Note: all the prices are deflated values by the price index

**Table 24.** Changes in producer surplus of the fresh coconut market due to the trade liberalization in edible oil market (1978-1999) in million Rupees

		Producer surplus at the base	Producer surplus at policy liberalization on edible oils	Change in the producer surplus
Fresh Market	Coconut	7639.79	7626.08	- 13.71

It is clear that the changes occurred in the coconut oil market due to the tariff policy liberalization on edible oil market has indirectly influenced the fresh coconut market as well. The producer price for fresh coconut declines by 0.23% while the fresh coconut supply declines by about 0.6% in response to the trade liberalization in edible oil market. Based on the annual average coconut production figure, which is around 2500 million coconuts, the reduction in fresh coconut supply is about 15 million nuts.

The producer surplus analysis implies that there is a welfare loss for fresh coconut producers due to the trade liberalization policy in edible oil market. This loss accounts Rupees 13.71 million per year on average for the period of 1978-1999. This can make a depreciation of the set objectives of the development programs such as subsidy on cultivation, and other institutional policy measures that has been implemented to enhance the welfare of the primary coconut producers. Therefore, the welfare gain of these different policy devices needs to be high enough to compensate the welfare loss occurred by such

indirect implications of other policy instruments alien to the coconut markets, to achieve the desired objectives in the coconut producer sector.

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<sup>1</sup> *Dep. Of Agricultural Economics, Faculty of Agriculture, University of Peradeniya*

### **Study 27.3 : Analysis of the factors influencing the aggregate fertilizer consumption in the coconut sector**

The use of chemical fertilizers on perennial plantation crops has been widely accepted as one of the most effective strategies to enhance the outputs in the short run. The responsiveness of coconuts to chemical fertilizer application and the profitability on the investment has been proven by a number of studies carried out by several researchers. Recognizing the importance of chemical fertilizer use on enhancing the yield of coconut, the government implemented a program on fertilizer subsidies effective on the coconut sector as earlier as in 1956 and continued until late 1970's. Thereafter the scheme was integrated into the general fertilizer subsidy scheme. However, the introduction of open economic policies in 1978 instigated crucial changes in the general fertilizer subsidy policy implemented by the successive governments.

The fertilizer use in the coconut sector accounted only 6% of the total fertilizer consumption in the country in the year 1999 (National fertilizer secretariat, 2000). According to recent statistics, the coconut growers have used only 16% of the total recommended fertilizer requirement of the sector in the year 2000 (Coconut Statistics, 2000). Hence, the rate of inorganic fertilizer application on coconuts has not been properly maintained.

The use of fertilizer as an agro-input would primarily be an economic decision, which depends on the return from fertilizer at any time. Most of the coconut small holders are resource poor and not in a position to intensify coconut cultivation by using costly inputs like fertilizer even though the coconut estate owners still prefer investing on chemical fertilizers to enhance the output. Nevertheless, the removal of subsidies on inorganic fertilizers and the predominance of the smallholdings in the domestic coconut sector may prevent any increasing amount of fertilizer application on coconuts. Therefore, this study was designed to analyse the fertilizer demand in the domestic coconut sector and to identify the salient factors influencing the fertilizer consumption on coconuts.

The input demand function for coconut fertilizer was specified and estimated using appropriate econometric techniques. The study period was 1978- 2000. This period was purposively selected for the study to investigate the fertilizer consumption patterns in the coconut sector under the open economic situation prevailed in the country. Table 25 gives the estimated results of the regression.

**Table 25: Regression results of the fertilizer demand in the coconut sector**

Variable	Co-efficient	Std. Error	t - statistic	Probability
Price of Fertilizer	-0.457 **	0.143	- 3.19	0.001
Price of Coconuts	0.466 **	0.137	3.38	0.001
Quantity of Rainfall	0.527 **	0.228	2.31	0.021
Time trend	-0.009 *	0.005	-1.82	0.060
Constant	7.10			

$R^2 = 0.88$       Adjusted  $R^2 = 0.85$

Durbin Watson = 1.77

\*\* - Significant at 5% level

\* - Significant at 10% level

According to the results (Table 25), the fertilizer users in the coconut sector have significantly responded to the fertilizer price changes. This suggests the increase in coconut fertilizer price significantly reduces the quantity of fertilizer use in the sector. The demand elasticity of fertilizer with respect to fertilizer price is computed as  $-0.46$ . This value indicates that for a ten percent increase in the fertilizer price, the quantity of fertilizer consumption in the coconut sector decreases by 4.6 percent.

Also the price of coconut is one of the determining factors for the grower to use fertilizer on coconut. A remunerative price for coconuts is undoubtedly a positive factor for the coconut grower to use more fertilizers, expecting a better output in the coming year. Therefore, the price received for coconuts should compensate the cost incurred on fertilizer application on coconuts, while keeping profit margins to the grower. It is clearly denoted by the elasticity value of fertilizer use with respect to the output price, which is 0.46. The value indicates that for a ten percent increase in the producer price of coconuts, the fertilizer use in the coconut sector increases by 4.6 percent.

The availability of rainfall is another significant factor that influences the growers' decision on fertilizer use on coconuts. Therefore, a favorable rainfall in major coconut growing areas may significantly enhance the coconut fertilizer demand. The estimated coefficient for the time trend was negative and significant at 10% level. This suggests that there is a significant negative trend in the fertilizer consumption in the coconut sector over time.

*S R Samarajewa*

#### **Study 27.4 : Analysis of consumer demand for fresh coconuts in Sri Lanka**

The average annual per capita consumption of coconuts in Sri Lanka is about 110 nuts and it is considerably a higher number of nuts than any other coconut producing country in the world. The highest per capita consumption of coconuts as fresh nuts is observed in the rural sector of the country, consuming around 100 fresh coconuts per head per year (Central Bank of Sri Lanka, 1996). The Sri Lankan consumers spend 9 percent of their total food budget on fresh coconuts and coconut oil (Central Bank of Sri Lanka, 1997). Accordingly, coconuts and coconut oil have become the third most important food item in the consumer's food budget followed by rice and fish expenditures.

During the last two decades the food consumption patterns observed in Sri Lanka have been changing gradually. Despite, the coconut is considered as an essential food commodity in Sri Lanka and subsequently makes a strong domestic demand; the coconut

consumers' responses to the changes in the economic and other non-economic variables are yet to be determined. The understanding of the coconut consumers' responses for different demand influencing factors provides guidance on effective policy formulation for the coconut sector. Therefore, the objectives of this study were to identify the major factors influencing the demand for coconuts in Sri Lanka and to estimate the elasticity of demand for coconuts with respect to price and income variables.

Demand is a behavioral relationship that describes how much product will be purchased at different prices under a carefully designed set of conditions. The market or the aggregate demand for a consumer good is the sum of all consumer demands at given prices in a particular time period. Economic theory suggests that the important economic factors, which influence the demand for a particular commodity, are consumer per capita income and the price of that commodity relative to its complements and substitute goods. Based on these factors, the demand function for coconut consumers were specified and estimated econometrically using the data for the period from 1970 to 2000. Results of the estimation of the fresh coconut demand function are presented in Table 26.

**Table 26: Results of the Econometric Estimation**

Variable		Estimated coefficient	't' value	'p' value
Constant	$\alpha_0$	110.9	10.24	0.000
Own retail price	$\alpha_1$	- 3664.2**	- 3.88	0.000
Per capita income	$\alpha_2$	3.01**	2.00	0.045
Trend	$\alpha_3$	- 1.71**	-2.34	0.019

$R^2 = 0.83$ , Adjusted  $R^2 = 0.81$  DW = 1.89

\*\* Significant at 5% level

**Table 27. Estimated Elasticity Values of Coconut Demand in Sri Lanka**

	Elasticity value
Own price	-0.11** (-3.88)
Income	+0.38** (2.00)

Sample period -1970-2000

Figures in parenthesis are the 't' values

\*\* Significant at 5% level

The estimated results revealed that the retail price of coconuts is a significant variable, which alters the individual consumer's demand schedule and subsequently determines the aggregate quantity of coconut demand in Sri Lanka. The own price elasticity of coconut demand was calculated as - 0.11 and it is a highly inelastic value closer to zero. This implies that for a one percent change in retail price of coconuts, the consumer changes his demand only by 0.1 percent implying that the coconut consumers do not reduce their coconut consumption in a notable amount in case of a price increase. This suggests the coconut is an essential food commodity for the people in Sri Lanka.

The consumer's per capita income was also a significant variable, which determines the demand for coconuts in Sri Lanka. The income elasticity of coconut demand was calculated as 0.38, implying that for a one percent increase in consumer's income; the coconut demand increases by 0.38 percent. Thus the coconut behaves as a normal good for the consumer, where the demand rises when the consumer's incomes rises. The estimated coefficient for the trend variable, which was used as the proxy to indicate coconut consumers' tastes and preferences, was negative and significant at 5 percent level, indicating a significant negative trend in coconut consumption in Sri Lanka over the period of 1970-2000.

*S R Samarajeewa*

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

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

At each site, the existing farmer practices were compared with recommended practices. The plots were generally above 0.5 ha.

The effect of factors such as planting materials, fertilizer, husk burial, mulching, irrigation and different types of perennial and seasonal intercrops (cocoa, coffee, pepper, rambutan, cashew, lime, mango, grafted durian, pineapple, passion fruit, banana, papaya and yam etc.) are being compared. Agronomic and socio-economical data from each experiment site were collected during the year.

Operations in 116 sites, out of the intended 125 sites have been commenced covering 15 administrative districts.

Results are summarized as follows.

##### **a) Coconut**

Tall x San Raman (TSR) variety was tested widely in different agro-ecological regions along with Tall x Tall (TxT). Initial growth of TSR was better than TT in almost all the regions tested.

Coconut seedlings planted into 10 m x 7 m spacing were intercropped with four rows of cinnamon (1.3 m x 1.0 m spacing) showed that growth of coconut seedlings was unaffected in the Southern region.

Nut yield of coconut in shallow-boralu soils (S<sub>5</sub> lands) was improved from 5000 nuts/ha to 6600 nuts/ha/yr within two years of intensive cropping with pineapple and banana (Site: Mr. A V L Jayawardena, Kotadeniyawa). This was an indication that low yielding coconut plantations would be improved by systematic intercropping with improved management systems.

The effect of irrigation vs no irrigations for adult coconut palm in Kurunegala district was tested in land of Mr. N Kabral. The nut yield improvement in irrigated coconut was 36% over no irrigated coconut.

b) Banana var: 'Israel Kavendish' produced average of 20 kg/bunch in several crop models (eg. Ms. K Gnathana, Kegalle, Mr. N. V. Wickramasena, Weligama). Application of 1 1/2 dose of recommended banana fertilizer mixture increased banana yield by 24% over plants had recommended fertilizer dose.

Pineapple prices prevailed high during the year (Rs. 20-45 per kg of fresh weight) hence crops models with pineapple returned to growers good income (Rs. 220,000/ha/yr).

Cinnamon established with young coconut reached first harvest within 2 1/2 years (site: K Kariyawasam, Elpitiya). The first yield was 375 kg per ha. Planting cinnamon in coconut lands into 1.3 m x 1.0 m spacing observed better than the spacing of 1.3 x 0.6 m.

Yield of pineapple in models of Galle, Matara and Kegalle was almost equal to yield at Gampaha (average weight per fruit was 1.2 - 1.6 kg).

Intercropping orange in coconut lands having deep soils (Ambilipitiya, Mihintale) showed promising. Application of organic fertilizers appeared over come several unknown disorders of orange too. Grafted orange reached to bear within 3 years (site: S. Siriwitenevasam, Ambilipitiya).

Bud-grafted cashew showed promising for coconut lands in Matara, Hambantota, Anuradapura, and Kurunegala districts. Farmers prefer grafted cashew due to easy establishment, early flowering and low management cost.

The project is in progress.

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### **3.2 Fuel Wood Plantation Project: Pallama Seed Garden, 1998 (IL<sub>1</sub>/S<sub>5</sub>) -CESS Project**

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<sub>4</sub> and S<sub>5</sub> are the most suitable for planting NFT's and this will be generated additional income to the grower.

At present, fuel wood plantation is covered 18 hectares with 30,000 and 5,000 gliricidia and acacia trees respectively. The production details are given in Table 28.

50, 340 kg of gliricidia sold to Haycarb Ltd. at the rate of Rs. 2/- per 1 kg/at 20% moisture level.

It was noticed that large number of coconut growers are now interested for planting gliricidia for this purpose, hence several extension programmes were carried out.

The project is in progress.

*H A J Gunathilake and H G Wasantha*

**Table 28:** *Production details of fuel wood plantation , Pallama Seed Garden.*

<b>Item</b>	<b>Number</b>
Number of harvest during the year	1
Wood yield per tree/yr	4.2 kg
Total wood yield	50340 kg
Total income	Rs. 64,626
Net profit	Rs. 29,100

### **3.3 Developing Sustainable Coconut-based Income Generating Technologies in Poor Rural Communities (funded by the ADB)**

Three communities (i.e. Coconut fibre (white) producing community, Coconut bract handicraft producing community & Coconut-based livestock farming community, located respectively in the Southern Province and North Western Province in Sri Lanka) were selected for the deployment of project activities to develop and disseminate sustainable coconut-based income generating technologies under the project on "Developing Sustainable Coconut-Based Income Generating Technologies in Poor Rural Communities in Sri Lanka".

Community Based Organizations (CBOs) was formed for the implementation of project activities. The three CBOs were registered as "*Ththiripitigama* Entrepreneurship Development Society" (TEDS), *Dodanduwa* Women's Collective (DWE) and Women's Savings Effort (WSE) respectively in three communities above.

During the reporting period major emphasize were given on formation and restructuring of CBOs, training CBO members and officers and intercropping and livestock production programs.

Development of skills on entrepreneurship was given priority, as cottage industries in the poor communities are not market oriented. Training on Development of entrepreneurship was arranged for WSE. The trainings on high value coconut based products were arranged in all three CBOs during the reporting period. The trainings include, door mats making, brooms and broomstick production and coconut bracts (stipule) handicraft making.

Two trainings on coconut nursery management in Coconut-based livestock farming community and Coconut bract handicraft producing community were held followed by establishing coconut nurseries, each with 1000 nuts. The program to plants at least 5 seedlings per the participant of the project has already commenced with seedlings produced through the community-managed nurseries. Distribution of high value coconut var. (*Dikiri Pol*) was also initiated during the reporting period. Trainings on livestock keeping (cattle, goats & poultry) were arranged in 3 three communities followed by loan out 15 cattle and 55 goats. Plants for intercropping were loan out for farmers as the multiplication stock. The on going projects on intercropping and pasture evaluation were coupled with the poverty reduction project.

Market survey of the livestock farming community and Coconut bract handicraft producing community have been completed. During the reporting period, the product development and market promotion for bract handicrafts were initiated.

The project is in progress.

*A D Samarajeewa, M J I Costa, R Marasinghe,  
W R O Fernando*

**Project: 3.4            Improvement of the productivity of the coconut soils through Vermi-culture Technology (CARP funded)**

**Experiment 3.4.1:    Effect of vermi-compost on growth of plants (Bioassay)**

A bioassay was done to evaluate the effect of vermi-composts on plant growth along with the other material of wormy-tech origin such as vermi-wash, vermi-casts etc., before test it with coconut seedlings.

Tomato seedlings were used as the test plant for the bioassay. Following treatments were imposed.

- T1- Soil only
- T2- Soil with inorganic fertilizer
- T3- Soil with bio composts
- T4- Soil with vermi-compost
- T5- Soil with vermi-compost and worms
- T6- Soil with vermi-casts
- T7- Soil with vermi- wash

Inorganic fertilizer (T2) was added according to the plant requirement. Organic materials were added equivalent to the inorganic fertilizer added to T2.

**Table.29**      *Effect of different material of Vermi-tech Origin on growth of Tomato plants*

Treatment	Plant Height (cm)	Leaf Area (cm <sup>2</sup> )	Root Dry Weight (g)	Shoot Dry Weight	Shoot/Root
T1- Soil only	22.6	60.0	0.07	0.23	3.2
T2- Soil with inorganic fertilizer	35.3	278.5	0.08	0.76	9.6
T3- Soil with bio composts	54.4	289.7	0.16	1.30	8.0
T4- Soil with vermi-compost	57.2	437.7	0.20	1.89	10.1
T5- Soil with vermi-compost and worms	60.5	570.9	0.29	2.42	8.5
T6- Soil with vermi-casts	36.9	58.4	0.09	0.44	4.8
T7- Soil with vermi- wash	20.5	53.5	0.05	0.21	3.9
Significance	***	***	***	***	***
LSD	4.6	65.3	0.03	0.17	1.1

\*\*\* P > 0.001

There is a significant difference ( $P>0.001$ ) among treatments. Plants grown in the media with vermi-compost ( $T_4$ ) and vermi-compost plus worms ( $T_5$ ) showed the enhanced growth in comparison to other treatments, indicating the positive effect of worms on plant growth.

### Chemical characteristics of different vermi-products Vs bio-composts

**Table 30:** Chemical characteristics of different vermi-products Vs bio-composts

Property	Vermi-compost*	Vermi-wash	Vermi-casts	Bio-compost
O.C (%)	39.3	0.03	5.4	50.4
pH	7.99	6.60	7.67	7.83
E.C (us)	226.5	337.3	49.8	241.6
Total Nitrogen (%)	1.02	0.02	0.48	1.23
N-NO <sub>3</sub> (mg/kg)	364.2	-	0.63	449.5
N-NH <sub>4</sub> (mg/kg)	14.42	-	12.73	36.10
P(%)	0.132	Trace	0.015	0.101
K(%)	0.34	0.46	0.05	0.52
Mg(%)	0.149	0.02	0.074	0.153
Ca(%)	0.339	0.079	0.083	0.285
Na	0.02	0.042	0.012	0.048
Fe (mg/kg)	750	1.09	790	727.5
Mn (mg/kg)	134	3.31	189	107.25
Cu (mg/kg)	6.25	0.165	9.75	5.5
Zn (mg/kg)	36.25	0.115	13.5	31.25

\* Excluding worms

Higher content of micro nutrients were shown in vermi-compost in comparison to bio compost. Low content of O.C and Nitrogen in vermi-compost may be due to assimilation by worms, which will be recycled to the substrate when worms die.

### Biological properties of Vermi-compost in comparison to bio-compost

**Table 31.** Biological properties of Vermi-compost vs bio-compost

Material	Rate of CO <sub>2</sub>	Total plate count	
	evolution ( $\mu\text{g}\cdot\text{g}^{-1}\cdot\text{hr}^{-1}$ )	(per gram of material)	
		Bacteria	Fungi
Vermi-compost	$0.038 \times 10^6$	$54 \times 10^5$	$15 \times 10^4$
Bio compost	$0.088 \times 10^6$	$52 \times 10^5$	$10 \times 10^4$

Total bacteria and Fungi count was found to be higher in vermi-compost in comparison to bio compost. But rate of CO<sub>2</sub> evolution, which is an indication of the biological activity, was found to be higher in bio compost showing some inconsistency of two parameters. This will be further investigated.

The project is in progress.

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<sup>1</sup> Soil and Plant Nutrition Division

#### 4. MISCELLANEOUS STUDIES

##### 4.1.1 Demonstration Farm, Tabbowa, Nattandiya.

Total extent of 2.5 ha of farm is being managed on a self-financing basis to demonstrate improved cultural practices in coconut cultivation and to increase productivity of lands by intercropping selected crops such as cinnamon, pepper etc.

During the year, 10,554 coconut seedlings were issued and received Rs. 345,285.00 as an income. Using the income, several infrastructure development activities were completed eg: fencing, improvement of buildings and irrigation facilities.

Several groups from various agricultural training schools and coconut growers visited the farm.

**Table 32. Annual Income and Expenditure of Demonstration Farm, Tabbowa**

Income			Expenditure	
Item	Quantity Nuts/Seedlings	Value Rs.	Item	Value Rs.
a. Sale of coconut	25073	289,509.21	a. Labour	266,240.38
b. Sale of coconut seedlings			b. Other materials	106,047.80 11,441.00
Poly bagged T x T	1641	73,845.00	c. Electricity	277,249.67
D x T	190	8,550.00	d. Seednuts	
R.D	10	450.00		
K.C	70	3,150.00		
Bare rooted T x T	7886	236,580.00		
D x T	753	22,590.00		
	4	120.00		
C. Sale of other crops		27,296.70		
Total Income		662,090.91		660,978.85
Profit: Rs. 1112.05				

H A J Gunathilake and R A Swarnathilake

## 4.2 Animal Breeding Programs

An animal-breeding programme at Ambakelle, Makandura and Pothukulama is being continued to provide improved breeds of buffalo and goats for coconut growers.

During the year 86 goats were maintained as a parent breeding stock.

Place	Breed	End of 2001		End of 2002		Sold in 2001	
		F	M	F	M	F	M
Makandura	Moora	16	10	14	15	-	3
Ambakelle	Moora	19	14	20	10	-	4
PRS	Sri Lankan	21	82	66	20	23	-
	Boer						

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# REPORT OF THE GENETICS AND PLANT BREEDING DIVISION

Head - J M D T Everard M.Sc.

## 1. General

The year, 2002 mark a milestone in coconut breeding research in Sri Lanka. The much debated, discussed and solicited germplasm importation became a reality through mediation of the Coconut Genetic Resources Network (COGENT) and financial assistance of the CESS fund. Four promising Indian coconut varieties, West Coast Tall, Laccadive Ordinary Tall, Andaman Tall and Banawali Round Dwarf were brought to the country as *in-vitro* cultured embryos.

The routine experiments on genetic evaluation of existing cultivars and crosses among locally available germplasm were continued with a few restrictions due to financial constraints faced by the institute.

The year 2002 has been a bad year for all field experiments because of the severity of drought in consecutive years, 2001 and 2002 throughout the country. The substantial drop in coconut yields all over the country was reflected in the field experiments. The inter-varietal hybrids continued to outperform pure tall cultivars in all the sites even with relatively low yields resulted from drought. The nine-year average of yield, which was a better indicator of the genetic potential of cultivars, elucidated the superiority of *dwarf green x tall* over all the other cultivars.

The evaluation of progenies arising from *tall x tall*, *tall x dwarf green* and *tall x san ramon* at Bandirippuwa and Ratmalagara sites were fully investigated by recording individual palm yields and analysing fruit components in a sample. Here again the progeny of *tall x dwarf green* outperformed the other crosses. The performance of the hybrid *dwarf green x san ramon* at the Daisy Valley (Mawathagama) was remarkable as the hybrid appears to possess both high yielding character as well as high copra per nut. This promising performance of *dwarf green x san ramon* lead us to initiate a pollination programme to produce *dwarf green x san ramon* in sufficient quantities to establish evaluation trials in farmer fields for further justification of this variety before releasing as an improved cultivar. Conservation of coconut germplasm was continued with proper maintenance of all field gene banks and collection of characterization data. Eleven more new accessions were planted in the gene bank at Pallama Seed Garden.

DNA based studies for enhancement of the coconut breeding programme was continued with a long term study proposed for mapping the coconut genome. Investigation of the presence of phytoplasma in Coconut Rapid Decline (CRD) affected palms was continued with the consultative assistance of FAO.

## PROGRESS OF RESEARCH

**Project:** EVALUATION OF EXISTING CULTIVARS (1983/86)

**Experiment 12.1.1** Evaluation of five improved cultivars; *dwarf green x tall (CRIC65)*, *dwarf yellow x tall (CRIC65)*, *tall x tall (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	1983	Loamy sand	Wet intermediate
12.1.2	Thammenna	1983	Latasol	Dry
12.1.3	Palugaswewa	1985	Sandy clay loam	Dry intermediate
12.1.4	Suriyapura	1986	Lateritic gravel/ clayey	Wet

The experiment at the two sites, Bandirippuwa and Thammenna are comparable as they both commenced at the same year. However, the yield data at the Thammenna site was not recorded during the year due to budget constraints. Further the yield records of the palms at other two sites, Palugaswewa and Suriyapura too were not recorded during the year for same reason. These three sites were maintained as observational blocks during the year and it is hoped to commence collection of yield data from year 2003 onwards. It should be noted that the maintenance of the two sites Thammenna and Palugaswewa were far below the standard. Weeding and mulching was hardly attended and still a substantial number of old palms are remaining in these fields. In addition mite infestation was severe at the Thammenna site. Both these estates are currently maintained by the Chilaw Plantations (Pvt) limited.

The rainfall intensity and distribution and the coconut yields (nuts/palm/year) of the five cultivars in these sites since 1993 are tabled below (Table 1). The average annual rainfall and its distribution over the 10-year period as expected, was evidently better at Bandirippuwa than Thammenna. The intensity of rainfall at Bandirippuwa was twice more than Thammenna while the number of wet days per year (125 against 42 days/year) was even more at the former site. Rainfall distribution despite being the crucial factor in determining the coconut yield the eight-year yield averages do not indicate such a drastic difference between the two sites. The yield gaps at the two sites between analogous cultivars, although significant do not show a marked difference matching to the 2-3 fold difference in the rainfall intensity and distribution, despite both these sites falling in the low rainfall regime in relation to water requirements of the coconut palm. The obvious reason for this is the deep moderately drained lateritic soil at Thammenna that own the better capacity to hold water for a much prolonged period of time than the loamy sand soil at Bandirippuwa. Nevertheless this observation will be pursued for few more years to see how palms react when the root system penetrate into more deeper and wider areas of soil in response to moisture stress as they grow in age.

The significant feature of these results is the consistently better performance of *dwarf x tall* hybrids (*dwarf green x tall* and *dwarf yellow x tall*) in comparison to pure *tall* cultivars in good and as well as bad years and more surprisingly in the worse year, 1998 at both sites. The same outcome was evident by the results of the progeny trials that will be discussed in a subsequent section of this report. This outcome strongly refutes the apprehension of the people, especially coconut growers that *dwarf x tall* hybrids are highly susceptible to moisture stress and unsuitable for planting in a wider scale as pure *tall* cultivars. At the same time this agrees with the popularity gained by *dwarf x tall* coconut hybrids worldwide judged by the preference of farmers for planting hybrids from 46% - 74% over the last three decades (APCC report, 2002).

The year 2002 has been a very adverse year for coconut production all over the country reporting a drastic drop in the national yield than the previous year. The yield drop in estates of the CRI was 47% comparing to 2001. This poor outcome was ascribed to the poor rainfall and a long dry spells intermittently occurred in the preceding years, 2000 and 2001. The same trend was seen in the yields of all cultivars at the site, Bandirippuwa where nut production was lowest ever in the nine-year period (10-18 years after planting) under observation. However, it is interesting to note that the nine-year average yield has not changed much by overall six, seven or eight-year averages beginning from the 10<sup>th</sup> year after planting (See Table 2). This authenticates the acceptance that average yield of six consecutive years as a more appropriate indicator of coconut yield in a particular variety/cultivar than the yield in a given point of time or a much shorter duration, a year or two etc. In view this recognition the respective yield potential of the five cultivars under average management with a planting density of 200 palms/ha can be presumed as *dwarf green x tall* (CRIC65); 73 nuts/palm year or 14,600 nut/ha/year, *dwarf yellow x tall* (CRIC65); 67 nuts/palm year or 13,400 nut/ha/year, *tall x tall* (CRIC60); 48 nuts/palm year or 9,600 nut/ha/year, *Moorck tall* (MT); 42 nuts/palm year or 8,400 nut/ha/year, and *plus palm tall* (PPT); 47 nuts/palm year or 9,400 nuts/ha/year.

**Table 1.** *Rainfall intensity (annual rainfall in mm) and distribution (number of wet days/year) and nut production (nuts/palm/year) of dwarf green x tall (CRIC65), dwarf yellow x tall (CRIC65), tall x tall (CRIC60), Moorck tall (MT) and plus palm tall (PPT) in the multi-locational evaluation of improved cultivars at the two sites, Bandirippuwa (BE) and Thammenna (TE) from 1994 - 2002.*

<b>Year/ years after planting</b>	<b>1994</b>	<b>1995</b>	<b>1996</b>	<b>1997</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>Eight -year mean</b>	<b>Nine -year Mean</b>	
<b>Site - Bandirippuwa</b>												
Rainfall (mm)	1905	1944	1739	1902	1998	2215	1687	1055	1687	1806	1792	
Wet days	140	135	128	140	130	126	110	87	108	125	123	
	<b>Cultivar</b>											
Nuts/	DGxT	101	70	67	46	47	103	78	89	43	75	75
Palm/	DYxT	83	61	65	45	57	88	71	76	35	68	65
Year	TxT	51	47	48	32	32	63	64	64	29	50	48
	MT	39	45	42	32	30	51	55	52	29	43	42
	PPT	50	50	44	34	34	56	60	59	32	48	47
<b>Site - Thammenna</b>												
Rainfall (mm)	875	1163	823	916	1009	1086	976	756		951		
Wet days	40	44	42	62	34	48	34	35		42		
	<b>Cultivar</b>											
Nuts/	DGxT	60	80	73	81	32	107	30	89	-	69	
Palm/	DYxT	39	63	65	71	32	81	35	72	-	57	
Year	TxT	28	46	51	46	20	45	26	49	-	39	
	MT	24	35	36	36	17	39	25	41	-	32	
	PPT	31	47	49	49	22	46	30	49	-	40	

**Table 2.** Average yields (nuts/palm/year and nuts/ha/year) of last six, seven, eight and nine consecutive years of the five improved cultivars, dwarf green x tall (CRIC65), dwarf yellow x tall (CRIC65), tall x tall (CRIC60), Moorck tall (MT) and plus palm tall (PPT) in the multi-locational evaluation of improved cultivars at the site, Bandirippuwa (1994 - 2002).

Cultivar		Six-year average yield (year 13-16)	Seven-year average yield (year 12-18)	Eight-year average yield (year 11-18)	Nine-year average yield (year 10-18)
DGxT	Nuts/palm/Year	73	75	75	73
	Nuts/ha/Year	14600	15000	15000	14600
DYxT	Nuts/palm/Year	67	68	65	67
	Nuts/ha/Year	13400	13600	13000	13400
TxT	Nuts/palm/Year	48	50	48	48
	Nuts/ha/Year	9600	10000	9600	9600
MT	Nuts/palm/Year	42	43	42	42
	Nuts/ha/Year	8400	8600	8400	8400
PPT	Nuts/palm/Year	47	48	47	47
	Nuts/ha/Year	9400	9600	9400	9400

*J.M.D.T. Everard, W.B.S. Fernando, M.H.L. Padmasiri and S. Mallawarachchi*

**Project: ON-FARM EVALUATION OF NEW CULTIVARS**

**Experiment 12.1.2 Evaluation of CRISL98 (tall x san ramon) under farmer conditions**

Production of CRISL98 (tall x san ramon) was continued by hand pollinating 51 tall palms at ISG with pollen collected and processed from san ramon palms at Bandirippuwa. The seeds were raised at ISG and issued to growers for planting one to two acre small blocks. In addition, these seedlings were also issued to adaptive trials of the Agronomy Division to assess their performance in a range of agro-climatic environments under various farming systems. For all these studies, the seedlings were sold at the rate of Rs. 60.00 per seedling.

A steady demand for the new release CRISL98 (tall x san ramon) was observed throughout and hence attempts were made to issue seedlings for small growers representing a wide range of agro-ecological zones. However, some stocks that matured during dry spells had to be issued for large scale growers to avoid congestion in the nursery. During the year, 2803 seedlings were issued for planting in 29 farmer plots. Two plantations were also established at CRI estates Duncannawa and Bandirippuwa as observational blocks. A complete list of all growers (other than adaptive trials of the Agronomy Division) who established CRISL98 since the inception of this programme is attached as an affix to this report.

*J.M.D.T. Everard, S. Mallawarachchi and S.A. Chandrasiri*

**Experiment 12.1.3 Evaluation of Ambakelle special under farmer conditions**

Ambakelle special seeds raised for on-farm evaluation were badly affected by *Plesispa reichei* and hence no issues were made during the year.

*J.M.D.T. Everard and S. Mallawarachchi*

#### **Experiment 12.1.4 Evaluation of dwarf green x san ramon under farmer conditions**

The promising cross *dwarf green x san ramon*, now under evaluation at the Daisy Valley estate Mawathagama was also decided to test under farmer conditions. Hand pollination of 100 *dwarf green* palms at ISG by *san ramon* pollen was commenced for production of *dwarf green x san ramon* seedlings.

*J.M.D.T. Everard, S. Mallawarachchi and S.A. Chandrasiri*

**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)**

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

*L. Perera, J.M.D.T Everard, M.H.L Padmasiri and R. Jayatillke*

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

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

**Location :** ISG Ambakelle **Agro-climatic zone/soil type :** Dry intermediate zone;

This assessment of full sib families was established to evaluate the performance of the progeny of palms selected from fields 1 and 2 of the ISG based on consistency in giving high yields for over 18 consecutive years. This experiment however, suffered a severe set back at early stages of development due to high casualties of water logging. The nut productions as family means along with last 6-year averages are given in Table 7.

**Table 3.** Nut yields (nuts/palm/year) of the half sib families planted in field 11A/ISG arising from parents selected from Field 1 and 2 at ISG

Mother palm	Family Mean	Six-year average	Mother palm	Family mean	Six-year average
1.02	19	44	1.21	10	33
1.04	16	36	1.28	29	50
1.05	17	36	1.31	15	40
1.06	23	40	1.34	19	33
1.07	23	39	2.01	19	33
1.09	25	49	2.37	20	37
1.10	19	40	2.44	19	41
1.11	7	23	2.53	12	28
1.12	20	41	2.57	25	42

The yield has drastically dropped due to drought and it appears that this experiment is not giving the desired result i.e. identification of superior genotypes for drought resistance. The observed averages are far below the mark and even worse than unselected palms. This is probably due to the early set back in establishing the experiment due to heavy water logging in the field that lead to nearly 50% casualties and thereby masking the true genetic potential of the selected palms.

*J.M.D.T. Everard and M.H.L Padmasiri*

**Experiment 12.2/12.3 Crossing of selected palms at ISG with promising germplasm accessions (1993)**

Progeny of four crosses between *Ambakelle tall* and high yielding germplasm accessions *Moorock tall* and *St Anne's tall* and putative drought tolerant accessions *Kasagala tall* and *Debarayaya tall* and *Ambakelle special* as a control were established in five different locations to test the vigor giving special reference to yield stability and drought tolerance.

**Design:** Five Randomized blocks with a replicate of each cross. Plot size = 12.

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

The measurement of growth was completed in locations and the early growth failed to reveal significant differences among crosses for any of the growth parameters measured including physiological and biochemical indicators of vigour and drought tolerance.

Flowering has initiated in all the sites and the percentages of flowering of crosses are given in Table 4.

**Table 4.** *Cumulative percentage of flowering in progeny of the five crosses planted at Siringapatha, Melsiripura and Girtland since four years of planting (since 1999)*

Cross/Site	Girtland				Siringapatha				Melsiripura			
	99	00	01	02	99	00	01	02	99	00	01	02
Year												
Years after planting	4	5	6	7	4	5	6	7	4	5	6	7
<i>Tall x Moorock</i>	5	5	5	10	-	4	16	28	2	19	31	38
<i>Tall x Deberayaya</i>	2	2	7	10	-	-	17	20	-	15	37	53
<i>Tall x Kasagala</i>	-	2	4	5	-	-	2	17	2	18	37	48
<i>Tall x St. Anne's</i>	-	5	17	22	-	-	3	13	-	17	24	37
<i>Ambakelle special</i>	2	5	8	13	-	-	7	18	2	15	17	34

*L. Perera, M.H.L Padmasiri, W.B.S Fernando, G.K Ekanayake and S. Mallawarachchi*

#### **Experiment 12.7.3 Evaluation of dwarf green x Debarayaya tall**

Forty-eight seedlings of *dwarf green x Debarayaya tall* were planted with an equal number of *dwarf green x tall* (CRIC65) seedlings for comparison at Raddegoda estate Delwita in 1995. All seedlings are now in flower from year 2004.

*J.M.D.T. Everard and G.K Ekanayake*

#### **Experiment B-8. 6 Evaluation of hybrid crosses utilizing local and exotic germplasm to test the potential for sap production (1997)**

Three hybrid crosses were established at Loling Estate, Halkandawila, Payagala in May 1997 in order to evaluate the progenies for sap production. The growth characters measured after three and half years from planting are summarized in Table 5. As an extension to this trial, 25 *Navasi*, 14 *Kamandala*, 25 *Andigama tall*, 39 *St. Anne's tall* and 33 *Tall x Debarayaya* along with 77 *tall x tall* (guard rows) seedlings were also planted.

**Table 5.** Total number of leaves, rate of leaf production/6 months, girth and height of seedlings planted at Loling Estate Payagala 42 months after planting

Cross	Number of seedlings measured	Total number of leaves	Half yearly leaf production
<i>Dwarf green x Ambakelle tall</i>	154	13	5
<i>Ambakelle special</i>	110	10	5
<i>Cameroon red dwarf x Ambakelle tall</i>	109	11	5
<i>Dwarf green x Debarayaya tall</i>	49	12	5

*J.M.D.T. Everard and N. Herath*

**Experiment 12.4 Selfing of F<sub>2</sub> palms at Bandirippuwa Estate and evaluation of F<sub>3</sub> progenies at Ratmalagara (1994)**

This experiment was established for comparing self and open pollinated progenies arose from *dwarf x tall* hybrids in order to assess the segregation of desirable traits in subsequent generations. Thirty-six F<sub>3</sub> families arose from selfed and open pollinated 18 F<sub>2</sub> palms were planted in a fully randomized fashion at the Ratmalagara Estate in November 1995. The leaf production was measured up to 60 months and the results are given in Table 6.

**Table 6A.** Mean number of split leaves up to 12 months of planting in F<sub>3</sub> families origin green x tall hybrids at the Ratmalagara Estate (1995)

F <sub>1</sub> Self Cross	F <sub>2</sub> Mother palm	F <sub>3</sub> Family by selfing/outcrossing	Planting Stage	One year after planting
222x222	4563	HP	2.33	5.20
222x222	4563	OP	2.86	5.33
125x125	4837	HP	3.29	5.88
125x125	4837	OP	3.50	5.69
125x125	4911	HP	4.25	6
125x125	4911	OP	3.20	5.79
125x125	4973	HP	2.56	5.64
125x125	4973	OP	2.86	6.20
144x144	4868	HP	3.60	6.67
144x144	4868	OP	3.00	6.17
144x144	4935	HP	3	5
144x144	4935	OP	2.17	4.00
144x144	4944	HP	2.44	4.20
144x144	4944	OP	3.3	6.0
144x144	4945	HP	2.33	5.75
144x144	4945	OP	2.62	5.40
144x144	4865	SP	3.67	4.75
144x144	4865	OP	3.25	5.46
148x148	4914	HP	5	6.5
148x148	4832	HP	-	5.5
148x148	4832	OP	4.2	-
148x148	4833	HP	3.60	6.28
148x148	4833	OP	3.50	6.00
226x226	4580	HP	2.67	5.25
226x226	4580	OP	3.10	5.20
226x226	4635	SP	5	5
226x226	4635	OP	2.25	4.25
226x226	4579	HP	3.5	5.5
226x226	4579	OP	3	5.5
132x132	4923	HP	3.15	5.89
132x132	4923	OP	2.11	5.82
157x157	4917	SP	3.69	5.78
157x157	4917	OP	2.45	4.25
158x158	4677	HP	2.7	-
158x158	4677	OP	3.33	4.67

**Table 6B.** Mean number of new leaves up to 60 months of planting in  $F_3$  families originated from dwarf green x tall hybrids at the Ratmalagara Estate (1995)

$F_1$ Self Cross	$F_2$ Mother palm	$F_3$ Family by selfing/ outcrossing	One year after planting	Two years after planting	Three years after planting	Four years after planting	Five years after planting
222x222	4563	HP	2.40	3.00	2.75	3.25	3.50
222x222	4563	OP	2.33	3.22	3.06	3.89	4.12
125x125	4837	HP	3.00	3.73	4.07	5.14	5.36
125x125	4837	OP	2.63	3.63	3.44	3.69	4.75
125x125	4911	HP	2.5	3.5	3.75	4	4.75
125x125	4911	OP	2.80	3.45	3.80	4.20	4.40
125x125	4973	HP	2.57	3.17	3.83	4.75	5.25
125x125	4973	OP	2.80	3.10	3.30	3.90	4.70
144x144	4868	HP	3.33	3.50	3.00	3.33	4.17
144x144	4868	OP	3.00	3.83	3.83	4.00	5.00
144x144	4935	HP	2	3.5	3.25	4	4.25
144x144	4935	OP	2.00	-	-	-	-
144x144	4944	HP	2.20	4.50	3.50	4.50	5.00
144x144	4944	OP	2.8	3.6	3.3	4.7	4.6
144x144	4945	HP	2.63	3.50	3.50	4.50	5.50
144x144	4945	OP	2.30	2.80	3.00	3.60	3.90
144x144	4865	SP	2.50	2.75	2.75	3.25	3.88
144x144	4865	OP	2.62	3.60	3.50	4.80	5.10
148x148	4914	HP	4	4.5	4	4.5	5.5
148x148	4832	HP	4	4.5	4.5	5	5.5
148x148	4832	OP	-	-	-	-	-
148x148	4833	HP	3.88	5.67	7.38	9.00	10.50
148x148	4833	OP	3.33	3.00	3.00	4.67	5.00
226x226	4580	HP	2.75	3.25	2.25	3	3.5
226x226	4580	OP	2.40	3.13	3.38	3.75	4.38
226x226	4635	SP	2.5	4.5	3.5	4.5	6
226x226	4635	OP	1.75	3	2.75	3	3.5
226x226	4579	HP	2.5	3	4	5.5	5.5
226x226	4579	OP	2.5	3	2.5	2.5	4
132x132	4923	HP	2.44	3.39	3.17	4.00	4.72
132x132	4923	OP	2.82	3.08	3.08	3.58	4.08
157x157	4917	SP	2.56	3.75	3.75	4.63	5.00
157x157	4917	OP	2.50	3.67	4.00	4.25	5.00
158x158	4677	HP	-	-	-	-	-
158x158	4677	OP	2.67	4.00	2.75	3.25	4.25

**Table 6C.** Mean number of total leaves up to 60 months of planting in F<sub>3</sub> families originated from dwarf green x tall hybrids at the Ratmalagara Estate (1995)

F <sub>1</sub> Self Cross	F <sub>2</sub> Mother palm	F <sub>3</sub> Family by selfing/ outcrossing	Planting Stage	One year after planting	Two years after planting	Three years after planting	Four years after planting	Five years after planting
222x222	4563	HP	3.79	5.60	6.00	7.50	8.00	9.00
222x222	4563	OP	3.80	5.67	6.22	7.56	8.33	9.41
125x125	4837	HP	4.21	6.31	7.13	10.43	11.36	13.29
125x125	4837	OP	3.71	5.69	6.69	8.56	8.56	11.19
125x125	4911	HP	4.25	6	7.25	8.25	10	11.75
125x125	4911	OP	4.27	6.47	7.27	9.20	9.40	11.30
125x125	4973	HP	3.44	6.14	6.25	8.83	9.33	11.42
125x125	4973	OP	4.13	6.70	6.70	8.20	8.60	10.90
144x144	4868	HP	5	7	6.83	7.83	7.17	9.33
144x144	4868	OP	4.80	7.17	7.67	9.33	8.83	10.83
144x144	4935	HP	3	5	7	8.25	9.5	11
144x144	4935	OP	3.83	5.00	-	-	-	-
144x144	4944	HP	2.44	4.20	5.50	7.50	8.50	10.50
144x144	4944	OP	4.3	6.4	7.1	9.1	10.5	12.3
144x144	4945	HP	2.83	5.75	6.88	8.88	9.88	13.00
144x144	4945	OP	2.62	5.40	6.50	7.50	8.10	9.70
144x144	4865	SP	3.92	4.75	5.75	6.88	6.63	8.63
144x144	4865	OP	3.57	5.54	7.00	8.80	10.10	12.10
148x148	4914	HP	6	8	9.5	14	13	15.5
148x148	4832	HP	5	7.5	9.5	11	11.5	14.5
148x148	4832	OP	4.4	-	-	-	-	-
148x148	4833	HP	4.36	7.11	9.22	12.88	14.28	17.56
148x148	4833	OP	4.38	7.33	7.67	9.75	12.25	15.25
226x226	4580	HP	4	5.25	6.25	6.5	5.5	7.75
226x226	4580	OP	4.10	5.60	6.25	8.38	8.88	10.75
226x226	4635	SP	5	5	8.5	9	11.5	13
226x226	4635	OP	2.5	4.25	6.25	6.25	6.75	7.25
226x226	4579	HP	4	6	6.5	9	10.5	14.5
226x226	4579	OP	4.5	5.5	6.5	8	6	9
132x132	4923	HP	3.15	5.94	6.67	8.28	9.72	12.28
132x132	4923	OP	3.91	6.18	6.42	7.92	8.08	10.67
157x157	4917	SP	3.79	5.89	7.50	10.13	11.00	13.13
157x157	4917	OP	3.57	5.50	7.00	9.25	10.25	11.75
158x158	4677	HP	3.8	-	-	-	-	-
158x158	4677	OP	4.50	5.67	6.25	8.00	7.75	9.25

**Table 6D.** Mean petiole length up to 24 months of planting in F<sub>3</sub> families originated from dwarf green x tall hybrids at the Ratmalagara Estate (1995)

F <sub>1</sub> Self Cross	F <sub>2</sub> Mother palm	F <sub>3</sub> Family by selfing/outcrossing	Planting Stage	One year after planting	Two years after planting
222x222	4563	HP	32.07	67.00	50.75
222x222	4563	OP	32.20	63.90	58.94
125x125	4837	HP	28.29	53.50	46.47
125x125	4837	OP	24.21	52.19	46.69
125x125	4911	HP	33.25	67	45.625
125x125	4911	OP	29.91	59.07	46.41
125x125	4973	HP	23.06	44.71	47.75
125x125	4973	OP	28.63	63.90	57.70
144x144	4868	HP	27.40	70.00	49.83
144x144	4868	OP	28.40	72.83	67.00
144x144	4935	HP	53	64.5	51
144x144	4935	OP	33.33	54.00	-
144x144	4944	HP	30.67	35.20	55.25
144x144	4944	OP	27.8	71.1	55.9
144x144	4945	HP	28.50	50.63	51.00
144x144	4945	OP	31.85	58.10	51.80
144x144	4865	SP	29.75	43.13	44.56
144x144	4865	OP	24.00	52.85	50.20
148x148	4914	HP	28	60	51
148x148	4832	HP	17	51	44.5
148x148	4832	OP	40.4	-	-
148x148	4833	HP	26.82	54.11	56.72
148x148	4833	OP	32.50	75.00	51.50
226x226	4580	HP	20	41.75	37
226x226	4580	OP	32.20	51.80	55.75
226x226	4635	SP	42	44.5	58.5
226x226	4635	OP	23.25	41.25	43.5
226x226	4579	HP	45	93.5	76
226x226	4579	OP	30.5	77.5	54.75
132x132	4923	HP	29.38	63.61	49.14
132x132	4923	OP	24.45	60.27	50.42
157x157	4917	SP	33.14	65.00	51.38
157x157	4917	OP	29.21	42.50	49.50
158x158	4677	HP	25.2	-	-
158x158	4677	OP	33.25	64.33	71.63

**Table 6E** Mean girth up to 36 months of planting in  $F_3$  families originated from dwarf green x tall hybrids at the Ratmalagara Estate (1995)

F <sub>1</sub> Self Cross	F <sub>2</sub> Mother palm	F <sub>3</sub> Family by selfing/ outcrossing	One year after planting	Two years after planting	Three years after planting
222x222	4563	HP	21.40	34.00	41.00
222x222	4563	OP	22.71	36.22	51.44
125x125	4837	HP	18.31	31.63	57.71
125x125	4837	OP	17.56	29.63	46.00
125x125	4911	HP	21.25	31.75	58.75
125x125	4911	OP	23.60	34.05	56.10
125x125	4973	HP	15.07	26.50	45.75
125x125	4973	OP	18.00	29.55	43.90
144x144	4868	HP	22.83	31.00	49.83
144x144	4868	OP	23.17	36.67	54.33
144x144	4935	HP	22.75	32.25	53.25
144x144	4935	OP	12.00	-	-
144x144	4944	HP	12.80	32.50	47.00
144x144	4944	OP	22.8	39.9	67.0
144x144	4945	HP	19.25	34.13	58.50
144x144	4945	OP	20.00	29.95	49.00
144x144	4865	SP	17.00	24.13	33.63
144x144	4865	OP	18.77	31.40	55.00
148x148	4914	HP	25.5	41	71
148x148	4832	HP	24.5	44.5	76.5
148x148	4832	OP	-	-	-
148x148	4833	HP	19.44	34.83	58.00
148x148	4833	OP	23.67	32.50	36.50
226x226	4580	HP	14.25	24.75	29.5
226x226	4580	OP	18.20	27.00	46.13
226x226	4635	SP	15.5	31.5	57
226x226	4635	OP	14.25	24.5	36.75
226x226	4579	HP	22.5	57.67	76.5
226x226	4579	OP	25.5	39	54.5
132x132	4923	HP	22.33	36.78	57.50
132x132	4923	OP	21.91	35.92	52.17
157x157	4917	SP	23.22	40.25	70.13
157x157	4917	OP	15.75	28.33	58.25
158x158	4677	HP	-	-	-
158x158	4677	OP	18.67	28.00	51.00

**Table 6F.** Mean leaf length up to 24 months of planting in F<sub>3</sub> families originated from dwarf green x tall hybrids at the Ratmalagara Estate (1995)

F <sub>1</sub> Self Cross	F <sub>2</sub> Mother palm	F <sub>3</sub> Family by selfing/ outcrossing	Planting Stage	One year after planting	Two years after planting
222x222	4563	HP	81.50	105.80	161.50
222x222	4563	OP	91.47	104.71	168.00
125x125	4837	HP	68.86	82.81	143.40
125x125	4837	OP	71.86	81.25	140.03
125x125	4911	HP	74.25	100.75	153.25
125x125	4911	OP	75.91	94.53	154.55
125x125	4973	HP	63.56	66.07	130.00
125x125	4973	OP	74.63	90.40	137.75
144x144	4868	HP	72.25	111.00	157.17
144x144	4868	OP	63.00	117.67	178.83
144x144	4935	HP	92	95.25	176
144x144	4935	OP	77.83	78.00	-
144x144	4944	HP	67.78	53.60	149.00
144x144	4944	OP	74.1	112.5	175.0
144x144	4945	HP	75.67	77.63	157.75
144x144	4945	OP	85.15	85.80	146.20
144x144	4865	SP	76.08	71.63	120.25
144x144	4865	OP	67.79	83.46	167.20
148x148	4914	HP	70.5	138.5	238.5
148x148	4832	HP	58	122.5	182
148x148	4832	OP	84	-	-
148x148	4833	HP	84.73	90.89	149.67
148x148	4833	OP	90.50	113.33	161.00
226x226	4580	HP	60.67	72.75	122.25
226x226	4580	OP	86.10	84.40	150.00
226x226	4635	SP	91	85	168
226x226	4635	OP	57.25	65	122.5
226x226	4579	HP	112	120	177
226x226	4579	OP	98.5	125	147.5
132x132	4923	HP	106.69	112.89	188.50
132x132	4923	OP	69.36	106.73	173.00
157x157	4917	SP	83.93	117.22	195.88
157x157	4917	OP	73.79	70.50	123.67
158x158	4677	HP	80.0	-	-
158x158	4677	OP	102.25	104.33	159.00

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

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

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

<b>Crosses</b>	<b>Fertilizer levels</b>
tall x dwarf green (V <sub>1</sub> )	Recommended APM dosage (T <sub>1</sub> )
tall x tall (V <sub>2</sub> )	Half the recommended dosage (T <sub>2</sub> )
tall x san ramon (V <sub>3</sub> )	One and half the recommended dosage (T <sub>3</sub> )

**Treatments**

V <sub>1</sub> T <sub>1</sub>	V <sub>1</sub> T <sub>2</sub>	V <sub>1</sub> T <sub>3</sub>
V <sub>2</sub> T <sub>1</sub>	V <sub>2</sub> T <sub>2</sub>	V <sub>2</sub> T <sub>3</sub>
V <sub>3</sub> T <sub>1</sub>	V <sub>3</sub> T <sub>2</sub>	V <sub>3</sub> T <sub>3</sub>

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

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

<sup>2</sup> with *dwarf green x tall* and *dwarf green x san ramon* as additional varieties

Differential fertilizer application was commenced after 75% of the palms attained flowering at Ratmalagara and Bandirippuwa sites. Rest of the sites were used purely for testing progenies under different agro-climatic areas and soil types with average management. The nut yield during 1998-2002 at the two sites are given in Table 7 and Table 8.

**Table 7.** *Nut yield (nuts/palm/year) of the progenies, tall x dwarf green, tall x tall and tall x san ramon and three fertilizer levels at Bandirippuwa during 1996-2002*

Site	Bandirippuwa <sup>1</sup>						
Year	1997	1998	1999	2000	2001	2002	Six-year average
Years after planting	12	13	14	15	16	17	
Variety							
TxDG	47 <sup>a</sup>	41 <sup>a</sup>	97 <sup>a</sup>	74 <sup>a</sup>	78 <sup>a</sup>	30 <sup>a</sup>	61 (or 12,200 nuts/ha/yr)
TxT	30 <sup>b</sup>	40 <sup>a</sup>	54 <sup>b</sup>	61 <sup>b</sup>	51 <sup>b</sup>	25 <sup>b</sup>	44 (or 8,800 nuts/ha/yr)
TxSR	26 <sup>a</sup>	34 <sup>a</sup>	40 <sup>b</sup>	54 <sup>b</sup>	48 <sup>b</sup>	25 <sup>b</sup>	38 (or 7,900 nuts/ha/yr)
<b>Fertilizer level</b>							
T <sub>1</sub> recommended	35 <sup>a</sup>	41 <sup>a</sup>	62 <sup>a</sup>	67 <sup>a</sup>	60 <sup>a</sup>	25 <sup>a</sup>	48
T <sub>2</sub> half	25 <sup>b</sup>	35 <sup>a</sup>	57 <sup>a</sup>	58 <sup>b</sup>	56 <sup>a</sup>	28 <sup>a</sup>	43
T <sub>3</sub> one and a half	36 <sup>a</sup>	39 <sup>a</sup>	63 <sup>a</sup>	64 <sup>a</sup>	60 <sup>a</sup>	25 <sup>a</sup>	48

**Table 8.** *Nut yield (nuts/palm/year) of the progenies, tall x dwarf green, tall x tall and tall x san ramon and three fertilizer levels at Rathmalagara during 1996-2002*

Site	Rathmalagara <sup>1</sup>						
Year	1997	1998	1999	2000	2001	2002	Six-year average
Years after planting	12	13	14	15	16	17	
Variety							
TxDG	50 <sup>a</sup>	50 <sup>a</sup>	110 <sup>a</sup>	89 <sup>a</sup>	100 <sup>a</sup>	45 <sup>a</sup>	74 (or 14,800 nuts/ha/yr)
TxT	30 <sup>b</sup>	30 <sup>b</sup>	60 <sup>b</sup>	66 <sup>b</sup>	72 <sup>b</sup>	31 <sup>b</sup>	48 (or 9,600 nuts/ha/yr)
TxSR	29 <sup>b</sup>	33 <sup>b</sup>	57 <sup>b</sup>	68 <sup>b</sup>	68 <sup>b</sup>	34 <sup>b</sup>	48 (9,600 nuts/ha/yr)
<b>Fertilizer level</b>							
T <sub>1</sub> recommended	37 <sup>a</sup>	35 <sup>a</sup>	76 <sup>a</sup>	69 <sup>a</sup>	79 <sup>a</sup>	33 <sup>a</sup>	55
T <sub>2</sub> half	33 <sup>a</sup>	35 <sup>a</sup>	78 <sup>a</sup>	75 <sup>b</sup>	79 <sup>b</sup>	26 <sup>b</sup>	54
T <sub>3</sub> one and a half	38 <sup>a</sup>	39 <sup>a</sup>	74 <sup>a</sup>	78 <sup>b</sup>	82 <sup>b</sup>	39 <sup>c</sup>	58

The coconut yields of all the three progeny has been poor during the year and *tall x dwarf green* progeny has been the worst affected by drought at the Bandirippuwa site recording a 62% drop comparing to previous year and the corresponding yield losses of *tall x tall* and *tall x san ramon* has been 51% and 48% respectively at the same site. The average coconut yields at Rathmalagara was relatively better and in this site *tall x tall* was more affected by the drought recording a 57% drop comparing to previous year than *tall x dwarf*

green and *tall x san ramon* whose corresponding yield losses have been 55% and 50% respectively. Therefore, a definite variety x site interaction is evident. As expected the progeny *tall x san ramon* has been the least affected at both sites.

In spite of the poor performance of all the three progeny during the year 2002 as expected by poor coconut yields all over the country due to intermittent droughts in previous years *tall x dwarf green* remained superior at both sites recording significantly higher yields at both sites comparing to *tall x tall* and *tall x san ramon* both recorded similar yields at the two respective sites. The six-year yield averages clearly indicate the superiority of *tall x dwarf green* progeny at the two sites, Bandirippuwa and Ratmalagara recording an annual per palm yield of 61 and 74 respectively. The corresponding yields of *tall x tall* at Bandirippuwa and Ratmalagara are 44 and 48 nuts/palm/year respectively while analogue of *tall x san ramon* was 48 nuts/palm/year at both sites. The yield potential of *tall x dwarf green* as expressed by the six-year average, 14,800 nuts/ha/year has been substantial comparing to all coconut hybrids in the world.

Response to differential application of fertilizer was once again giving chaotic results by failing to respond aptly to differential application. Variety x level of fertilizer interaction was also not evident at both sites (Table 9). However, the impact of differential fertilizer application is expected to reflect on the yields with the age as the nutrients are becoming more and more demanding for the palms.

**Table 9.** Nut yield (nuts/palm/year) of the progenies, *tall x dwarf green*, *tall x tall* and *tall x san ramon* with three fertilizer levels at Bandirippuwa and Ratmalagara in 2001

Progeny	Fertilizer level	Nut yield at BE Nuts/palm/year	Nuts yield at RE (nuts/palm/year)
TxDG	Normal	31	39
TxT		23	26
TxSR		24	34
TxDG	Half normal	34	43
TxT		26	34
TxSR		26	34
TxDG	One and a half normal	26	49
TxT		21	34
TxSR		27	33

**Table 10.** Fruit components of the crosses tall x dwarf green, tall x tall and tall x san ramon at the two sites andirippuwa and Ratmalagara from 1998-2002.

Site:	Ratmalagara						Bandirippuwa					
	1998	1999	2000	2001	2002	5-year average	1998	1999	2000	2001	2002	5-year average
<b>Progeny: tall x dwarf green</b>												
Fresh weight	1457	1223	1373	1362	1489	1381	1433	1116	1243	1059	1089	1188
Husked nut weight	660	655	742	692	764	703	596	626	750	650	545	633
Split nut weight	489	502	544	531	567	527	444	490	551	500	432	483
Kernel weight	325	325	371	353	350	345	269	328	399	338	273	321
Estimated copra weight	211	210	237	221	244	225	191	200	240	208	174	203
<b>Progeny: tall x tall</b>												
Fresh weight	1397	1541	1587	1621	1476	1524	1677	1444	1554	1371	866	1382
Husked nut weight	749	810	870	841	697	793	682	816	887	818	584	757
Split nut weight	555	613	645	623	528	593	514	613	652	631	358	554
Kernel weight	351	380	419	407	318	375	311	397	433	404	233	356
Estimated copra weight	240	259	278	269	223	254	218	261	284	262	187	242
<b>Progeny: tall x san ramon</b>												
Fresh weight	1718	1873	1942	1913	1531	1795	2011	1851	1852	1640	1308	1732
Husked nut weight	892	943	996	889	747	893	779	951	1019	981	687	883
Split nut weight	646	690	838	660	543	675	581	728	731	729	498	653
Kernel weight	421	439	472	434	329	419	349	486	494	479	320	426
Estimated copra weight	285	302	319	284	239	286	249	304	326	314	220	283

**Table 11.** Productivity (kg/palm/year or Mt/ha/year) of the tall x dwarf green, tall x tall and tall x san ramon progeny at the two sites Bandirippuwa and Ratmalagara from 1998-2002.

Year	1998	1999	2000	2001	2002	Five-year average
Years after planting	13	14	15	16	17	
Variety						
Site	<b>Ratmalagara</b>					
<i>Tall x dwarf green</i>	10.55	23.10	21.09	22.10	10.98	16.65
Kg/palm/year	2.11	4.62	4.22	4.42	2.20	3.33
Mt/palm/year						
<i>Tall x tall</i>	7.20	15.54	18.35	19.37	6.91	12.19
Kg/palm/year	1.44	3.11	3.67	3.87	1.38	2.44
Mt/palm/year						
<i>Tall x san ramon</i>	9.41	17.21	21.69	19.31	8.13	13.73
Kg/palm/year	1.88	3.44	4.34	3.86	1.63	2.75
Mt/palm/year						
Variety						
Site	<b>Bandirippuwa</b>					
<i>Tall x dwarf green</i>	7.83	19.40	17.76	16.22	5.22	12.38
Kg/palm/year	1.57	3.88	3.55	3.24	1.04	2.48
Mt/palm/year						
<i>Tall x tall</i>	8.72	14.09	17.32	13.36	4.68	10.65
Kg/palm/year	1.74	2.82	3.46	2.67	0.94	2.13
Mt/palm/year						
<i>Tall x san ramon</i>	8.47	12.16	17.60	15.07	5.50	10.75
Kg/palm/year	1.69	2.43	3.52	3.01	1.10	2.15
Mt/palm/year						

The fruit components, fresh nut weight, husked nut weight, split nut weight and kernel weight and estimated copra weight (copra weight = 0.32 x husked nut weight) of the three progenies over the last five-years (1998-2002) is given Table 10. The drought has adversely affected all components of the fruit in the three types of progeny except in *tall x dwarf green* at Ratmalagara where an increase in the weights of all components was observed. It is unusual to note that the copra per nut in *tall x dwarf green* was higher than *tall x tall* and *tall x san ramon* at the Ratmalagara site. Nevertheless the five-year averages at both sites clearly indicate *tall x san ramon* (286g of copra/nut) as the producers of largest nuts followed by *tall x tall* (254g of copra/nut) and *tall x dwarf green* (225 g of copra/nut).

The overall copra out turn of the three progenies is given in Table 11. *Tall x dwarf green*, clearly demonstrate it's superiority in overall productivity of copra in spite of the low copra out turn per nut throughout the five years irrespective of good or bad (drought hit) years. The five-year average copra productivity of *tall x dwarf green* at Ratmalagara, 3.3 Mt of copra/ha/year under rain-fed conditions is a substantial outturn of copra under all standards. *Tall x san ramon* ranked second in both sites by copra productivity because its significantly higher per nut copra yield.

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The progeny trials at the other three sites are not satisfactorily progressing besides one at the Daisy Valley Estate, Mawathagama. The trials at NLDB farm, Andigama and Mangala Eliya Estate at Mundel are poorly managed. The yield records were not taken at these sites during the year. The trial at Daisy Valley is progressing well and the yields are given in Table 12.

**Table 12.** Nut yield (number of nuts/palm/year) of the progeny trials at Daisy Valley Estates (1987)

Year	2000	2001	2002	Three-year Average
Years after planting	13	14	15	
Cultivar				
<i>tall x dwarf green</i>	82 <sup>a</sup>	60 <sup>a</sup>	57 <sup>a</sup>	66 <sup>a</sup>
<i>tall x tall</i>	46 <sup>b</sup>	38 <sup>b</sup>	36 <sup>b</sup>	40 <sup>b</sup>
<i>tall x san ramon</i>	48 <sup>b</sup>	41 <sup>b</sup>	31 <sup>b</sup>	40 <sup>b</sup>
<i>dwarf green x san ramon</i>	78 <sup>a</sup>	57 <sup>a</sup>	53 <sup>a</sup>	63 <sup>a</sup>
<i>dwarf green x tall</i>	88 <sup>a</sup>	62 <sup>a</sup>	56 <sup>a</sup>	69 <sup>a</sup>

The yields remained almost the same in all the progenies except of the cross, *tall x san ramon* where a drastic drop was recorded than the previous year. However, progeny of both tall crosses, *tall x tall* and *tall x san ramon* recorded low yields comparing hybrid progeny. The progeny of *dwarf green x tall* and progeny of the reciprocal, *tall x dwarf green* were the best but *dwarf green x san ramon* too performed equally well.

The fruit components were analyzed for the first time in these progenies and the results were very promising (Table 13). Dwarf green x san ramon is showing great promise as a high producer of nuts as well as a high producer of copra with an average production potential of 3.75 Mt/ha/year. This indicates that the cross *dwarf green x san ramon* as the best

hybrid CRI has so far produced having the greatest potential for producing copra with a substantial number of nuts to satisfy varying needs of growers.

**Table 13.** *Nut yield (number of nuts/palm/year) of the progeny trials at Daisy Valley Estates (1987)*

	Fresh nut weight	Husk nut weight	Split nut Weight	Kernel weight	Estimated Copra weight	Copra production Kg/ha/year	Copra productio Mt/ha/yea
<i>tall x dwarf green</i>	1791	783	573	356	251	16.57	3.31
<i>tall x tall</i>	1816	832	603	366	266	10.64	2.13
<i>tall x san ramon</i>	2299	1012	720	441	324	12.96	2.59
<i>dwarf green x san ramon</i>	1884	931	632	374	298	18.77	3.75
<i>dwarf green x tall</i>	1685	762	551	345	244	16.84	3.37

Two observation trials established at Sirikandura (1989) with *tall x dwarf green*, *tall x dwarf yellow*, *tall x san ramon* and *tall x tall* at Ratmalagara (1989) with *dwarf green x tall*, *dwarf yellow x tall*, *dwarf green x san ramon* and *dwarf yellow x san ramon* were monitored during the year. The status of the Sirikandura trial has improved a great deal. Collection of yield data of this trial will be commenced from year 2003 onwards. The observation trial at Ratmalagara was in a poor state. The seedlings have never recovered from the Elephant damage that caused at the very early stage of establishment.

*J.M.D.T. Everard, N.Hearth, W.B.S. Fernando and G.K. Ekanayake*

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

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

**Crosses:** *dwarf green x tall* from first generation dwarf selected at ISG  
*dwarf green x tall* from second generation dwarf at ISG  
*dwarf green x tall* (CRIC65)  
*Ambakelle special*

**Year of Planting:** December 1993

This trial despite early set back due to water logging and severe rat damage due to poor management have recovered to a great extent and is now progressing well. Collection of yield data was not commenced as it is still too early for the yields to stabilize in these progenies.

*J.M.D.T. Everard and R. Jayatilaka*

**Project : COLLECTION CONSERVATION AND EVALUATION OF COCONUT GERmplasm**

**Enrichment of coconut germplasm**

Four promising Indian coconut varieties, West Coast tall, *Laccadive Ordinary tall*, *Andaman tall* and *Banawali round dwarf* were brought to the country as *in-vitro* cultured embryos. The year, 2002 mark a milestone in coconut breeding research in Sri Lanka. This programme was assisted by Coconut Genetic Resources Network (COGENT) in mediating the exchange and CESS fund by financial assistance. Approximately 200 embryos of each variety were collected, cultured and transported under direct supervision meeting appropriate quarantine requirements. The embryos transported are now being raised at the Tissue Culture laboratory for subsequent establishment in the field with necessary precautions. These material are expected to be established in the field and subsequently evaluated as pure lines as well as hybrids by crossing in varying combinations with local coconut cultivars. The enrichment of coconut germplasm by these exotic introductions hence strengthened the capacity of CRI to produce more hybrids of coconut with higher productivity and greater adaptability.

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

Conservation of coconut germplasm was continued with proper maintenance of all field gene banks and collection of characterization data. The COGENT's data base (CGRD) was updated with information gathered of all conserved accessions. Eleven more new accessions, Nipuni, Gannoruwa, Kalagedihena, Nittambuwa, Rambukkana, Yakkala, Amparai, Bogamuwa, Bathigama, Diddenipotha and Aparakka were planted in the gene bank at Pallama Seed Garden. Two phenotypically distinct palms, one an exceptionally high yielding bodiri-like palm at Thuwakkugala watta temple (Galle) and the other a palm characteristic of large round nuts in a home garden at Pilimathalawa, Kandy were identified for obtaining selfed progenies for conservation.

*J.M.D.T. Everard and G.K. Ekanayake*

The field gene banks at Bandirippuwa, Pottukulama, Lenawa, Pallama Seed Garden and Kohombana at Coconut Cultivation Board (CCB) premises, Gonagolla, Amparai Raddegoda were maintained successfully. The Coconut Genetic Resources Database (CGRD) of the COGENT was updated with the progress of rejuvenated germplasm accessions in field gene banks. The trials established for evaluation of germplasm and crosses generated from germplasm accessions were maintained successfully.

**Experiment 12.7.2 Status of field gene banks (1988 onwards)**

Yield recording was continued at the gene bank at PRS conservation block in 10 accessions. Mean annual nut yields of the accessions are given in Table 16.

**Table 14.** Yield data of seven germplasm accessions at the Poththukulama Gene bank (sample size = 30 palms)

Accession	Age (Year)	Nuts/palm/year		
		2000	2001	2002
Year		2000	2001	2002
Moorock	12	42	32	36
Palugaswewa	12	55	46	36
Pitiyakande	12	60	42	44
Clovis	11	43	40	22
Margaret	11	63	58	36
Namalwatta	9	63	56	38
St. Anne's	9	59	43	44

The status of field gene banks and various other conservation blocks as at 31<sup>st</sup> December 2002 are summarized in preceding tables (Tables 15 - Table 22).

**Table 15.** *The status of the Pottukulma Field Gene Bank as 31<sup>st</sup> December 2002(Planted in 1988/89)*

<b>Accession</b>	<b>Number of bearing palms</b>	<b>Number of young palms</b>	<b>Number of vacancies</b>	<b>Total planted</b>
1. Moorock	81	0	1	82
2. Palugaswewa	79	0	6	85
3. Pitiyakande	77	0	8	85
4. Clovis	75	0	10	85
5. Namalwatta	81	0	5	85
6. St. Anne's	79	0	6	85
7. Margaret	78	0	7	85
8. Kasagala	69	0	11	80
9. Deberayaya	79	0	2	81
10. Kundasale dwarf	39	15	34	88
11. Akuressa	78	0	12	90
12. Ambakelle special	81	0	10	91
13. Melsiripura	78	0	13	91
14. Mangala Eliya	79	0	7	86
15. Goyambokka	81	0	9	90
16. Cameroon red dwarf	45	0	41	86
17. Goluwapokuna	74	0	7	81
18. Keenakelle	65	0	25	90
19. Dwarf Brown	27	0	74	102
20. Maliboda	78	0	11	90
21. Horakelle	65	0	25	90
22. Walahapitiya	66	9	8	85
23. Wellawa	51	1	20	79
24. Embryo Culture Plants	16	0	3	19
25. Brazillian green dwarf	16	0	23	39

*Seedlings raised from open pollination of dwarf brown parents comprising natural selfs and hybrids are present in this accession.*

*J.M.D.T. Everard, N. Herath*

**Table 16.** *The status of the Kotakanada (Bandirppuwa) Filed Gene Bank as at 31<sup>st</sup> December 2002 (Planted in 1988/89).*

Accession	Number of bearing palms	Number of young palms	Number of vacancies	Total planted
1. Wellawa	80	0	4	84
2. Pitiyakande	80	0	6	86
3. Ambakelle tall	72	0	14	86
4. Moorock	36	6	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

*J.M.D.T. Everard, N. Herath*

**Table 17.** *The status of the Pallama Field Gene Bank as at 31<sup>st</sup> December 2002 (Planted from 1999-2002)*

Accession	Number of bearing palms	Number of young palms	Number of vacancies	Total planted
1. Thelidiriya (TLD)	None	48	5	53
2. Kalawewa (KL)	None	60	0	60
3. Ambakelle Special (AS)	None	60	0	60
4. Galadivulwewa (GDW)	None	58	2	60
5. Sindurupitiya (SP)	None	25	3	28
6. Wanathawillu (NM)	None	55	5	60
7. Ihala Kagama (IK)	None	58	2	60
8. Vijithapura (VJ)	None	60	1	61
9. Mahawelathenna (MWT)	None	46	8	54
10. Hangiliyagama (HNG)	None	60	0	60
11. Blackstone (BT)	None	52	5	57
12. Lanlib (LL)	None	58	2	60
13. Kirillapone	None	45	5	50
14. Gannoruwa	None	41	6	47
15. Kalagedihena	None	58	2	60
16. Yakkala	None	59	1	60
17. Bogamuwa	None	52	8	60
18. Rambukkana	None	50	10	60
19. Nittambuwa	None	57	3	60
20. Amparai	None	61	11	72
21. Damana	None	32	18	50
22. Deegawapi	None	41	6	47
23. Batheegama	None	58	2	60
24. Aparekka	None	58	2	60
25. Diddenipotha	None	57	3	60

*J.M.D.T. Everard and G.K. Ekanayake*

**Table 18** *The status of the Lenawa Field Gene Bank as at 31<sup>st</sup> December 2002((Planted in 1998)*

<b>Accession</b>	<b>Number of flowering palms</b>	<b>Number of young palms</b>	<b>Number of vacancies</b>	<b>Total planted</b>
1. Sitrakala (SK)	32	45	2	79
2. Wilhelmina (WHM)	11	65	2	78
3. Kivulakelle (KK)	23	56	1	80
4. Thammenna (TM)	37	31	2	70
5. Yatawatta (YT)	30	34	6	70
6. Marandawila (MW)	29	47	4	80
7. Mirishena (MH)	47	10	3	60
8. <i>tall x tall</i>	14	64	2	80
9. Andigama (AND)	11	65	4	80
10. Dehigahalanda (DHL)	0	43	6	49
11. Dickwella (DW)	4	44	2	50
12. Haragama (HG)	0	62	3	65
13. Namalwatta (NM)	2	71	2	75
14. Deberayaya (DB)	1	61	13	75
15. Goyambokka (GB)	2	63	10	75
16. Tissue Cultured Palms	0	7	15	22
17. Beliatta	0	6	16	22

*J.M.D.T. Everard and G.K. Ekanayake*

**Table 19.** *The status of the Raddegoda Field Gene Bank as at 31<sup>st</sup> December 2001 (Planted in 1996)\**

Accession	Number of flowering palms	Number of young palms	Number of vacancies	Total planted
1. Daddalla		41	7	48
2. Galenbindunuwewa		53	5	58
3. Madagama		43	22	65
4. Millawana		37	28	65
5. Mahakumbukadawala		47	18	65
6. Beliatta		12	53	65
7. Wellawaya (G)		4	51	55
8. Raddegoda	1	15	34	50
9. Wellawaya (B)		39	5	44
10. Wakwella		38	7	45
11. Aluthwatta		28	22	50
12. Zoysawatta		58	18	76
13. Pamunugama		47	9	56
14. Sedawatta		53	24	77
15. Iranawilla		55	2	57
16. Adikarigoda		74	1	75
17. Yodakandiya		97	6	103
18. Magama		68	3	71

*Not updated in 2002*

*J.M.D.T. Everard and R.B. Attanayake*

**Table 20.** *The status of the Kohobana Field Gene Bank as at 31<sup>st</sup> December 2001 (Planted in 1999/2000)*

Accession	Number of flowering palms	Number of young palms	Number of vacancies	Total planted
Magama	NA	NA	NA	146
Wellawaya	NA	NA	NA	57
Beliatta	NA	NA	NA	62
Kivulakelle	NA	NA	NA	165
Clovis	NA	NA	NA	126
Debarayaya	NA	NA	NA	160
Dickwella	NA	NA	NA	95
T x T (HP)	NA	NA	NA	203
Ambakelle special	NA	NA	NA	137
Kirinda	NA	NA	NA	146

NA = Not available

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**Table 21.** *The status of the crop museum at Bandirippuwa as at 31<sup>st</sup> December 2002 (Planted in 1983)*

Accession	Number of bearing palms	Number of young palms	Number of vacancies	Total planted
Dwarf yellow	4		3	7
Dwarf green	7		0	7
Dwarf red	5		2	7
King coconut	6		1	7
<i>Rathran thembili</i>	2		5	7
San Ramon (Russet)	7		0	7
San Ramon (Green)	7		0	7
Kamandala	6		1	7
Gon thembili	7		0	7
Nawasi	7		0	7
Bodiri	7		0	7
Pora pol	2		5	7
Ran thembili	7		0	7
Deekiri pol	7		0	7
Nawasi thembili	0		7	7
Dwarf green x tall	7		0	7
Dwarf yellow x tall	6		1	7

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**Table 22.** *The status of the indigenous tall coconut conservation block at Bandirippuwa as at 31<sup>st</sup> December 2002 (Planted in 1984) and the San Ramon conservation in the adjoining block (Planted in 1986)*

Accession	Number of bearing palms	Number of young palms	Number of weak palms	Number of vacancies	Total planted
Ran thembili	28	2	4	8	42
Bodiri	37	0	3	43	83
Porapol	30	1	7	26	64
Nawasi	31	0	4	5	40
Kamandala	4	0	0	2	6
Gon thembili	52	1	1	16	70
Dikiri	1	0	0	2	3
<i>San ramon</i>	148	0	12	14	162

\*41 of these are used for production of *san ramon* seedlings by cross pollinating with pollen collected from six selected *san ramon* palms from fields 4, 9 and 16 at BE for planting in the Pallama Seed Garden

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**Table 23.** *The status of the dwarf palm conservation blocks at Bandirippuwa as at 31<sup>st</sup> December 2001 (Planted in 1987)\**

Accession	Number of bearing palms	Number of young palms	Number of vacancies	Total planted
Dwarf green	44		29	73
Dwarf yellow	10		33	44
Dwarf red	28		71	99
Mirishena dwarf (1993)	4	16	13	41
Brazilian green dwarf (1993)	16	16	37	77
Dwarf brown (1993)	7			33
Dwarf brown (1993 at RE)	27			70

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**Project: EVALUATION OF CONSERVED COCONUT GERMLASM**

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

The experiment was initiated to carry out a systematic evaluation of the between and within population variability of a representative set of germplasm accessions conserved within the gene banks. For this purpose 9 germplasm accessions, which were diverse in their origins were selected and 15 half sib families of 5 each were planted per accession in a fully randomized design in January 1995 at Andigama Farm Giriulla. The status of flowering to date is given in table 24.

**Table 24.** *The status of flowering of the nine germplasm accessions planted at Andigama farm (NLDB), Giriulla (1994)*

Name of accession	Percentage of Palms in flower	Vacancies	Number of seedlings Planted
Maliboda	63%	32	60
St Anne's	80%	25	59
Ambakelle special	60%	32	71
Margaret	56%	32	76
Moorock	52%	29	72
Deberayaya	33%	30	85
Walahapitiya	55%	33	60
CRIC60	50%	26	87
Clovis	37%	19	60

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

King coconut seedlings raised from self pollination of selected parent palms at Marandawila, Walpita, Walahapitiya and Madampe were planted in two trial blocks at Raddegoda Estate, Delwita and Margaret Estate, Pallama in May and June 1999 respectively. In each population the king coconut palms, which are regular in bearing and producing nuts with desirable palatability were selected as parents and selfed for fixing these characters in the progeny.

Forty individuals each from Marandawila, Walpita and Walahapitiya along with the open pollinated control from Marandawila (40 seedlings) were planted at Raddegoda in a randomized block design with 10 seedlings/plot. Fifty four seedlings from Marandawila, 25 from Walpita, 45 from Walahapitiya, 25 from Madampe and 48 open pollinated (control) from Marandawila were planted in a fully randomized design at Pallama. These trials are progressing satisfactorily.

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### **Project : MOLECULAR CHARACTERIZATION OF COCONUT GERMPLASM**

#### **Experiment 2 Simple sequence repeat polymorphism (micro satellite or SSR) based characterization of coconut germplasm**

Seventeen pairs of primers were used for detection of simple sequence repeat polymorphisms (SSRPs) in the 43 coconut accessions. The primers identified 82 alleles with an average of 4.8 alleles per locus ranging from 2 to 10. All the loci were polymorphic within the 43 genotypes analyzed. Among all the accessions studied the collection from Gampaha (named Indian) had the maximum number of alleles (29) while dwarf red had the minimum number of alleles (15). The average number of SSR loci per accession was 20.28. Eight accession specific alleles were found in accessions Goyambokka, Blackstone, Mirishena, Nipuni, Margaret and Wanathawillu.. There was no correlation observed between the number of repetitive units in the microsatellite sequence and the number of alleles detected in coconut accessions.

The 82 microsatellite polymorphisms in 17 loci were scored in 43 accessions and the distance matrix was calculated. Genetic distances among the accessions ranged from 0.13 to 1.0 with an average of 0.63. Lowest distance was found between pairs, Cameroon red dwarf and Mirishena dwarf and Cameroon red dwarf and dwarf green. Maximum distance was observed between 41 pairs (1.0) all being between tall and dwarf accessions. This high distance was observed due to sharing of completely different alleles between tall and dwarf. The high values of genetic distances obtained with SSRs clearly indicate the highly polymorphic nature of SSR loci.

All 43 accessions were constructed in a dendrogram (Figure 2) to assess the genetic relatedness of the accessions based on SSRPs. The 43 accessions clustered into two major sub groups. The first comprised all dwarf forms, semi tall and semi dwarf (Mirishena), king

coconut (*aurantiaca*) forms, bodiri, and the two Philippine coconuts, clovis (san Ramon) and Nipuni the exotic collection obtained from a home garden in Colombo. Further sub clustering of this group show separation of more heterozygous types such as semi tall (Mirishena), Clovis, Nipuni and Bodiri.

The second sub group consisted entirely of tall coconut collections with an average genetic distance of 0.40 within the cluster. This major group comprised two sub divisions 2.1 and 2.2 the former consisting only of Sri Lankan tall accessions with an average distance of 0.39. The latter also constituted of tall coconuts but not typical of Sri Lankan tall except the ran thembili, which was classified traditionally as a Sri Lankan tall form. The other coconuts in this group, Dickwella, Margaret, Indian San Ramon-RT, and Blackstone are characterized by bigger nuts of round shape, typical of the Clovis (san ramon) accession. The average genetic distance within the latter group (0.41) was slightly higher than that in the former group.

The pattern of the genetic structure of 43 coconut accessions unveiled by SSRPs in this study sheds light on more accurate understanding of the genetical make up of many coconuts in the country that has not been explained before. For instance the position Mirishena accessions, Indian, Nipuni, Blackstone, Margaret, Dickwella etc. In addition separation of bodiri and ran thembili from the main group of Sri Lanka tall are all important observations which need discussion.



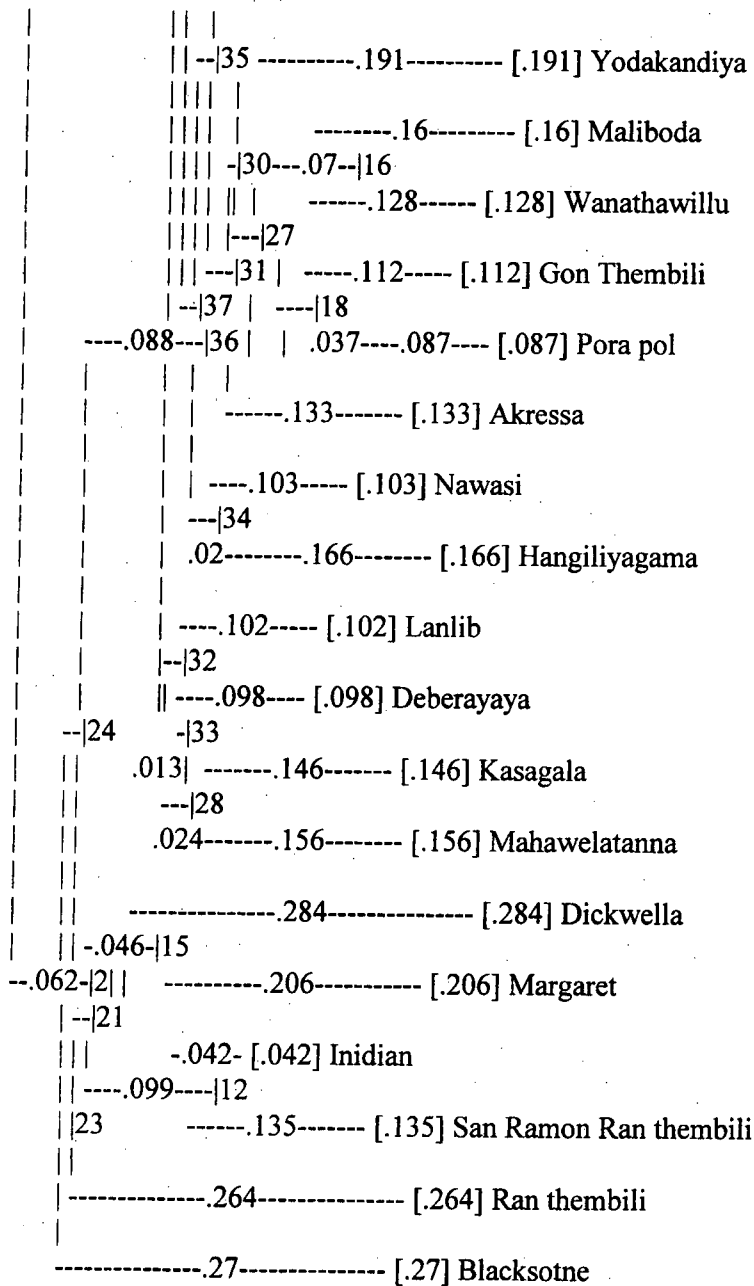


Figure 2. SSR based dendrogram revealing the genetic relationships of 43 accessions of coconut germplasm conserved *ex-situ* in field gene banks of the CRI

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**Project: MOLECULAR MARKER BASED MAPPING OF THE COCONUT GENOME**

**Experiment 1 Construction of a genome map using simple sequence repeat polymorphisms (SSRP) in a segregating population of selfed *dwarf green x tall***

A pollination programme was initiated to construct F<sub>2</sub> families of *dwarf green x tall* with known pedigree for constructing the genome map for coconut. Development of molecular markers to discriminate *tall* and *dwarf* is being continued with giving emphasis on micro-satellite polymorphisms. Construction of the new laboratory for molecular biological studies at the CRI through CESS assistance is completed and now the functioning with molecular assay procedures for development of molecular markers and diagnosis of pathogens of unknown etiology in coconut. The work on FAO project for diagnosis of Rapid Decline Syndrome and in addition on other syndromes are now in progress in collaboration with Plant Physiology and Plant Protection Divisions.

**1.2 Establishment of the Pallama Seed Garden**

Establishment of Pallama Seed Garden (PSG) for mass production of CRISL98 was continued and during the year total of 1,317 *tall x tall* and 1,459 *san ramon* seedlings were planted. Fifteen seedlings (12 *san ramon* and 3 *tall x tall*) in field 1 has attained flowering. Planting of *tall x tall* in a section of field 04 had to be postponed to allow continuation of the weed experiment of the Agronomy division for two more years.

**Table 25.** *The status of planting in the new seed garden at Pallama as at 31<sup>st</sup> December 2001*

	Variety	Year(s) of Planting	Number of palms in flower	Number of vacancies	Seedlings Planted
Field 1 Seed palms	Tall	1998-2001	3	52	710
	San Ramon*		14	29	333
	Guard row		0	324	1145
	<b>Total</b>		<b>17</b>	<b>405</b>	<b>2188</b>
Field 2 Seed palms	Tall	1999-2002	6	66	1058
	San Ramon		12	86	529
	Guard row		0	191	2518
	<b>Total</b>		<b>18</b>	<b>343</b>	<b>4105</b>
Field 3 Seed palms	Tall	1999-2002	0	169	1236
	San Ramon		0	346	718
	Guard row		0	0	0
	<b>Total</b>		<b>0</b>	<b>515</b>	<b>1954</b>
Field 4 Seed palms	Tall	2002	0	122	1317
	San Ramon		0	0	0
	Guard row		0	0	0
	<b>Total</b>		<b>0</b>	<b>122</b>	<b>1317</b>
	<b>Grand Total</b>		<b>0</b>	<b>1385</b>	<b>9564</b>

## **Extension and Other Services**

Involvement in training and providing extension services by the GPB division has been quite substantial during the year 2002. The annual one-day programme conducted for growers of both categories large and small sector on planting material of coconut, planting technique and early care of seedlings, conducted at ISG, Ambakelle on 24<sup>th</sup> May 2002 was well attended by 154 participants. The programme conducted with short lecturers and field demonstrations amply convinced the growers to adopt scientifically developed technology for increasing the coconut productivity in their lands.

The number of clients who visited the division in search of technical knowledge during the year exceeds one thousand apart from school children who visit in very large numbers. Training of coconut estate managers in the Wayamba Plantation Company, diploma students from NIPM and Agriculture schools and individuals from organizations such as Kapruka Societies are noteworthy.

GPB division for the first time moved a step forward by conducting a training programme for fellow scientists from Universities and other research organizations on 'Use of DNA technique for assessment of genetic diversity in plants. This course was conducted with a course fee charged from each participant.

Carried out a one-day demonstration on DNA isolation from plant tissues for undergraduate students in the Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka.

# REPORT OF THE SOILS AND PLANT NUTRITION DIVISION

Actg. Head – N A Tennakoon, Ph D

## 1. GENERAL

The Soils and Plant Nutrition Division continued 16 on going field experiments and commenced a new field experiment. The on going deep ground water survey in the Kurunegala District was continued with Cess Fund assistance. The total research and maintenance expenditure of the division were Rs. 1,378,000/- and Rs. 309,000/- respectively.

A young palm experiment carried out at Ratmalagara Estate with different sources of phosphate fertilizers i.e. Eppawela Rock Phosphate (ERP), Imported Rock Phosphate (IRP), and Triple Super Phosphate (TSP) revealed that no significant difference in phosphorous levels in the 14<sup>th</sup> leaf. Therefore it is possible to recommend ERP for young coconut palms grown in the Wet and the Wet-Intermediate zones. This recommendation will lead to substantial foreign exchange saving.

Two experiments conducted at Walpita and Marandawila lead to formulate suitable fertilizer recommendation for king coconut palms. A significant yield increase ( $p < 0.05$ ) against the control (no fertilizer) was observed when the palms receiving N P K and Mg fertilizers equivalent to 75% removal by nuts or 1 ½ the dose of Adult Palm Mixture (APM) was applied. Until the experiment is completed, a tentative fertilizer recommendation for king coconut palms, was given as 600 g Urea, 325 g IRP, 1000 g Muriate of potash and 600 g Dolomite to be applied once in 6 every months.

Comparison of efficiency of 3 organic manures, a green manure and 3 kg of Adult Palm Mixture (APM) at the end of the fifth year showed 55% yield improvement in poultry manure treated palms compared to the control (no fertilizer). With other organic manures namely cow dung, goat dung and gliricidia, the yield increase was 35%, 18% and 15% over the control respectively, while the yield increase due to chemical fertilizer (APM) was 33%.

Drip irrigation experiment conducted at Ratmalagara Estate showed 47% increase in yield compared to control (no irrigation) when 600 l of water was given in every 5 days interval.

## 2. RESEARCH PROJECTS

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

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

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

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

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

**Table 1 :** *Nut yields in the experimental sites at Caran Estate, Bingiriya and Muthugala Estate, Dambadeniya*

Treatment	Nut yield per palm per year			
	Caran Estate, Bingiriya Dambadeniya		Muthugala Estate,	
	Cumulative 1999 – 2001 (nuts/palm)	2002 (nuts/palm)	Cumulative 1999 – 2001 (nuts/palm)	2002 (nuts/palm)
T <sub>1</sub>	182	32	150	58
T <sub>2</sub>	164	30	166	67
T <sub>3</sub>	171	22	166	67
T <sub>4</sub>	192	18	174	71
T <sub>5</sub>	179	29	193	69
CV%	17.3	26	22.5	18
Significance ( $p \leq 0.05$ )	ns	ns	ns	Ns

T<sub>1</sub> - Mulch only; T<sub>2</sub> - 300 Husks, buried on 1/3 circular trench ; T<sub>3</sub> - 1/3 circular trench without husks but refilled with soil; T<sub>4</sub>- 300 Husk buried in 3' x 4' x 2' pit; T<sub>5</sub>-300 Husks buried in 1/3 circular trench + mulch

Nut yield have not shown any significant difference among the treatments from 1999 up to 2002. However, nut yield of all the treatments were slightly higher than the control in Mutugala Estate. But yield of Caran Estate did not show such a trend. This experiment has not shown a significant effect of husk burial on the nut yield at both sites where soils were moderately deep and gravelly. The experiment was terminated in December 2002 at both sites.

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**PROJECT 6.0: SUBSTITUTION OF LOW COST PHOSPHATE (ERP) IN PLACE OF SAPHOS PHOSPHATE FERTILIZER 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, on a Randomized Block Design with 3 replicates and 6 palms per plot, was established in 1991 by planting T x T seedlings on Andigama series soils at Ratmalagara Estate in IL<sub>1</sub> agro ecological region. The site falls into land suitability class S<sub>4</sub>.

The treatments of this experiment up to year 2001 consisted of three phosphate sources viz. triple super phosphate (TSP), saphos phosphate (SP) and Eppawela rock phosphate (ERP) applied in terms of P<sub>2</sub>O<sub>5</sub> equivalents of 150 g, 300 g and 600 g (recommended dose is 180 P<sub>2</sub>O<sub>5</sub> g) per year respectively. The treatments were applied at 6 monthly intervals.

The growth performances of some experimental palms were very poor by 2002. A detailed soil survey of the experimental site done in May 2002, revealed that the performance of palms were very poor in the section where the soils were very shallow. Therefore the experiment was re-designed and reduced the number of plots from 30 to 12, avoiding the not suitable area for coconut cultivation. Only one treatment level was used according to the new design as given in Table 2.

**Table 2 :** *The sources of P and the rates of application with the control*

Treatments	Rate of application g/palm/y
TSP (46% P <sub>2</sub> O <sub>5</sub> )	350
SP (27.5% P <sub>2</sub> O <sub>5</sub> )	600
ERP (30% P <sub>2</sub> O <sub>5</sub> )	600
Control	0

**Basal application ;** Urea 800 g/palm/y  
Muriate of potash 1600 g/palm/y  
Dolomite 1000 g/palm/y

Leaf samples from 14<sup>th</sup> frond of each treated palms were taken in February 2002. Fertilizer application was carried out in November 2002. Nut yield from November 2001 to October 2002 did not show any significant difference among the treatments (Table 3). Generally, the nut yield of all the plots were as low as 12 – 18 nuts per palm per year. It must be the combined effect of shallow soil depth and the drought prevailed during the year.

**Table 3 :** *Nut yield of the experiment*

Treatment levels	Nut yield (per palm per year)
TSP 1	14
2	13
3	12
SP 1	16
2	18
3	17
ERP 1	12
2	14
3	13
Control (No P sources)	16
Level of significance	ns

Leaf samples were chemically analyzed and the data are given in Table 4.

**Table 4 :** *Nutrient concentrations in the 14<sup>th</sup> frond of the palm*

Treatment levels	N%	P%	K%	Mg%
TSP 1	2.04	0.15	1.57	0.22
2	1.85	0.14	1.43	0.26
3	2.04	0.15	1.36	0.25
SP 1	1.73	0.13	1.45	0.27
2	1.91	0.14	1.48	0.24
3	2.03	0.14	1.42	0.25
ERP 1	1.92	0.13	1.36	0.26
2	1.92	0.14	1.39	0.29
3	2.12	0.13	1.49	0.27
Control	1.75	0.12	1.50	0.24
Level of significance	ns	$P \leq 0.001$	ns	ns
LSD ( $p \leq 0.05$ )	-	0.02	-	-

The leaf analysis results showed that only P has shown significantly increase than the control. All the leaf P levels were above the critical level ( $> 0.11\%$ ). It was clearly showed there were no significance difference of leaf P levels between Eppawela Rock Phosphate treated palms and saphos phosphate treated palms. However, significant difference has shown TSP treated palms against either Eppawela Rock Phosphate or Saphos Phosphate treated palms. Therefore Eppawela Rock Phosphate can be introduced instead of Saphos Phosphate to the coconut as P fertilizer source.

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**Experiment :** **Evaluation of residual P availability of soil after long term rock phosphate application**

**Pot Experiment - 1**

The objective of this experiment was to evaluate the phosphorus availability in Andigama series soils (lateritic gravel in the Intermediate zone) after ten years annual and

continuous application of different levels of Eppawela Rock Phosphate, Saphos Phosphate and Triple Super Phosphate.

Two pot experiments were established to study the plant response to residual phosphorus content in the soil. Ginger (*Cingiber opisonarlae*) and the indicator plants *Panicum maximum* were used. The soil for this experiment were taken from the manure circles of the palms in experiment 6.0.1 at Ratmalagara Estate. The soils have received phosphate treatments over the last 10 years as follows (Table 5).

**Table 5 :** *The cumulative phosphate doses received by soils with different phosphate source*

Treatment levels	Cumulative phosphorus fertilizer dose from 1991-2001 g/kg soil
TSP 1	0.379
2	0.717
3	1.434
SP 1	0.599
2	1.197
3	2.394
ERP 1	0.549
2	1.096
3	2.193
Control	-

Pot experiment was in Randomized Block Design with three replicates. Pots filled with 6 mm mesh sieved 3.5 l of respective soils.

Ginger rhizomes were planted in each pot of experiment - 1. Each soil was treated with a basal dose of 10 g urea and 20 g muriate of potash as split doses during 6 month growing period of ginger.

Table 6 shows P status of phosphorus pre treated soils for ten years.

**Table 6 :** *Phosphorus status of the pre-treated soils*

Treatment levels	P (mg/kg)		
	Bray & Kurtz	Olsen	2.5% Acetic acid
TSP 1	54.17	32.96	27.75
2	157.70	126.13	100.69
3	263.43	138.20	139.82
SP 1	25.27	15.71	90.58
2	37.16	15.28	151.47
3	31.57	13.79	458.68
ERP 1	15.84	9.46	135.33
2	18.20	11.07	252.80
3	18.40	8.04	438.38
Control	10.42	5.60	6.09

Acetic acid (2.5%) extractable P content is higher in SP and ERP treated soils than the TSP treated soils. But the Bray & Kurtz extractable P content is higher in TSP treated soils than SP and ERP treated soils.

The number of tillers per bush, height of the plants, number of leaves in each plant were recorded. Six months after planting, ginger plants were remained and fresh and dry weight of vegetative parts of the plants, roots and rhizomes were recorded. Chemical analysis of soil samples from pots, after removing ginger plants, rhizomes and vegetative parts of the ginger is in progress.

Table 7 shows the dry weight of rhizomes, roots and vegetative parts of ginger in different treatments.

**Table 7 :** *Dry weight of different parts of ginger plants*

Treatment levels	Dry weight (g)		
	Rhizome	Root	Vegetative part
TSP 1	4.86	1.33	5.33
2	5.17	2.40	11.96
3	9.87	2.84	15.05
SP 1	5.27	1.25	5.34
2	8.17	2.04	8.37
3	8.39	3.12	14.63
ERP 1	4.37	1.89	7.46
2	6.15	2.24	7.89
3	8.05	2.58	9.50
Control	4.82	2.30	5.89

Dry weight of rhizomes, roots and vegetative parts of ginger increase with the increase of the TSP, SP and ERP treatment levels.

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In the Experiment – 2 *Panicum maximum* was planted. The basal treatments were N at the rate of 0.18 g of Urea, K at the rate of 0.36 g of muriate of potash and Mg at the rate of 0.28 g Epsom salt. Grass was cut at one month interval to get the vegetative part. Dry weight of the grass cuttings given in Table 8. Soil and leaf analysis is in progress.

**Table 8 :** *Dry weight of grass cuttings*

Treatment levels	Dry weight ) (g) (1 <sup>st</sup> cutting)
TSP 1	2.08
2	1.86
3	2.41
SP 1	2.16
2	2.28
3	2.41
ERP 1	1.62
2	1.43
3	1.60
Control	1.73

The results showed that the TSP and SP produced more shoot dry matter than ERP.

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### **Experiment 6.0.3 : Evaluation of the efficiency of rock phosphate as a phosphorus fertilizer for coconut growing soils in the Dry zone**

The objective of this study was to test the solubility of various rock phosphates such as Imported Rock Phosphate (IRP), Eppawela Rock Phosphate(ERP) and High grade Eppawela Rock Phosphate (HERP) when applied to weakly acidic or neutral soils of the Dry zone.

#### **Pot Experiment 1**

A pot experiment was established to quantify the solubility of different phosphate sources applied to soils that were watered based on the rainfall pattern of the Dry zone. Four soils from the Dry zone and one soil from the Wet zone were taken for this experiment. Details of soils used for the pot experiment are given below.

Great Soil Group	Soil series	Agro-ecological region	Soil sampling area
Regosols	Mampuri	DL <sub>3</sub>	Madurankuliya
Latosols	Gambura	DL <sub>3</sub>	Attavillu
Reddish Brown Earth	Elayapattuwa	DL <sub>3</sub>	Kottukachchy
Red Yellow Podzolic	Boralu	WL <sub>3</sub>	Walpita

Treatments were changed as follows according to the pot size (6.1 kg soil)

Soils filled into pots (6 kg soil/pot) and treatments were applied as follows.

T <sub>1</sub>	-	No fertilizer
T <sub>2</sub>	-	TSP, 1.19 g/pot
T <sub>3</sub>	-	IRP, 1.83 g/pot
T <sub>4</sub>	-	ERP, 1.83 g/pot
T <sub>5</sub>	-	HERP, 1.37 g/pot

The phosphorus fertilizer application rates were calculated based on general fertilizer recommendation for adult palms. According to that 600 g of ERP, 600 g of IRP, 474 g of HERP and 391 g of TSP apply per 2000 kg of soil.

All pots were treated with the basal doze of urea at the rate of 2.44 g , muriate of potash at the rate of 4.88 g and dolomite at the rate of 3.05 g per pot.

Pots were watered according to the rainfall pattern existing in the location of the soil sampling. Leached water samples is being collected weekly. Soil samples are being taken from pots at 14 days interval for 2 times and one month interval for three months. Analysis of leached water and soil samples is in progress.

Solubility of rock phosphates used for the experiment is given as follows.

Source	Water soluble P <sub>2</sub> O <sub>5</sub> %	50% HCl soluble	2% Citric acid soluble
		P <sub>2</sub> O <sub>5</sub> %	P <sub>2</sub> O <sub>5</sub> %
HERP	0.013	39.69	4.33
ERP	0.0106	38.20	3.84
IRP	0.00099	29.89	6.61

Chemical properties of the soils used for the pot experiment are given in Table 9.

**Table 9 :** *Chemical properties of the soil*

Soil series	pH (1:5 H <sub>2</sub> O)	EC µmho/cm (1:5 H <sub>2</sub> O)	Available P (2.5% Acetic acid) mg/kg	Total P mg/kg
Boralu series	5.58	129.36	3.38	195.35
Gambura series	5.89	12.23	1.76	93.62
Mampuri series	6.64	120.05	33.01	77.41
Elayapattuwa series	6.00	78.52	33.29	176.31

Available phosphorus content is higher in both Mampuri series and Elayapattuwa series soils than the Boralu and Gambura series soils.

Soluble phosphorus concentrations in leached water through the pots are given in Table 10.

**Table 10 :** *Soluble P concentrations in leached water*

Soil series	Treatments				
	T <sub>1</sub> (Control)	T <sub>2</sub> (TSP)	T <sub>3</sub> (IRP)	T <sub>4</sub> (ERP)	T <sub>5</sub> (HERP)
	<----- p mg ----->				
Boralu series	0.888	0.911	0.936	0.789	0.926
Gambura series	0.487	1.342	0.656	0.646	0.577
Mampuri series	1.985	3.646	2.858	3.153	2.573
Elayapattuwa series	0.589	1.489	0.525	0.462	0.533

Table 10 showed that P content of leached water of Mampuri soils series treated with TSP, IRP, ERP, HERP and control was the highest in this experiment.

## Pot Experiment II

A green house pot experiment has been established with all four soils to quantify the soluble phosphorus content by indicator plant, *Panicum maximum*. Soils filled into pots (400 g soil/pot) and planted *Panicum* cuttings after treatment application. The experiment on Randomized Complete Block Design with three replicates.

Treatments were as follows.

T <sub>1</sub>	-	Control (no phosphorus fertilizer)
T <sub>2</sub>	-	TSP, 0.733g/pot
T <sub>3</sub>	-	IRP, 0.12 g/pot
T <sub>4</sub>	-	ERP, 0.12 g/pot
T <sub>5</sub>	-	HERP, 0.094 g/pot

Phosphorus fertilizer rates based on the same as pot experiment I.

All the pots were treated with a basal doze of N at the rate of 0.16 g of urea, K at the rate of 0.32 g of MOP and Mg at the rate of 0.25 g of Epsam salt.

*Panicum* shootings were cut at one month intervals for one year and dry weight of cuttings were recorded. Chemical analysis for phosphorus content in vegetative part of the *Panicum* is in progress.

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

### Experiment 6.1.1 : Effect of sodium and chloride on yield of coconut (1996)

The experiment, on a Randomized Block Design with 3 replicates and 6 palms per plot, was established in 1996 at the following sites.

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

Palms at both sites are about 40 years old.

The treatments of this experiment are T<sub>1</sub> - control (no potassium, sodium or chloride treatment), T<sub>2</sub> - muriate of potash (1.6 kg/palm/y), T<sub>3</sub> - potassium sulphate (1.8 kg/palm/y), T<sub>4</sub> - sodium chloride (1.2 kg/palm/y) and T<sub>5</sub> - sodium sulphate (1.45 kg/palm/y). All plots was given a basal dose of ammonium sulphate (1.2 kg/palm/y) and saphos phosphate (0.6 kg/palm/y). The nut yields of both sites are given in Table 11. There were no significant differences in nut yield among treatments at both sites up to 2002.

However, at Wayagolla Estate, where the soils are lateritic gravel (Boralu series), the yields of sodium treatments (T<sub>4</sub> and T<sub>5</sub>) were quite close to those of potassium treatments (T<sub>2</sub> and T<sub>3</sub>). The yield of the control treatment, which has not received both potassium and sodium, was lower than other treatments though the differences were not significant. This trend was not observed in yield data of Ganewatte Estate where the soils were deep sandy loam.

**Table 11 :** *Nut yields of the experiments at Wayagolla and Ganewatta in 1997 – 2001 and 2002*

	Wayagolla Estate		Ganewatte Estate	
	Nuts/palm/year		Nuts/palm/year	
	1997-2001 Cumulative	2002	1997-2001 Cumulative	2002
T <sub>1</sub> (No Fertilizer – Control)	272	58	266	55
T <sub>2</sub> (Muriate of potash)	319	71	236	54
T <sub>3</sub> (Potassium sulphate)	302	69	272	53
T <sub>4</sub> (Sodium chloride)	280	64	276	50
T <sub>5</sub> (Sodium sulphate)	319	72	283	42
Level of significance	ns	ns	ns	ns

The soil samples in the manure circle at Ganewatte site were taken in February 2002 and chemical analysis were completed. The results showed that, at Ganewatte Estate, the exchangeable K of the soils receiving the two potassium treatments (T<sub>2</sub> and T<sub>3</sub>) were significantly higher ( $p \leq 0.001$ ) than that of the other soils. Within the treatments of T<sub>2</sub> and T<sub>3</sub> the potassium concentration in the sub soils (25 – 50 cm and 50 – 75 cm) were significantly higher ( $p \leq 0.05$ ) than the top soils (0-25 cm). Also, the exchangeable potassium concentrations at different depths of the soils in the control plots were also significantly higher ( $p \leq 0.001$ ) than the that of the plots receiving sodium treatments (T<sub>4</sub> and T<sub>5</sub>). The increase of exchangeable potassium in treatments T<sub>2</sub> and T<sub>3</sub> was significant only at 25 - 50 cm and 50-75 cm depths compared to the control (Table. 12). The above results show that the potassium, applied to the soils in the site, tends to leach down. Also, sodium application has resulted in leaching of exchangeable potassium in the soil. However the potassium concentration of the 14<sup>th</sup> leaf of palms in all plots, ranged from 1.45% to 1.53%, which is well above the critical limit (1.2%), and there were no significant differences between treatments (Table 13). The foregoing results show that, although there were significant differences in exchangeable potassium concentration in the soils due to different treatments, those differences have not affected potassium uptake by coconut palms. Also, the sodium treatments have not affected the potassium uptake by palms.

The exchangeable sodium concentration was significantly higher in the control than all the other treatments including the two sodium treatments (T<sub>4</sub> and T<sub>5</sub>). Also, there was no significant difference between sodium concentrations of the 14<sup>th</sup> leaf between treatments (Table 13). It implies that sodium treatments have not affected the sodium uptake of palms also.

The results showed that exchangeable Mg concentration was significantly higher in sodium treatments (T<sub>4</sub> and T<sub>5</sub>) than other treatments. However, there was no significant difference in magnesium concentration in the 14<sup>th</sup> leaf (Table 13) between treatments. It

indicates that differences in the exchangeable magnesium in the soils up to 75 cm depth has not affected the magnesium nutrition of the palms.

At Ganewatte site, the exchangeable Na level in the soil has not increased due to sodium chloride application which indicates that applied Na had leached by the time of soil sampling (8 months after fertilizer application). However, the exchangeable K has significantly increased (Table 12). It seems that strong cations such as  $K^+$ ,  $Ca^{2+}$  and  $Mg^{2+}$  are preferably retained at exchange sites of the soils at Ganewatte because the CEC of the soils (sand to sandy loam) is low. The  $Na^+$  could be easily leached due to above reason despite regular application of NaCl. The leaf concentration also has not shown significant differences in Na and K concentration in leaf between control and the sodium and potassium plots. It is possible that palms may absorb N, P, K and Mg from the water table which fluctuate at the range of 0.75 m to 1.5 m from the surface.

**Table 12 :** Soil nutrient levels in soils at Ganewatte site (Mean values of 3 replicares)

Treatment	Depth (cm)	K Mg Ca Na			
		----- (meq/100 g soil) ----->			
T <sub>1</sub> Control	0-25	0.29	1.33	2.12	0.26
	25-50	0.30	0.99	1.55	0.27
	50-75	0.30	0.83	1.57	0.27
T <sub>2</sub> (Muriate of potash)	0-25	0.28	1.23	1.76	0.10
	25-50	0.52	0.98	1.38	0.29
	50-75	0.61	0.82	1.78	0.15
T <sub>3</sub> (Potassium sulphate)	0-25	0.41	1.57	2.62	0.10
	25-50	0.60	1.50	2.09	0.11
	50-75	0.50	0.62	1.71	0.13
T <sub>4</sub> (Sodium chloride)	0-25	0.15	1.71	2.39	0.07
	25-50	0.13	1.24	1.73	0.14
	50-75	0.17	1.30	1.97	0.17
T <sub>5</sub> (Sodium sulphate)	0-25	0.16	1.91	2.56	0.06
	25-50	0.17	1.55	1.97	0.17
	50-75	0.19	1.21	1.58	0.18
Level of Significance					
Treatments		$p \leq 0.001$	$p \leq 0.001$	ns	$p \leq 0.001$
Depth		$p \leq 0.05$	$p \leq 0.05$	ns	$p \leq 0.05$
LSD ( $p \leq 0.05$ ) Treatments		0.091	0.283	-	0.061
Depth		0.071	0.208	-	0.047

**Table 13 :** Leaf nutrient status of 14<sup>th</sup> leaf of the palm at Ganewatte site

Treatments	K%	Mg%	Ca%	Na%	Cl%
T <sub>1</sub> No Fertilizer – Control	1.45	0.29	0.29	0.21	0.68
T <sub>2</sub> Muriate of Potash	1.46	0.27	0.32	0.16	0.69
T <sub>3</sub> Potassium sulphate	1.51	0.30	0.35	0.16	0.70
T <sub>4</sub> Sodium chloride	1.53	0.30	0.29	0.21	0.73
T <sub>5</sub> Sodium sulphate	1.46	0.28	0.28	0.16	0.67
Level of Significance	ns	ns	ns	ns	ns

The contrast of the results between Ganewatte site and the Wayagolla site is remarkable. The exchangeable potassium concentration of the soils in the potassium treatments (T<sub>2</sub> and T<sub>3</sub>) about 4 to 6 times higher than that the soils in sodium treatments (T<sub>4</sub>

and T<sub>5</sub>) and the control (T<sub>1</sub>) (Table 14). The differences were highly significant. In contrast to Ganewatte site, the exchangeable potassium concentration decreases with the depth at Wayagolla site. Moreover, the potassium concentrations of the 14<sup>th</sup> leaf significantly higher in potassium treatments than the other treatments. The leaf potassium concentration of palms in the control plots and sodium treated plots were far below the critical level of 1.2% (Table 15).

The exchangeable sodium concentration of the soil was significantly higher in sodium treatment plots (T<sub>4</sub> and T<sub>5</sub>) than that of the control plot (T<sub>1</sub>) and the potassium treatment (T<sub>2</sub> and T<sub>3</sub>) plots. The potassium concentrations of the leaf also show the same pattern (Tables 13 and 15).

The foregoing results show that there is a good relationship between the exchangeable potassium and sodium status of soils and the concentrations of the respective elements in the 14<sup>th</sup> leaf at the Wayagolla site. Such a relationship was not seen at Ganewatte site. The difference can be attributed to the differences in soil properties between the two sites. Ganewatte site comprises sandy to sandy loam soils with low CEC (2 meq/100 g). It is also interesting to note that, though there were no significant difference in exchangeable Mg between treatments, the magnesium concentration of the 14<sup>th</sup> leaf of potassium treated palms (T<sub>2</sub> and T<sub>3</sub>) were significantly lower than that of the other palms. This could be due to interaction between magnesium and potassium within the palm rather than the effect of soil magnesium status.

**Table 14 :** Soil nutrient levels in soils at Wayagolla site (Mean value of 3 replicates)

Treatment	Depth (cm)	K	Mg	Ca	Na
		<----- (me eq/100 g soil) ----->			
T <sub>1</sub> Control	0-25	0.17	0.76	1.43	0.08
	25-50	0.11	0.49	0.85	0.05
	50-75	0.09	0.42	0.68	0.03
T <sub>2</sub> (Muriate of potash)	0-25	0.43	0.66	1.51	0.14
	25-50	0.37	0.53	1.02	0.13
	50-75	0.32	0.45	0.82	0.11
T <sub>3</sub> (Potassium sulphate)	0-25	0.65	0.78	1.76	0.07
	25-50	0.52	0.52	0.71	0.08
	50-75	0.39	0.55	0.70	0.05
T <sub>4</sub> (Sodium chloride)	0-25	0.10	0.66	1.11	0.17
	25-50	0.08	0.39	0.87	0.22
	50-75	0.06	0.27	0.67	0.21
T <sub>5</sub> (Sodium sulphate)	0-25	0.13	0.56	1.16	0.15
	25-50	0.08	0.37	0.72	0.18
	50-75	0.05	0.33	0.59	0.18
Level of Significance					
Treatments		p ≤ 0.001	ns	ns	p ≤ 0.001
Depth		ns	p ≤ 0.001	p ≤ 0.001	-
LSD (p ≤ 0.05) Treatments		0.015	-	-	0.041
Depth		-	0.101	0.258	-

Although potassium status of palms in T<sub>1</sub>, T<sub>4</sub> and T<sub>5</sub> are in the deficiency level (< 1.2%) at the Wayagolla site, only the palms in T<sub>1</sub> plots (control) showed a lower yield compared to potassium treated palms. This trend is seen not only in yield data of the year 2002 but also in the cumulative yield data from 1997 – 2001. In terms of major nutrients, the difference between palms in the control and sodium treated plots lies only in the sodium

concentration (Table 14). Therefore the results of Wayagolla Estate implies that sodium can offset the effect of potassium deficiency of coconut palms to a certain extent.

Since the palms at Ganewatte Estate have not shown any significant response to sodium and potassium treatments either in terms of nut yield or nutrient uptake, the experiment was terminated at the end of year 2002. The experiment at Wayagolla Estate will be continued in the year 2003.

**Table 15 :** Leaf nutrient status of 14<sup>th</sup> leaf of the palm at Wayagolla site

Treatments	K%	Mg%	Ca%	Na%	Cl%
T <sub>1</sub> (No Fertilizer – Control)	0.69	0.31	0.69	0.16	0.48
T <sub>2</sub> (Muriate of Potash)	1.27	0.20	0.40	0.13	0.55
T <sub>3</sub> (Potassium sulphate)	1.19	0.21	0.48	0.11	0.50
T <sub>4</sub> (Sodium chloride)	0.53	0.33	0.56	0.36	0.53
T <sub>5</sub> (Sodium sulphate)	0.78	0.24	0.43	0.40	0.41
Level of Significance	p ≤ 0.01	P ≤ 0.05	P ≤ 0.05	P ≤ 0.001	Ns
	0.308	0.087	0.175	0.114	-

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

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

The experiment was established in 1991 with T x T seedlings planted on Andigama series soil at Ratmalagara Estate. The new treatment combinations are given in Table 16.

**Table 16 :** Treatment combinations and nut yield of the experiment

Treatments	g/palm/y	Mean yield nuts/palm/year
N (Urea 46% N)		
N <sub>1</sub>	0	25 ± 5
N <sub>2</sub>	600	26 ± 4
N <sub>3</sub>	1200	25 ± 4
K (Muriate of potash 60% K <sub>2</sub> O)		
K <sub>1</sub>	0	24 ± 3
K <sub>2</sub>	1200	26 ± 4
K <sub>3</sub>	2400	27 ± 4
Mg (Kieserite 24% MgO)		
Mg <sub>1</sub>	0	24 ± 3
Mg <sub>2</sub>	750	26 ± 4
Mg <sub>3</sub>	1500	27 ± 5
Basal Phosphate application		
Imported Rock Phosphate 600 g/palm/y		

Application of treatment in Table 17 combinations was commenced from 2002. The experiment will be continued as a 3 x 3 x 3 N, K Mg factorial experiment. In all the plots 90-95% of the palms were in bearing stage.

The nut yield of the experiment have not shown any significant differences among the treatments. The yield per palm remained as low as 20-30 in the year 2002 probably due to the dry period prevailed in the year.

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**Experiment 7.0.2 : Formulation of a suitable fertilizer mixture, irrigation and ethrel levels for palms in tapping continuously or seasonally (1998)**

This experiment was established in November 1998 at Bandirippuwa Estate (IL1, Sandy loam, S<sub>2</sub>) in a factorial design with 3 replicates and with three fertilizer treatments, two irrigation treatments and two ethrel treatments. There were four effective palms per plot. The treatments were as follows.

No Fertilizer (FL <sub>0</sub> )	-	Control for fertilizer treatments
Fertilizer 1 (FL <sub>1</sub> )	-	Equal to nutrient removal by toddy and other parts ( N = 460 g, P <sub>2</sub> O <sub>5</sub> = 248 g, K <sub>2</sub> O = 1890 g and MgO = 100 g)
Fertilizer 2 (FL <sub>2</sub> )	-	1 ½ times of FL1 treatment
No irrigation (IL <sub>0</sub> )	-	Control for irrigation treatment
Irrigation (IL <sub>1</sub> )	-	Watering to 80% of field capacity
No ethrel (EL <sub>0</sub> )	-	Control for ethrel treatment
Ethrel (EL <sub>1</sub> )	-	Application of 2.5% ethrel solution on the flower

As reported in the Annual Report 2001, according to the results obtained upto 2001, the significantly highest toddy yield (mean toddy yield was 62.5 l/palm/year) was obtained from the treatment combination of FL<sub>2</sub> IL<sub>1</sub> EL<sub>1</sub>. Therefore a fertilizer recommendation for toddy tapping palm was formulated for the consideration of the Research Committee. The fertilizer recommendation is application of 1.5 kg urea, 1.4 kg Imported Rock Phosphate, 4.8 kg of muriate of potash and 0.75 kg of dolomite per palm per year. The above quantity has to be split into two halves and applied six monthly as the quantity is too much for single application. Eppawela Rock Phosphate 2.1 kg can be recommended instead of 1.4 kg of Imported Rock Phosphate.

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

This experiment, on a Randomized Block Design with 4 replicates and 3 palms per plot and six treatments was established on adult palms in 1997 at the following two locations.

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

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

The fertilizer treatments are given in Table 17.

**Table 17 :** *N, P, K and Mg treatment combinations of the experiment*

Treatment	Rate of application g/palm/6 months			
	Urea (g)	SP (g)	MOP (g)	Dolomite (g)
T <sub>1</sub>	-	-	-	-
T <sub>2</sub>	400	250	650	400
T <sub>3</sub>	600	375	1000	600
T <sub>4</sub>	800	500	1350	800
T <sub>5</sub>	400	300	800	500
T <sub>6</sub>	600	450	1200	750

The mean nut yields of Marandawila and Walpita sites are given in Table 18.

**Table 18 :** *The nut yields at Marandawila and Walpita sites*

Treatment	Marandawila nuts/palm		Walpita nuts/palm	
	Cumulative yield from 1998 -2001	2002	Cumulative yield from 1997-2001	2002
T <sub>1</sub>	456	105	337	45
T <sub>2</sub>	448	118	430	55
T <sub>3</sub>	512	124	442	66
T <sub>4</sub>	441	112	403	54
T <sub>5</sub>	402	105	426	56
T <sub>6</sub>	-	-	439	75
Level of Significance		ns	ns	P ≤ 0.05
LSD (p ≤ 0.05)	-	-	-	26

T<sub>1</sub> – Control – no fertilizer; T<sub>2</sub> – ½ NPK removal/6 months; T<sub>3</sub> – ¾ times NPK removal/6 months; T<sub>4</sub> – NPK equal to removal/6 months; T<sub>5</sub> – APM; T<sub>6</sub> – 1 ½ times APM

At Walpita site, the yield of T<sub>6</sub> treatment (1 ½ times the APM) was significantly (p ≤ 0.05) higher than the control. The yield of treatment T<sub>3</sub>, which is based on (¾ times NPK removal) the annual average nutrient removal by king coconut palms, was also quite high

although the difference was not significant at 5% level. At Marandawila site the highest yield have reported from palms receiving T<sub>3</sub> treatment. However the difference was not significant at 5% level.

In addition to nut yield, the nut weight was also measured in 2002 at Marandawila site. It showed that the nut weights of T<sub>3</sub> and T<sub>4</sub> were higher than other treatments (Table 19).

**Table 19 :** *Copra weight at Marandawila site*

Treatment	Husked nut weight (kg/nut/year)
T <sub>1</sub>	2.76
T <sub>2</sub>	2.92
T <sub>3</sub>	3.30
T <sub>4</sub>	3.44
T <sub>5</sub>	3.33
Significance level	p ≤ 0.05
LSD (p ≤ 0.05)	0.378

Although, there was no increased in nut yield at Marandawila site, there was a significant increase in the husked nut weight in response to treatments T<sub>3</sub>, T<sub>4</sub> and T<sub>5</sub>. It indicates the size of king coconut would increase due to fertilizer treatment.

Soils samples, taken in January 2002 from Walpita site were analyzed. The results are given in Table 20.

**Table 20 :** *Nutrient concentrations of the soil of Walpita Estate (0-25 cm)*

Treatment	pH	Total N	Av. P	Exch. K	Exch. Na	Exch. Ca	Exch. Mg
		mg/kg	mg/kg	< ----- me eq100 g soil ----- >			
T <sub>1</sub>	6.3	1506	187	0.68	0.10	5.73	1.66
T <sub>2</sub>	6.3	1400	659	1.39	0.10	6.48	2.49
T <sub>3</sub>	6.2	1387	616	1.30	0.10	6.36	2.31
T <sub>4</sub>	6.4	1464	657	1.92	0.12	6.99	2.95
T <sub>5</sub>	6.4	1427	610	1.53	0.11	7.51	2.78
T <sub>6</sub>	6.5	1685	894	1.69	0.12	7.29	3.38
Level of Significance	ns	ns	P ≤ 0.05	P ≤ 0.001	ns	ns	P ≤ 0.01
LSD (p ≤ 0.05)	-	-	164.940	0.225	-	-	0.352

T<sub>1</sub> – Control – no fertilizer; T<sub>2</sub> – ½ NPK removal/6 months; T<sub>3</sub> – ¾ times NPK removal/6 months; T<sub>4</sub> – NPK equal to removal/6 months; T<sub>5</sub> – APM; T<sub>6</sub> – 1 ½ times APM

According to results of the analysis of soils from Walpita site, only exchangeable K and Mg and available P has increased according to treatment levels. The leaf analysis data of Walpita site in both January and May 2002 shows (Table 21) that only potassium concentrations has increased according to treatment levels and concentration in the soil. The

high value of leaf Mg concentration obtained for the control in May could be due to low K concentration in the leaf. The results show that king coconut palms on Boralu series soils at Walpita, respond to K fertilizer. The low nut yield of the control (Tale 18) could be due to low K level in the leaf.

**Table 21 :** Nutrient concentration in the 14<sup>th</sup> frond of the palms in different treatments Walpita Estate in January 2002

Treatment	N%	P%	K%	Ca%	Mg%
T <sub>1</sub>	2.05	0.12	1.15	0.30	0.17
T <sub>2</sub>	2.15	0.12	1.37	0.29	0.15
T <sub>3</sub>	2.18	0.12	1.36	0.34	0.13
T <sub>4</sub>	2.06	0.11	1.38	0.30	0.16
T <sub>5</sub>	2.06	0.12	1.27	0.34	0.17
T <sub>6</sub>	2.17	0.12	1.41	0.28	0.12
Level of Significance	ns	ns	ns	ns	ns
LSD (p< 0.05)	-	-	-	-	-

**Table 22 :** Nutrient concentration in the 14<sup>th</sup> frond of the palms in different treatments Walpita Estate in May 2002

Treatment	N%	P%	K%	Ca%	Mg%
T <sub>1</sub>	1.71	0.12	0.90	0.23	0.25
T <sub>2</sub>	1.69	0.11	1.16	0.23	0.19
T <sub>3</sub>	1.82	0.17	1.28	0.22	0.15
T <sub>4</sub>	1.78	0.11	1.21	0.22	0.19
T <sub>5</sub>	1.83	0.12	1.10	0.21	0.19
T <sub>6</sub>	1.83	0.12	1.28	0.19	0.17
Level of Significance	ns	ns	P ≤ 0.05	ns	P ≤ 0.01
LSD (p ≤ 0.05)	-	-	0.222	-	0.053

The soil samples taken in April 2002 at Marandawila site were analyzed and the results were given in Tables 23 and 24.

**Table 23 :** Nutrient concentration of the soils of Marandawila site (0-25 cm)

Treatment	pH	EC	Total N	Av. P	Ex K	Ex. Na	Ex. Ca	Ex. Mg
		μmhos/cm	mg/kg	mg/kg	< -----	meq/100 g soil -----		
T <sub>1</sub>	5.8	42.65	399	107	0.10	0.11	0.87	0.06
T <sub>2</sub>	6.0	51.54	459	185	0.36	0.10	0.82	0.06
T <sub>3</sub>	5.9	61.53	486	222	0.30	0.11	1.14	0.07
T <sub>4</sub>	6.1	57.06	418	307	0.26	0.08	1.03	0.07
T <sub>5</sub>	5.9	62.29	423	169	0.28	0.12	1.11	0.06
Level of Significance	ns	ns	ns	P ≤ 0.001	P ≤ 0.001	ns	ns	ns
LSD (p ≤ 0.05)	-	-	-	77.559	0.063	-	-	-

According to results of the soil analysis of Marandawila site, exchangeable K and available P were significantly lower in the control compared to other treatments. However such differences were seen only in 0-25 cm layer. The nutrient status of the sub soil (25-50 cm) were much lower compared to the top soil.

**Table 24 :** *Nutrient concentration of the soils of Marandawila site (25-50cm)*

Treatment	pH	EC µmhos/cm	Total N mg/kg	Av. P mg/kg	Ex. K <----- meq/100 g soil	Ex. Na ----->	Ex. Ca	Ex. Mg
T <sub>1</sub>	5.7	24.56	263	<25	0.04	0.04	0.50	0.05
T <sub>2</sub>	5.9	22.23	244	5.58	0.05	0.04	0.75	0.05
T <sub>3</sub>	5.8	25.94	260	8.87	0.04	0.02	0.42	0.05
T <sub>4</sub>	6.0	22.24	204	6.78	0.05	0.03	0.50	0.04
T <sub>5</sub>	5.7	21.89	224	5.21	0.04	0.03	0.41	0.04
Level of Significance	ns	ns	ns	ns	ns	ns	ns	ns
LSD (p ≤ 0.05)	-	-	-	-	0.063	-	-	-

The soil analysis showed that available P and exchangeable K in the soils of 0-25 cm depth have shown significant difference among the treatments while exchangeable K has shown significant difference in depth 25-50 cm.

Leaf samples taken in April and December 2002 at Marandawila site were analyzed and the results are given in Tables 25 and 26 respectively.

**Table 25 :** *Nutrient concentration in the 14<sup>th</sup> frond of the palms in different treatments – Marandawila Estate in April 2002*

Treatment	N%	P%	K%	Ca%	Mg%
T <sub>1</sub>	1.97	0.13	0.86	0.33	0.28
T <sub>2</sub>	1.90	0.12	1.09	0.34	0.30
T <sub>3</sub>	1.88	0.13	1.18	0.33	0.24
T <sub>4</sub>	1.90	0.12	1.21	0.33	0.26
T <sub>5</sub>	1.89	0.13	1.19	0.34	0.26
Level of Significance	ns	ns	P ≤ 0.001	ns	ns
LSD (p ≤ 0.05)	-	-	0.140	-	-

**Table 26 :** *Nutrient concentration in the 14<sup>th</sup> frond of the palms in different treatments – Marandawila Estate in December 2002*

Treatment	N%	P%	K%	Ca%	Mg%
T <sub>1</sub>	2.11	0.14	0.60	0.33	0.38
T <sub>2</sub>	2.02	0.14	0.85	0.33	0.34
T <sub>3</sub>	1.98	0.14	1.06	0.31	0.29
T <sub>4</sub>	1.99	0.14	1.03	0.28	0.29
T <sub>5</sub>	1.99	0.13	1.01	0.31	0.29
Level of Significance	ns	ns	P ≤ 0.001	ns	P ≤ 0.01
LSD (p ≤ 0.05)	-	-	0.097	-	0.056

Leaf analysis data of Marandawila site showed that potassium concentration in the 14<sup>th</sup> leaf was less than 1.21%. However the potassium concentration of the control was significantly lower than the that of other treatments and in the deficiency range. Contrary to Walpita site, the magnesium concentrations of all plots in Marandawila were in the sufficiency range (> 0.25%). This could be due to low concentration of K in the leaf.

According to the overall results, nutrient application equivalent to  $\frac{3}{4}$  times the annual removal appears to be a suitable fertilizer application rate. A fertilizer recommendation for king coconut on this basis will be made after reviewing the results of the next year.

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**PROJECT 7.1 : IMPROVEMENT OF DIFFERENTIAL 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 lands of different suitability classes to fertilizer doses that are higher than the generally recommended dose and to collect data on soil, plant and fertilizer rates to develop criteria for coconut palms in high potential lands.

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

Expt. No	Location	Agro ecological Region	Soil series	Year of commencement	Land suitability Class
7.1.2.1	Sirigampola	IL <sub>1</sub>	Madampe series	2002	S <sub>1</sub>
7.1.2.2	Mangala-eliya	DL <sub>1</sub>	Borupan series	2000	S <sub>3</sub>
7.1.2.3	Mawathagama	IL <sub>1</sub>	Kurunegala series	2000	S <sub>2</sub>
7.1.2.4	Kobeigana	IL <sub>1</sub>	Wariyapola series	2002	S <sub>3</sub>
7.1.2.5	Naiwala	WL <sub>3</sub>	Boralu series	2002	S <sub>4</sub>

The treatments for the all sites are given in Table 27.

**Table 27 :** *Treatment combinations in the experiment (g/palm/y)*

Treatments	Urea	SP/ERP	MOP	Dolomite
T <sub>1</sub>	0	0	0	0
T <sub>2</sub>	800	600	1600	1000
T <sub>3</sub>	1100	825	2200	1375
T <sub>4</sub>	1400	1050	2800	1750
T <sub>5</sub>	1700	1225	3400	2125

**Experiment 7.1.2.1 - Sirigampola Estate, Lunuwila**

A new site for Madampe soil series was selected at Sirigampola Estate, Lunuwila in 2002 instead of the previously selected site which was abandoned due to poor co-operation of the land owner. The area was mapped and plots were demarcated in May 2002. Preliminary yield recordings were done this year.

### Experiment 7.1.2.2 – Siriwasa Estate, Mangala-eliya

The sampling of soil and leaf after the 1<sup>st</sup> fertilizer application was done in January 2002 and the 2<sup>nd</sup> treatment application was made April 2002. The nut yield data from January 2002 to December 2002 are given in Table 28. There was significant difference in nut yield between treatments.

**Table 28 :** *The nut yield of Mangala-eliya site in 2001 and 2002*

Treatment	Nut yield (palm/year)	
	2001	2002
T <sub>1</sub>	58	65
T <sub>2</sub>	59	93
T <sub>3</sub>	63	80
T <sub>4</sub>	59	85
T <sub>5</sub>	58	81
Level of Significance		P ≤ 0.01
LSD (p ≤ 0.05)		12

The data in Table 28 showed that the highest nut yield has obtained in T<sub>2</sub> treatments which is the APM recommendation. The differences between yield of T<sub>2</sub> and T<sub>5</sub> treatment, which was the highest NPK treatment, was highly significant (p ≤ 0.001). The yield should be observed for few more years better making a recommendation.

The soil samples, taken in January 2001 i.e. 12 months after 1<sup>st</sup> treatment application, have shown significant differences in electrical conductivity and total nitrogen among the treatments (Tables 29 and 30).

**Table 29 :** *Nutrient concentration of the soils of Sirivasa Estate (Depth 0-25 cm)*

Treatment	pH	EC	Total N	Av. P	Ex. K	Ex. Na	Ex. Ca	Ex. Mg
		µmhos/cm	mg/kg	mg/kg	< ----- meeq/100 g soil ----- >			
T <sub>1</sub>	6.1	41.9	122	311	0.09	0.06	0.85	0.46
T <sub>2</sub>	6.1	47.5	129	328	0.27	0.07	0.80	0.45
T <sub>3</sub>	6.2	59.3	162	403	0.30	0.10	0.87	0.48
T <sub>4</sub>	6.3	65.5	210	468	0.42	0.08	0.99	0.53
T <sub>5</sub>	6.3	72.8	117	421	0.45	0.07	0.91	0.50
Level of Significance	ns	0.001	0.05	ns	ns	ns	ns	ns
LSD (p ≤ 0.05)	-	13.982	44.447	-	-	-	-	-

**Table 30 :** *Nutrient concentration of the soils of Sirivasa Estate (Depth 25-50 cm)*

Treatment	pH	EC	Total N	Av. P	Ex.. K	Ex. Na	Ex. Ca	Ex. Mg
		$\mu\text{mhos/cm}$	mg/kg	mg/kg	< -----	meeq/100 g soil	----	>
T <sub>1</sub>	6.2	39.7	87	73	0.13	0.09	0.55	0.09
T <sub>2</sub>	6.3	51.3	99	139	0.29	0.09	0.54	0.04
T <sub>3</sub>	6.1	44.2	108	123	0.29	0.09	0.62	0.06
T <sub>4</sub>	6.3	57.7	133	141	0.34	0.09	0.51	0.10
T <sub>5</sub>	6.3	73.6	114	205	0.43	0.09	0.70	0.19
Level of Significance	ns	0.001	0.05	ns	ns	ns	ns	ns
LSD	-	8.843	28.111	-	-	-	-	-

( $p \leq 0.05$ )

However, the nutrient concentration in the 14<sup>th</sup> leaf of sample taken in January 2002 have not shown any significant differences among the treatments (Table 31). Results also showed that the K concentration of the palm were below the critical levels (1.2 – 1.4%).

**Table 31 :** *Nutrient concentration in the 14<sup>th</sup> frond of the palms in different treatments – Sirivasa Estate (12 months after the 1<sup>st</sup> fertilizer application)*

Treatments	N%	P%	K%	Ca%	Mg%	Na%
T <sub>1</sub>	2.19	0.124	0.95	0.34	0.32	0.17
T <sub>2</sub>	2.13	0.135	1.09	0.34	0.29	0.19
T <sub>3</sub>	2.21	0.123	1.09	0.31	0.29	0.16
T <sub>4</sub>	2.10	0.136	1.11	0.34	0.31	0.20
T <sub>5</sub>	2.23	0.130	1.02	0.37	0.32	0.15
Level of Significance	ns	ns	ns	ns	ns	ns

The 2<sup>nd</sup> leaf samples were taken in December 2002 i.e. 12 months after the 2<sup>nd</sup> fertilizer application. The chemical analysis showed that there was no significant differences among the treatment (Table 32). However the results showed that leaf K levels were below the critical levels (1.2 – 1.4%).

**Table 32 :** *Nutrient concentration in the 14<sup>th</sup> frond of the palms in different treatments – Sirivasa Estate – (12 month after the 2<sup>nd</sup> fertilizer application)*

Treatments	N%	P%	K%	Ca%	Mg%	Na%
T <sub>1</sub>	2.02	0.142	0.82	0.41	0.37	0.20
T <sub>2</sub>	2.03	0.141	0.88	0.37	0.29	0.21
T <sub>3</sub>	2.06	0.138	0.88	0.35	0.31	0.19
T <sub>4</sub>	2.00	0.143	0.89	0.37	0.32	0.21
T <sub>5</sub>	2.03	0.143	0.87	0.41	0.34	0.19
Level of Significance	ns	ns	ns	ns	ns	ns

### Experiment 7.1.2.3 – Mawathagama

This site was abandoned in 2001 and a new site from Ganewatte area of Kurunegala series were selected. Due to intensive *Aceria* mite damage, this site was also abandoned. The selection of new site of Kurunegala series is in progress.

### Experiment 7.1.2.4 - Kobeigana

To represent Wariyapola soil series, a new site was selected at Kobeigane. Mapping of area and demarcating the plots were completed in February 2002 and preliminary nut yield recording was carried out during the year.

### Experiment 7.1.2.5 – Naiwala

A site at Naiwla, Gampaha was selected in February 2002 to represent Boralu series soil. The area was mapped and plot demarcating was completed. Preliminary nut yield recording was carried out through out the year.

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

### Experiment 7.2.1 : Determination of critical levels for Zn and Cu in the coconut palm (1997)

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

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

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

There was no significant difference in the cumulative yield from 1998 to 2001 and also in yield of 2002 at both Pottukukama and Ratmalagara Estate (Table 33).

**Table 33 :** *The treatment combinations and the average nut yield*

	Treatments		Pottukulama Site		Ratmalagara Site	
	CuSO <sub>4</sub> g/palm	ZnSO <sub>4</sub> g/palm	Cumulative yield From 1998 to 2001	2002	Cumulative yield From 1998 to 2001	2002
T <sub>1</sub>	-	-	382	85	358	77
T <sub>2</sub>	50	100	386	94	334	70
T <sub>3</sub>	50	200	354	95	351	74
T <sub>4</sub>	100	100	365	91	329	69
T <sub>5</sub>	100	200	359	86	340	66
T <sub>6</sub>	200	400	391	95	328	68
Level of significance			ns	ns	ns	ns
CV%			22%	13%	17%	19%

The soil and leaf analysis data in 2001 (reported in the Annual Report 2001) showed that palms at both sites have not responded to increase in Zn and Cu concentrations in the soils.

The palms in both sites have not responded to five years continuous application of both ZnSO<sub>4</sub>.7H<sub>2</sub>O and CuSO<sub>4</sub>.7H<sub>2</sub>O at high levels as 400 g and 200 g per palm per year respectively. It was concluded that the palms are not absorbing Zn and Cu despite soil application. At both sites, the Zn concentration of 14<sup>th</sup> leaf was in the range of 22-28% and Cu concentration was in the range of 4-6%. Since the concentrations were not affected due to Zn and Cu treatment application, the above ranges can be accepted as sufficiency ranges for Zn and Cu under Sri Lankan conditions. With those concentrations, the yields of palms were as high as 70-95 nuts per palm per year. This experiment at both sites was terminated at the end of year 2002.

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

The aim of this experiment was to quantify the removal of some micronutrients from coconut palms growing in moderately suitable (S<sub>4</sub>) and highly suitable (S<sub>1</sub>) land classes.

The experiment, on the S<sub>1</sub> land suitability class (Madampe series soils) was commenced in September 1998 at the Bandirippuwa Estate. The dry weight of different components removed by a coconut palm in Madampe series soil over the period of 4 years given below in Table 34.

**Table 34 :** *The dry weight of different components removed by a palm in Madampe series soil over the period of 4 years*

Year	No. of nuts/palm	Dry wt. of nuts kg/palm	No. of fronds/palm fallen	Dry wt. of fronds Kg/palm	Inflorescence button nuts immature Kg/palm	Total kg/palm
1 <sup>st</sup> year (1998 Sep. to 1999 August)	110	117	15	44	26	187
2 <sup>nd</sup> year (1999 Sep. to 2001 August)	113	101	21	51	27	179
3 <sup>rd</sup> year (2000 Sept. to 2001 August)	92	82	17	48	13	143
4 <sup>th</sup> year (2001 Sept. to 2002 August)	88	73	8	24	13	110

There is a gradual decrease in nut productions as well as frond production. According to that nut weight decreased from 110 to 88, fronds from 44 to 24 and inflorescence from 26 to 13 kg/palm/year.

The experiment on land suitability class S<sub>4</sub> was commenced in 2000 in a field containing Boralu series soil in Bandirippuwa Estate. Ten T x T palms, which were 20 years old, were randomly selected as replicates for the latter experiments. The number and the weight of each component removed by the palm was determined monthly.

The dry weight of nuts removed by a coconut palm in Boralu series over a 2 years period are given in Table 35.

**Table 35 :** *The dry weight of nuts removed by a coconut palm in Boralu series over a 2 years period*

Palm No.	1 <sup>st</sup> Year (2001)		2 <sup>nd</sup> Year (2002)	
	Nuts/palm	Dry weight of nuts (kg/palm)	Nuts/palm	Dry weight of nuts (kg/palm)
1	3.7	3.90	5.0	3.76
2	2.6	2.29	9.6	6.92
3	7.8	5.68	7.6	5.11
4	5.2	4.93	8.6	6.18
5	6.2	5.50	8.4	5.53
6	2.8	2.33	9.0	6.29
7	4.3	3.77	7.5	5.49
8	1.3	0.98	3.7	3.72
9	5.7	5.68	3.5	3.37
10	1.1	1.23	1.3	2.00
11	7.2	6.38	4.5	3.15
12	7.5	6.80	3.1	1.78
Total	55.4	49.46	72.1	53.31

The nut yield has increased from 55 to 72 and dry weight from 50 to 53 kg/palm from year 2001 to 2002. The component analysis is in progress.

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**Experiment 7.2.3 : Determination of micronutrient status of coconut palms on major soil series under different fertilizer practices**

For this study, leaf and soil samples were collected from coconut lands managed with different fertilizer practices. The sites were located to represent some major soil series in the coconut triangle. Several locations were selected from each soil series. The soil series, the locations and the fertilizer practices at each site are given in Table 36.

**Table 36 :** *Sampling locations for micronutrient studies*

Soil series	Location	Fertilizer practices		
		Organic	Inorganic	No Fertilizer
Kalpitiya	Talawila, Palakuda, Kadayamatte, Daluwa, Seetapola, Theheliya, Kurinchipitiya	Organic	Inorganic	No Fertilizer
Weliketiya	Thoduwawa, Talwila, Kattantivu, Setapola, Pujapitiya, Marawila, Thoduwawa, Watawana, Ambakandawila, Udappuwa, Chilaw, Panapitiya	Organic	Inorganic	No Fertilizer
Pallama	Walpita, Gaspe	Organic	Inorganic	
Wilaththawa	Galmuruwa	Organic		
Katunayaka	Katunayaka, Kadirana		Inorganic	No Fertilizer
Rathupasa	Marawila, Mahawewa		Inorganic	No Fertilizer
Dummalasuriya	Kattimahana, Horombugama	Organic	Inorganic	No Fertilizer
Boralu	Walpita, Gaspe, Banduragoda, Wattemulla,	Organic	Inorganic	No Fertilizer
Kurunegala	Pahamunae			
Kuliyapitiya	Pahamunae	Organic	Inorganic	No Fertilizer
Madampe	Galmuruwa, Sirigampola, Mahawewa, Dematapitiya, Karukkuwa, Kirimetiayana, Marawila, Katuneriya, Mudukatuwa, Madampe, Kakkapalliya, Thalawila, Pambala, Milawa, Walahapitiya	Organic	Inorganic	No Fertilizer
Wariyapola	Hettipola, Ibbagamuwa, Peddawa, Nikadalupotha, Kanaththegama, Ganewatta, Warawala	Organic	Inorganic	No Fertilizer
Andigama	Henegedara, Dumalasuriya, Welipannagahamulla, Rathmalagara, Nattandiya, Hawana, Kachchakaduwa	Organic	Inorganic	No Fertilizer

The leaf samples were analyzed for Zn in this year. The mean value for Zn was calculated separately for sites having different fertilizer practices. The results are presented in Table 37.

**Table 37 :** Zn concentration of different leaf ranks of palms receiving different fertilizer treatments – Means of 29 sites

Fertilizer practice	Leaf rank	Zn (mg/kg)
Organic	1 <sup>st</sup>	20.74 ± 5.02
	6 <sup>th</sup>	21.36 ± 4.54
	14 <sup>th</sup>	24.18 ± 6.37
Inorganic	1 <sup>st</sup>	20.19 ± 5.95
	6 <sup>th</sup>	21.57 ± 5.83
	14 <sup>th</sup>	24.86 ± 5.85
No Fertilizer	1 <sup>st</sup>	26.26 ± 9.01
	6 <sup>th</sup>	27.52 ± 5.25
	14 <sup>th</sup>	35.67 ± 12.34

There was no significant differences of Zn concentrations among sites receiving different fertilizer application practices. Zn concentration in the 14<sup>th</sup> frond were the respective critical level (20 – 30 mg/kg).

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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 on a Randomized Block Design with 3 replicates and five treatment plot was established in 1999 at Pottukulama Research Station.

The same experiment, on a Restricted Randomized Grouped Block (Complete) Design with single palm per treatment within a block, four treatments per block, three blocks per group with six groups was established in 2002 at Bandirippuwa Estate.

Expt No.	Location	Agro-ecological Region	Soil type	Land suitability class
9.0.2.1	Pottukulama Research Estate	IL <sub>3</sub>	Sandy loam (Welipelessa series)	S <sub>2</sub>
9.0.2.2	Bandirippuwa Estate	IL <sub>1</sub>	Gravel (Boralu series)	S <sub>4</sub>

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

**PRS Site**

- T<sub>1</sub> - APM (3 kg) in the entire manure circle (1.75 m) – control
- T<sub>2</sub> - APM (3 kg) + kieserite (1 kg) in the entire manure circle (1.75 m)

- T<sub>3</sub> - Muriate of potash (1600 g) in one half of the manure circle and kieserite (1 kg) in the other half of the manure circle, 800 g of urea and 600 g of ERP in the entire manure circle
- T<sub>4</sub> - APM (3 kg) in the entire manure circle and kieserite (1 kg) in the entire manure circle six months later
- T<sub>5</sub> - The manure circle is divided into two portions; 0.8 m radius circle around the palm (portion 1) and a 0.8 m wide strip encircling the portion 1 (portion 2) kieserite (1 kg) in portion 1 and APM (3 kg) in portion 2

#### ***Bandirippuwa Estate Site***

- T<sub>1</sub> - APM (3 kg) in the entire manure circle (1.75 m) - control
- T<sub>2</sub> - APM (3 kg) + kieserite (1 kg) in the entire manure circle (1.75 m)
- T<sub>3</sub> - Muriate of potash (1600 g) in one half of the manure circle and kieserite (1 kg) in the other half of the manure circle. 800 g of Urea and 600 g of ERP in the entire manure circle
- T<sub>4</sub> - APM (3 kg) in the entire manure circle and kieserite (1 kg) in the entire manure circle 6 months later

Leaf samples at PRS site were taken from the 14<sup>th</sup> frond in December 2002. Leaf nutrient concentrations are given in Table 38. Final kieserite application will be done in January 2003. Leaf samples were taken from both the 6<sup>th</sup> and 14<sup>th</sup> fronds in November at BE site. Analysis is in progress.

**Table 38 :** *Leaf nutrient status of 14<sup>th</sup> leaf of the palms at PRS*

Tratments	N%	P%	K%	Ca%	Mg%
T <sub>1</sub>	2.14	0.13	1.53	0.47	0.20
T <sub>2</sub>	2.22	0.13	1.47	0.49	0.22
T <sub>3</sub>	2.29	0.14	1.47	0.50	0.22
T <sub>4</sub>	2.33	0.14	1.45	0.51	0.21
T <sub>5</sub>	2.31	0.14	1.51	0.47	0.19
Level of Significnacen	ns	ns	ns	ns	ns
LSD (p ≤ 0.05)	-	-	-	-	-

The leaf data of PRS site shows that the effect of spatial separation of placement of kieserite and muriate of potash (T<sub>3</sub>) and time separation of placement (T<sub>4</sub>) on magnesium uptake of the palm has been similar. Potassium (K) or Mg uptake has not been affected by separate placement in time or space.

The simultaneous placement of kieserite and muriate of potash (T<sub>2</sub>) also has the same effect on magnesium uptake as other treatments. At PRS site, none of the methods has been superior as magnesium deficiency (Mg concentration < 0.25%) has not been corrected in any of the plots.

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### Experiment 9.0.3 : Determination of the effect of dolomite application on the loss of nitrogen from soils treated with urea based NPK mixtures

This experiment was commenced in 2002 December on Boralu series soils (S<sub>4</sub>) in Bandirippuwa Estate. The experiment consisted of eight treatments with 3 replicates on a Randomized Block Design. The treatments were applied to the cement pots and placed on the manure circles of coconut palms.

The treatments were as follows.

- T<sub>1</sub> - Control (no fertilizer)
- T<sub>2</sub> - Application of 5.2 g dolomite/pot and incorporate to the soil
- T<sub>3</sub> - Application of 4.2 g urea/pot and incorporate to the soil
- T<sub>4</sub> - Application of 4.2 g urea/pot and 5.2 g dolomite/pot and incorporate to the soil
- T<sub>5</sub> - Application of 4.2 g urea/pot and 5.2 g dolomite/pot and incorporate to the soil with a time gap (one month after urea application)
- T<sub>6</sub> - Application of 4.2 g urea/pot and 5.2 g dolomite/pot mixed together and incorporate to the soil
- T<sub>7</sub> - T<sub>3</sub> with mulching
- T<sub>8</sub> - T<sub>6</sub> with mulching

Fertilizers were broadcast to the soil and immediately incorporated with the soil up to 4 cm depth.

After treatment application, soil samples up to 10 cm depth were taken daily from each pot. The samples will be analyzed for pH, moisture, total N, ammonical N and nitrate N at the field moist state. Temperature and NH<sub>3</sub> volatilization of each pot will be measured daily. Soil sampling and analysis is in progress.

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### Experiment 9.0.4 : Preparation of a nutrient solution from coconut husk

The objective of the present study was to develop a non-destructive method for extraction of potassium and other nutrients from coconut husk before utilizing them for other purposes. The extraction would be used as a nutrient solution for coconut and other crops.

As a preliminary step, fresh husks (immediately after dehusking) and dried husks (dry husks collected from a heap) were soaked in water for one week and pressed using a rubber roller to extract nutrients. Concentration of nutrients in water after soaking husks for one week and given in Table 39.

**Table 39 :** *Concentration of nutrient in water after soaking husks for one week*

	P (mg/l)	K (mg/l)	Mg (mg/l)	Ca (mg/l)	Na (mg/l)
Fresh husks	Trace	624	0.19	0.10	8.85
Dry husks	1.7	75.6	0.03	Trace	8.38

Concentration of nutrients in water extracted by pressing the husks using rubber roller are given in Table 40.

**Table 40 :** Concentration of nutrient in water extracted by pressing the husks using rubber roller (after soaking)

	P (mg/l)	K (mg/l)	Mg (mg/l)	Ca (mg/l)	Na (mg/l)
Fresh husks	6.31	2288	2.36	0.67	29.7
Dry husks	3.88	465	0.32	0.39	31.9

Also, water samples were collected from tanks where husks were soaked before processing for fiber and from wells close to those tanks. For this purpose, fibre mills were selected from Pannala, Welpalla, Udawela, Welipennagahamulla, Dummaladeniya, Bolawatta and Wennappuwa areas. Concentration of nutrients in husks in fibre mills are given in Table 41.

**Table 41 :** Concentration of nutrients in husk tanks in fibre mills

Location	pH	EC ( $\mu$ mho/cm)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)
Pannala	6.35	1560	401	0.09	0.12	85.6
Welpalla	6.63	1248	362	0.07	0.1	97.8
Udawela	6.59	5304	1270	0.21	0.54	226
Welipennagahamula	6.36	6240	1149	0.24	0.51	242
Dummaladeniya	6.57	9360	2039	0.85	2.3	907
Bolawatta	6.51	17160	666	1.46	2.62	610
Wennappuwa	6.32	9048	1531	0.43	3.77	481

Concentrations of nutrients in well water near the fibre mills are given in Table 42.

**Table 42 :** Concentration of nutrients in well water near the fiber mill

Location	pH	EC ( $\mu$ mho/cm)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)
Pannala	6.92	396	2.71	0.62	0.39	42.4
Welpalla	7.4	93	5.67	0.01	0.06	13.7
Udawela	7.67	592	20.7	1.68	0.23	42.9
Welipennagahamula	7.08	296	10.2	0.16	0.14	34.6
Dummaladeniya	7.26	468	5.63	0.11	0.2	79.4
Bolawatta	6.93	358	110	1.74	2.51	42.7
Wennappuwa	7.61	405	7.05	0.46	0.19	50.5

The results showed that the highest potassium extraction could be achieved by pressing fresh husks in a rubber roller. The extractable potassium is much lower in dry husks. The potassium and sodium concentrations of the water in husk soaking pits were found to be highly variable depending on the location.

Different methods were used for nutrient extraction of fresh husks. They were

- i. Pressed the fresh husks prior to soaking water
- ii. Collected water after the washings of pressed husks (pressed fresh husks soaked in water for few days)
- iii. Collected water by pressing the above husks as indicated in (ii)

Concentration of nutrients of water extracts from the above methods are given in Table 43.

**Table 43 :** Concentration of nutrients extracted from fresh husks

	K	Mg	Ca	pH	EC
	< ----- mg/l ----- >				( $\mu$ mhos/cm)
Pressed fresh husk prior to soaking in water	8058	3.68	7.1	4.9	31980
Washings of the pressed husk	1340	28	11	5.16	7176
Extract of the same husk by pressing after soaking in water	1267	26	12	5.12	6942
Coir dust	-	--	-	5.8	181

Potassium concentrations of pressed fresh husk prior to soaking in water was 8058 mg/l. The concentration of K in washings of the pressed husk and extract of the same husk by pressing after soaking in water was 1340 and 1267 mg/l respectively.

It follows that the most suitable method for efficient extracting of potassium from husks is to press the fresh husks without soaking in water.

Waste water samples in fibre mills were also analyzed (Table 44).

**Table 44 :** Nutrient concentrations in waste water of fibre mills

	K	Mg	Ca	Na
	< ----- mg/l ----- >			
Water after husks are soaked	666	2.62	1.46	107
Water squeezed out from fibre machine	821	2.16	1.14	621
Water squeezed out from coir dust pressing machine	877	2.73	1.58	738

Table 44 shows that waste water collected from the fibre mills are also dilute potassium solutions. However the concentration is not adequate to be used them as nutrient solution.

#### **Pot Experiment :**

A pot experiment was established to examine the plant growth when fresh coconut husk extract use as a nutrient solution. *Panicum maximum* grass was planted and following treatments were applied. There were 3 replicates for each treatment.

## Treatments

- T<sub>1</sub> - Control
- T<sub>2</sub> - Husk extracts
- T<sub>3</sub> - Nutrient solution (+N, +P, +K, and +Mg)

The experiment is in progress.

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### **Experiment 9.0.5: The effect of magnesium fertilizers on the potassium and magnesium dynamics in different coconut growing soils (2002)**

This experiment was carried out to determine the factors such as rate of change of quantity and intensity factors of potassium and magnesium after application of dolomite/kieserite to different coconut growing soils.

Madampe, Kalpitiya, Weliketiya and Boralu series soils were selected for the experiment. A pot experiment with Randomized Block Design with 3 replicates was established in the green house at Coconut Research Institute.

Treatments were as follows.

- T<sub>1</sub> - Neither dolomite nor kieserite - Control
- T<sub>2</sub> - 775 g of dolomite per 1 m<sup>3</sup> of soil (recommended rate of application of dolomite) - D<sub>1</sub>
- T<sub>3</sub> - 1550 g of dolomite per 1 m<sup>3</sup> of soil (recommended rate of application of dolomite x 2) - D<sub>2</sub>
- T<sub>4</sub> - 580 g of kieserite per 1 m<sup>3</sup> of soil (recommended rate of application of kieserite) - K<sub>1</sub>
- T<sub>5</sub> - 1160 g of kieserite per 1 m<sup>3</sup> of soil (recommended rate of application of kieserite x 2) - K<sub>2</sub>
- T<sub>6</sub> - 388 g of dolomite + 290 g of kieserite per 1 m<sup>3</sup> of soil (½ x recommended rate of application of dolomite + ½ x recommended rate of application of kieserite) - KD<sub>1</sub>
- T<sub>7</sub> - 775 g of dolomite + 580 g of kieserite per 1 m<sup>3</sup> of soil (recommended rate of application of dolomite + recommended rate of application of kieserite - KD<sub>2</sub>)

Soil moisture was maintained at its field capacity by watering to a constant weight. Soil sampling were carried out, at every 2 weeks intervals up to three months and at one month intervals up to six months to analyze the intensity and quantity factors with respect to K and Mg. Buffer capacity of each soil series was determined with respect to K and Mg by Q/I curves. In addition, equilibrium activity ratios for Mg in different soils before and after treatment application with dolomite/kieserite was determined (Table 45).

The equilibrium activity ratios obtained for the Madampe soil series was as follows and the chemical analysis for other samples are in progress.

Data were analyzed separately for each time treating the pre treatment equilibrium activity ratio as a covariate and found that there is no significant effect from pre-treatment data.

**Table 45 :** *Rate of change of equilibrium activity ratio of Mg with dolomite/kieserite applications for Madampe soil series*

Treatment	Time weeks							
	2	4	6	8	12	16	20	24
0	1.0565	0.6385	0.6714	0.7491	0.8734	0.8072	0.7500	0.9036
D <sub>1</sub>	1.0595	0.8285	0.8600	0.7964	1.0667	0.9460	0.9500	1.1534
D <sub>2</sub>	1.1800	0.8330	0.8642	0.8100	0.9748	1.1360	1.1516	1.1552
K <sub>1</sub>	1.1800	0.9950	1.0357	1.037	1.2135	1.2857	-	1.1490
K <sub>2</sub>	1.6600	1.1560	1.1528	1.2314	1.3912	1.2018	-	1.0139
KD <sub>1</sub>	1.0000	1.1305	1.0040	0.9855	-	1.2440	1.4854	1.3505
KD <sub>2</sub>	1.0515	1.2025	1.1414	1.1100	1.7364	1.3664	-	1.3384
Level of Significance	*	***	***	**	***	**	***	ns
LSD (p ≤ 0.05)	0.3348	0.0624	0.081	0.0717	0.1214	0.1103	0.1043	-

The equilibrium activity ratio of Mg was higher in the treatments K<sub>1</sub>, K<sub>2</sub>, KD<sub>1</sub> and KD<sub>2</sub> treatments. The higher values persisted throughout 24 weeks period. On the contrary, in dolomite treatments, the Mg activity ratio showed some increase from the 12<sup>th</sup> week onward. It shows that kieserite application results in increasing Mg intensity in the soil solution for a period of two weeks but dolomite application is not much effective in increasing the Mg of soil in Madampe series soils. The experiment will be continued.

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

**Experiment 10.0.1 : Designing a suitable drip irrigation system for coconut plantations in Andigama series soil (1996)**

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

Following are the treatments of the experiment

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

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

The irrigation treatments were meant to maintain different degrees of water stress in the palms by controlled irrigation and to determine the optimum irrigation rate that would nullify water stress. The nut yield data are given in Table 46.

**Table 46 :** *Nut yield for each treatment*

Treatment	Yield (nuts/palm/yr)	
	Cumulative yield from 1998 to 2001	2002
T <sub>1</sub>	217	38
T <sub>2</sub>	261	48
T <sub>3</sub>	227	56
T <sub>4</sub>	208	45
T <sub>5</sub>	287	50
T <sub>6</sub>	235	41
% CV	31	22
Significance of difference	ns	P < 0.05
LSD (p ≤ 0.05)	-	15.367

T<sub>1</sub> – Control; T<sub>2</sub> – 1/3 husk pits; T<sub>3</sub> – 600 l at 5 days interval; T<sub>4</sub> – 720 l at 10 days interval; T<sub>5</sub> – 1080 l at 25 days interval; T<sub>6</sub> – 1200 l at 40 days interval

The analysis of variance showed that palms treated with 600 l of water once in 5 days (T<sub>3</sub>) showed a yield increase of 47% over the control treatment. In each irrigation treatment, palms were irrigated by 4 drippers, each delivering water at the rate of 30 l/h. In treatments T<sub>4</sub>, T<sub>5</sub> and T<sub>6</sub> irrigation rates were 72 l, 42 l and 30 l per day respectively compared to T<sub>3</sub> where the irrigation rate was 120 l per day.

The soils and leaf sampling were completed in May 2002. The data of soil and leaf analysis are given in Tables 47 and 48.

**Table 47 :** *Nutrient concentrations of the soil (0-25 cm depth)*

Treatment	pH	EC	Total N	Av. P	Ex. K	Ex. Na	Ex. Ca	Ex. Mg
T <sub>1</sub>	6.04	91.09	515	588	1.07	0.18	1.77	3.22
T <sub>2</sub>	6.21	78.33	500	514	0.86	0.18	1.40	3.12
T <sub>3</sub>	5.90	73.60	514	638	0.85	0.20	1.82	2.83
T <sub>4</sub>	5.96	83.10	622	530	0.91	0.21	1.93	2.93
T <sub>5</sub>	6.16	68.93	445	424	0.82	0.18	1.68	2.85
T <sub>6</sub>	6.13	70.78	488	459	0.67	0.18	1.62	2.82
Level of Significance	ns	ns	ns	P ≤ 0.001	P ≤ 0.5	ns	ns	ns
LSD (p ≤ 0.05)	-	-	-	205.341	0.037	-	-	-

T<sub>1</sub> – Control; T<sub>2</sub> – 1/3 husk pits; T<sub>3</sub> – 600 l at 5 days interval; T<sub>4</sub> – 720 l at 10 days interval; T<sub>5</sub> – 1080 l at 25 days interval; T<sub>6</sub> – 1200 l at 40 days interval

The soil analysis showed that available P and exchangeable K concentrations have shown significant differences among the treatments. The potassium and magnesium concentrations were high in control (no irrigation) soils than irrigated soils. The electrical conductivity values were also showed the same pattern. It could be due to either increased uptake by the palm due to watering or leaching down with water or both.

**Table 48 :** *Nutrient concentrations in the 14<sup>th</sup> frond of the palms in different treatments*

Treatment	N%	P%	K%	Ca%	Mg%
T <sub>1</sub>	1.99	0.13	1.60	0.41	0.19
T <sub>2</sub>	2.02	0.14	1.78	0.41	0.18
T <sub>3</sub>	1.99	0.13	1.54	0.43	0.18
T <sub>4</sub>	2.03	0.14	1.72	0.40	0.19
T <sub>5</sub>	2.01	0.15	1.65	0.47	0.22
T <sub>6</sub>	2.01	0.14	1.34	0.37	0.22
Level of Significance	ns	ns	ns	ns	ns

T<sub>1</sub> – Control; T<sub>2</sub> – 1/3 husk pits; T<sub>3</sub> – 600 l at 5 days interval; T<sub>4</sub> – 720 l at 10 days interval; T<sub>5</sub> – 1080 l at 25 days interval; T<sub>6</sub> – 1200 l at 40 days interval

The leaf nutrient concentrations have not shown any significant differences among the treatments. The nutrient concentrations of the palms were in the sufficiency ranges (i.e. N – 1.9 – 2.5%, P - 0.11 - 0.13%, K – 1.2 - 1.4%) except magnesium. Magnesium concentration were shown lower values of sufficiency range (i.e. Mg – 0.25 – 0.35%).

The above application rates were changed with effect from November 2002. The new application rates are given in Table 49.

**Table 49 :** *Treatments effect from November 2002*

Treatment	Irrigation intervals in days	Application of water per day/palm	Application of water per day/palm in hours	Application of fertilizer per year	No. of time of fertilizer application per year
T <sub>1</sub>	-	-	-	3 kg	1
T <sub>2</sub>	-	-	-	3 kg	1
T <sub>3</sub>	6	40	2	3 kg	1
T <sub>4</sub>	3	80	2	3 kg	1
T <sub>5</sub>	6	40	2	250 g	12
T <sub>6</sub>	3	80	2	250 g	12

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

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

The objective of this experiment was to determine available nutrients in all major soils in the coconut growing areas and to attempt to establish threshold levels for each nutrient in the soil for coconut. Soil samples were collected to represent the top layer (0-25 cm depth) and the sub layer (25-50 cm) of two major soil series, namely Boralu series and Pallama 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<sup>th</sup> frond) from coconut palms were also taken from the same location.

Soil samples were analyzed for available Fe, Mn, Cu and Zn by extracting with 0.005 M DTPA-TEA solution. The results are presented in Table 50.

**Table 50 :** *The micronutrient content of Boralu series and Pallama series soils*

Soil series	Position in the coconut land	Soil depth (cm)	Mean value of micronutrient content (mg/kg)			
			Fe	Mn	Cu	Zn
Boralu series	Centre of square	Top soil (T) (0-25 cm)	36.99	21.58	1.12	1.69
			±	±	±	±
		15.07	25.41	0.45	0.94	
	Manure circle	Sub soil (S) 25-50 cm	31.78	20.06	1.3	1.41
			±	±	±	±
		11.69	29.06	1.26	0.5	
Pallama series	Centre of square	Top soil (T) (0-25 cm)	45.81	26.52	1.2	2.07
			±	±	±	±
		23.63	26.71	0.89	1.09	
	Manure circle	Sub soil (S) 25-50 cm	38.79	19.86	1.03	1.57
			±	±	±	±
		17.42	22.28	0.42	0.91	
Pallama series	Centre of square	Top soil (T) (0-25 cm)	33.23	11.06	0.95	1.56
			±	±	±	±
		14.02	16.27	0.77	0.72	
	Manure circle	Sub soil (S) 25-50 cm	28.78	7.75	0.92	1.52
			±	±	±	±
		12.29	9.81	0.5	0.75	
Manure circle	Top soil (T) (0-25 cm)	48.02	9.61	0.85	1.83	
		±	±	±	±	
	29.53	10.24	0.34	1.13		
Manure circle	Sub soil (S) 25-50 cm	41.32	6.1	0.79	1.45	
		±	±	±	±	
			21.23	7.34	0.38	0.68

The standard deviations of each value show that concentrations of each micronutrient were highly variable and found in a wide range. However Cu and Zn are found in very low concentrations. The Cu and Zn concentrations in Pallama soils were lower than that of Boralu soils.

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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)**

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

Expt No.	Location	Agro-ecological Region	Soil type	Land suitability class
30.1.1	Ratmalagara Estate	IL <sub>1</sub>	Andigama series (moderately deep phase)	S <sub>4</sub>

The annual treatments application was as follows.

T <sub>1</sub>	-	Control (no fertilizer)
T <sub>2</sub>	-	3 kg APM (Adult Palm Mixture) + 1 kg dolomite per palm
T <sub>3</sub>	-	35 kg cattle manure + 1200 g MOP per palm
T <sub>4</sub>	-	25 kg goat dung + 800 g MOP per palm
T <sub>5</sub>	-	30 kg poultry manure + 750 g MOP per palm
T <sub>6</sub>	-	30 kg Gliricidia + 750 g IRP + 1500 g MOP + 1000 g dolomite per palm

The annual leaf sampling was done in April 2002 (after the 5<sup>th</sup> manure application) and the 6<sup>th</sup> manure application was completed in May 2002.

**Table 51 :** *Nut yield data in the Ratmalagara site*

Treatment	April 1997 to March 2001 nuts/palm	April 2002
T1 - Control	232	48
T2 - APM + dolomite	269	65
T3 - CD + MOP	298	65
T4 - GD + MOP	302	57
T5 - PM + MOP	316	75
T6 - Gliricidia + SP + MOP + Dolomite	282	55
Level of Significance	ns	ns
CV%	21	19

The nutrient concentrations in the 14<sup>th</sup> leaf of the plot palms at Ratmalagara site were in the sufficiency range with respect to N, P, K, Ca and Mg. Nut yield data are given in Table 51.

Even though nut yield are not showing any significant difference among the treatments, increasing trend of nut yield have shown in poultry manure applied palms than others. It was shown further 56% and 15% nut yield increase in the poultry manure applied palms over no fertilized palms and recommended inorganic fertilizer applied palms respectively.

A new site which was selected last year for this experiment, was also abandoned due to unavailability of that land for experimentation. Therefore another site for this experiment will be selected in next year.

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## **2. LABORATORY/MISCELLANEOUS STUDIES**

### **1. Effect of liquid organic fertilizer on soil quality**

The objective of this experiment was to compare the changes of soil quality (physical, chemical and biological properties) between liquid organic fertilizer (HUMAT 2000) treated soils and the inorganic fertilizer treated soils.

Six fertilizer treatments were used in this study. These were control – no fertilizer or HUMAT (T<sub>1</sub>), 1 ml of HUMAT 2000 per 7 kg of soil (Recommended HUMAT 2000 fertilizer), (T<sub>2</sub>), 3 ml of HUMAT 2000 fertilizer, per 7 kg of soil (T<sub>3</sub>), 5 ml of HUMAT 2000 fertilizer per 7 kg of soil (T<sub>4</sub>), YPM fertilizer (35.7 g of urea, 53.55 g of saphos phosphate, 35.7 g of muriate of potash and 124 g of Dolomite per 7 kg of soil) (T<sub>5</sub>) and combination of T<sub>2</sub> and T<sub>5</sub> treatments (T<sub>6</sub>).

The experiment was conducted in a green house of the Coconut Research Institute. Seven kilograms of soil were filled into the pots containing moisture up to field capacity. Experiment was laid out on Randomized Complete Block design, with three replicates. Biological and chemical parameters such as total number of bacterial colonies, total number of fungal colonies, soil moisture, pH, electrical conductivity, available nitrogen, total nitrogen, CEC, available phosphorus, organic carbon and exchangeable bases were determined at 10 days intervals up to 40 days period.

All fertilizer treatments showed significantly increased chemical and biological values compared to the control (T<sub>1</sub>). Among the treatments, highest NH<sub>4</sub>-N, available P and exchangeable K values have shown significantly in the T<sub>6</sub>. The percentage increase above parameters compared to T<sub>1</sub>, were 45%, 32% and 227% respectively at the 1<sup>st</sup> sampling time (10 days after treatment application). There is no significant difference in chemical or biological parameters of different levels of HUMAT 2000 application (T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub>).

When compared to the treatments T<sub>5</sub> and T<sub>2</sub>, T<sub>5</sub> showed 1761.2% and 416% increase in NH<sub>4</sub>-N and exchangeable K concentration at the final sampling time respectively (40 days after treatment application). Compared to T<sub>6</sub> and T<sub>2</sub>, T<sub>6</sub> showed 1822.7% and 5739% increase in NH<sub>4</sub>-N and exchangeable K concentrations at the final sampling.

The different application rates of HUMAT2000 (T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub>) have not shown any significant difference for the studied chemical and biological parameters throughout the sampling period. The application of HUMAT 2000 along with YPM have shown the best soil improvement than only HUMAT 2000 or only YPM applications. Application of HUMAT along with YPM was beneficial rather than application of HUMAT or YPM alone.

W A J Fernando and N A Tennakoon

## 2. Determination of available N, P, K and Mg quantity in different coconut growing soils by bioassay

The objective of this experiment was to quantify the major nutrients of wide spread soils of the coconut growing area by bioassay techniques. A pot experiment was commenced using three different soil series (Boralu, Wariyapola and Kurunegala) with *Panicum maximum* as the indicator plant to estimate the available N, P, K and Mg quantity in major coconut growing soils.

Soils, filled into plastic pots (2 kg soil/pot) were treated with the following treatments with 3 replicates on a Completely Randomized Block Design.

T <sub>1</sub>	-	Control (- All)	
T <sub>2</sub>	-	-N	1 g TSP, 0.2 g KCl, 0.1 g MgSO <sub>4</sub> .7H <sub>2</sub> O/Pot
T <sub>3</sub>	-	-P	0.16 g (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> , 0.2 g KCl, 0.1 g MgSO <sub>4</sub> .7H <sub>2</sub> O/Pot
T <sub>4</sub>	-	-K	0.16 g (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> , 1 g TSP, 0.1 g MgSO <sub>4</sub> .7H <sub>2</sub> O
T <sub>5</sub>	-	-Mg	0.16 g (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> , 1 g TSP, 0.2 g KCl
T <sub>6</sub>	-	+NPKMg (+ All)	0.16 g (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> , 1 g TSP, 0.2 g KCl, 0.1 g MgSO <sub>4</sub> .7H <sub>2</sub> O

The grass was cut at one month intervals for 3 years and fresh and dry weights were recorded (Table 52). The treatment application was repeated at each cutting. Monthly harvesting was stopped at the end of the 3 years after the establishment of the experiment because vegetative growth of the grass was ceased in control treatment (T<sub>1</sub>). Grass cuttings were chemically analyzed for N, P, K and Mg.

**Table 52 :** Cumulative dry weight (g) of vegetative parts of *Panicum* grown on three soil series over a 3 years period

Treatment	Soil series		
	Boralu	Wariyapola	Kurunegala
- All	5.83 ± 1.07	5.43 ± 0.53	8.4 ± 1.17
- N	6.62 ± 1.93	11.37 ± 2.88	9.84 ± 2.27
- P	9.24 ± 0.59	12.21 ± 2.83	12.46 ± 3.7
- K	10.76 ± 0.93	16.1 ± 1.85	12.63 ± 3.7
- Mg	12.21 ± 1.48	15.6 ± 1.38	14.69 ± 2.89
+ All	13.28 ± 1.67	16.81 ± 1.94	15.27 ± 1.18
Level of Significance	P ≤ 0.001	P ≤ 0.001	ns
LSD (p ≤ 0.05)	2.42	3.68	-
CV%	14.36	16.81	22.79

The nutrients removal by *Panicum* shown in 3 different soil series are given in Tables 53 (a), (b), (c) and (d).

**Table 53 : N, P, K and Mg removal by *Panicum* grown on three different soil series**

**(a) Total N Removal**

Treatment	Soil series		
	Boralu	Wariyapola	Kurunegala
- All	0.06 ± 0.01	0.053 ± 0.013	0.065 ± 0.015
- N	0.062 ± 0.019	0.095 ± 0.01	0.078 ± 0.013
- P	0.136 ± 0.005	0.137 ± 0.041	0.15 ± 0.058
- K	0.156 ± 0.018	0.168 ± 0.054	0.175 ± 0.05
- Mg	0.124 ± 0.031	0.167 ± 0.033	0.152 ± 0.061
+ All	0.159 ± 0.023	0.170 ± 0.026	0.179 ± 0.031
Level of Significance	P ≤ 0.001	P ≤ 0.01	P ≤ 0.05
LSD (p ≤ 0.05)	0.035	0.059	0.076
CV%	16.90	26.04	33.08

**(b) Total P Removal**

Treatment	Soil series		
	Boralu	Wariyapola	Kurunegala
- All	0.008 ± 0.001	0.006 ± 0.002	0.01 ± 0.002
- N	0.035 ± 0.005	0.091 ± 0.015	0.089 ± 0.02
- P	0.01 ± 0.003	0.018 ± 0.009	0.020 ± 0.012
- K	0.056 ± 0.002	0.11 ± 0.024	0.074 ± 0.038
- Mg	0.048 ± 0.012	0.1 ± 0.013	0.1 ± 0.029
+ All	0.058 ± 0.008	0.15 ± 0.023	0.112 ± 0.006
Level of Significance	P ≤ 0.001	P ≤ 0.001	P ≤ 0.01
LSD (p ≤ 0.05)	0.02	0.029	0.039
CV%	31.28	23.51	35.35

**(c) Total K Removal**

Treatment	Soil series		
	Boralu	Wariyapola	Kurunegala
- All	0.072 ± 0.017	0.098 ± 0.025	0.087 ± 0.009
- N	0.13 ± 0.046	0.235 ± 0.086	0.191 ± 0.022
- P	0.224 ± 0.032	0.282 ± 0.104	0.297 ± 0.083
- K	0.196 ± 0.05	0.22 ± 0.059	0.154 ± 0.077
- Mg	0.3 ± 0.072	0.345 ± 0.092	0.344 ± 0.118
+ All	0.319 ± 0.062	0.375 ± 0.06	0.347 ± 0.054
Level of Significance	P ≤ 0.001	P ≤ 0.05	P ≤ 0.01
LSD (p ≤ 0.05)	0.089	0.134	0.126
CV%	24.64	31.13	31.19

**(d) Total Mg Removal**

Treatment	Soil series		
	Boralu	Wariyapola	Kurunegala
- All	0.017 ± 0.003	0.017 ± 0.006	0.022 ± 0.008
- N	0.018 ± 0.006	0.031 ± 0.004	0.029 ± 0.009
- P	0.028 ± 0.007	0.043 ± 0.023	0.035 ± 0.011
- K	0.023 ± 0.006	0.05 ± 0.009	0.039 ± 0.014
- Mg	0.019 ± 0.005	0.039 ± 0.005	0.032 ± 0.008
+ All	0.03 ± 0.006	0.045 ± 0.009	0.042 ± 0.004
Level of Significance	P ≤ 0.05	ns	ns
LSD (p ≤ 0.05)	0.01	-	-
CV%	23.35	31.31	29.83

Nitrogen and phosphorus were limiting in Boralu series soils. Only N was limiting in Kurunegala series compared with the P and K, nitrogen limited the vegetative growth of the grass largely.

Treatments -N, +P and -K resulted in lower uptake of the respective nutrients compared to +NPKMg treatments. The differences were highly significant ( $p \leq 0.001$ ) in the case of N, P and K in Boralu series. Treatments -P also resulted in lower uptake of the respective nutrient compared to +NPKMg treatment in Wariyapola series and it was highly significant ( $p \leq 0.001$ ). For Mg removal the differences were not significant.

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**3. Drooping Experiment**

An experiment was carried out as an observation trial to test the effect of irrigation, insecticides and common salt to avoid the drooping fronds of coconut palms at Makandura Seed Garden. The age of the palm was 20 years and 18 palms were selected per treatments. The treatments were as follows.

T <sub>1</sub>	-	Irrigation + insecticide
T <sub>2</sub>	-	Only irrigation
T <sub>3</sub>	-	No treatments; control as only drooped palm
T <sub>4</sub>	-	Healthy palms (without showing any drooping characters)
T <sub>5</sub>	-	Common salt
T <sub>6</sub>	-	Only insecticide

Irrigation frequency was once a week and water was applied according to the weekly rainfall as follows.

Rainfall (mm)	Applied water (l)
01	317
02	300
04	275
08	238
10	212
20	104
30	72
35	Irrigation not required

Insecticide - Chlorpyrifos was applied as 25 ml/5 l concentration twice a year  
 Common salt - 1 kg/year

The nut yield data were collected from 1997 to 2002 (6 years). The nut yield data are given in Table 54.

**Table 54 :** Nut yield data at Makandura site from 1997 to 2002

Treatment	Nut yield (palm/yr)					
	1997	1998	1999	2000	2001	2002
T <sub>1</sub> (irrigation + insecticide)	61	61	39	77	58	33
T <sub>2</sub> (irrigation only)	63	69	46	79	55	35
T <sub>3</sub> (Drooped palms)	53	49	48	68	56	35
T <sub>4</sub> (Healthy palms)	44	41	30	80	57	31
T <sub>5</sub> (Common salt)	17	54	38	57	58	27
T <sub>6</sub> (Insecticide only)	21	52	37	84	70	29
Level of Significance	ns	ns	ns	ns	ns	ns

Nut yield have not shown any significant differences among the treatments. Yield of irrigated palms have not increased compared 2002, 2001 and 1999 results. This experiment was terminated at the end of December 2002.

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#### 4. Study on the effective micro-organisms (EM) on the yield of cowpea (*Vigna unguiculata*)

A field experiment was conducted at the Aquinas Farm, Walpola, Ragama to test the efficacy on a group of beneficial microorganisms and improving the efficiency of organic matter utilization by crops. The design of the experiment was Randomized Complete Block Design with four replicates. The variety of bush type cow-pea 'Sena' was used in this experiment. There were four treatments viz; Control (T<sub>1</sub>), Effective microorganisms (EM) added compost (T<sub>2</sub>), Commercially produced compost named UNIGROW (T<sub>3</sub>), and Effective micro-organisms as foliar application with EM added compost (T<sub>4</sub>).

The treatments were evaluated by growth and physical changes of the plant and chemical changes of the soil. Destructive plant samples were taken at the 2<sup>nd</sup>, 4<sup>th</sup> and 6<sup>th</sup> weeks after planting to determine physical changes of the plants. The growth parameters such as number of leaves, plant height, number of root nodules, average leaf area, above ground and below ground bio-mass were measured. As the chemical parameters of the soil, pH, electrical conductivity, organic carbon, cation exchange capacity, total nitrogen, available nitrogen (ammonium nitrogen and nitrate nitrogen) and moisture content were measured in 40 days and 90 days after planting. Soil samples were chemically analyzed before the treatments application (pre treatment).

No significant differences were observed among treatments at the beginning of the experiment. But after 40 days of planting soil pH, electrical conductivity and available ammonium - N showed highly significant ( $p \leq 0.001$ ) differences among the treatments compared control and organic carbon, available nitrogen [Ammonium - N and Nitrate - N], and moisture content showed significant ( $p \leq 0.05$ ) difference among the treatments

compared the control. After 90 days of planting, only soil pH have shown highly significant ( $p \leq 0.001$ ) difference among the treatments against the control.

The growth parameters of the plant at two weeks after seed planting, number of root nodules have shown highly significant difference ( $p \leq 0.001$ ) among the treatments. But four weeks after seed planting, plant height, number of leaves, above ground and below ground biomass in wet and dry base showed highly significant ( $p \leq 0.001$ ) difference among the treatments. Six weeks after seed planting showed only a number of root nodules highly significant difference ( $p \leq 0.001$ ) among the treatments. Considering the pot yield, it gives highly significant difference ( $p \leq 0.001$ ) among the treatments.

The results of this experiment showed the EM treated green leaf compost plots improved the soil quality compared to the  $T_1$  and  $T_3$  plots. The soil parameters like pH, organic carbon, CEC, total nitrogen, ammonium nitrogen and nitrate nitrogen are clear indicators to prove the quality of the  $T_2$  and  $T_4$  plots soils. So it indicated that the EM treated plots were the best.

Considering the growth parameters like plant height, number of leaves also clearly showed that the EM treated plots had the highest values compared to the  $T_1$  and  $T_3$  plots. The yield parameter clearly showed that EM treated plots were the best.

Therefore it is evident from this Research study that EM based compounds have influenced plant growth and yield. However, further studies are needed with other crops too and at different seasons to arrive at a definite conclusion.

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## **5. Quantification of nitrogen loss as ammonia due to surface application of urea**

The aim of this study was to collect the evolved ammonia gas from urea and quantify the nitrogen loss due to surface application of urea.

This experiment was carried out in open place in Bandirippuwa Estate. Urea (3.43 g) was broadcast to the surface of the soil and the surface was covered with a bell jar. Two percent boric acid mixed indicator solution was kept inside the bell jar. A control, without urea was also established. Maximum and minimum temperature at the site was recorded daily. Ammonia absorbed boric acid solution was removed when colour change from red to green has occurred and new boric acid solution was placed. Then boric acid solution was titrated with standard  $H_2SO_4$  acid to quantify the ammonia moles absorbed to the acid. Results are given in Figures 1 and 2.

Figure 1 shows that evaporation of ammonia is very high within two weeks period. Ammonia volatilization reached the maximum value one week after urea application. After two weeks ammonia volatilization was gradually decreased with time.

Figure 2 shows that cumulative quantity of ammonia evolved during 2 months period was  $190.52 \times 10^{-4}$  moles. The nitrogen loss from 3.41 g of urea due to surface application was 0.2667 g which was 16.67% from the applied N.

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## 6. Studies on nutrient depletion of forest soils due to coconut cultivation

The objective of this experiment is to find out whether the soil is degraded when forests are converted to coconut cultivation. Samples from different soil series were taken from both forest and the adjacent coconut lands. The sampling depths were 0-10 cm, 10-20 cm and 20-30 cm.

The description of soils is given in Table 55.

Table 55 : *The description of soils*

Name of the forest	Location	Agro ecological zone	Soil series
Ambakelle forest	Ambakelle	IL <sub>3</sub>	Ambakelle series
Ambakelle forest	Ambakelle	IL <sub>3</sub>	Welipelessa series
Kankaniya Mukalana	Kuliyapitiya	IL <sub>1</sub>	Andigama series
Horakelle forest	Labugammana	IL <sub>1</sub>	Kuliyapitiya series
Horakelle forest	Mohottawa	IL <sub>1</sub>	Kiriwana series
Dickelle forest	Galayaya	IL <sub>3</sub>	Boralu series
Ahalagollayaya forest	Hawanatanna	IM <sub>3</sub>	Melsiripura series
Badagamuwa forest	Badagamuwa	IL <sub>1</sub>	Kuliyapitiya series
Weuda forest	Galdgedara	IM <sub>3</sub>	Melsiripura series
Sawarangala forest	Sawarangala	IM <sub>3</sub>	Melsiripura series

The available Fe, Mn, Cu and Zn contents of the studied soil series are given in Figures 3, 4, 5 and 6 respectively.

In case of Ambakelle, Andigama, Kuliyapitiya (Horakelle Forest), Boralu and Melsiripura (Sawarangala Forest) series soils, there was an increase of Fe content in the soils under forest cover compared to the coconut cultivated area. But in case of Welipelessa, Kiriwana, Melsiripura (Ahalagollayaya and Weuda Forests) and Kuliyapitiya (Badagamuwa forest) series soils, Fe contents were low in area under forest.

The Manganese content of all soils except Ambakelle and Kuliyapitiya (Badagamuwa Forest) soil series was higher under forest cover than under coconut.

In case of Welipelessa, Andigama and Melsiripura (Weuda and Sawarangala Forests) series soils, Cu content was high in forest cover than coconut cultivated area. But the Zn content in Andigama, Kuliyapitiya (Badagamuwa Forest) Boralu and Melsiripura (Ahalagollayaya and Weuda Forests) series soils was higher in the area under forest cover than coconut cultivated area.

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## 4. SERVICE FUNCTIONS

As service functions, the division provided Differential Fertilizer Recommendation (DFR) to 142 (8757 ac) growers during the year. For quality testing 151 inorganic fertilizer samples, 29 organic manure samples and 147 coir dust samples were analyzed. In addition, soil survey for land use evaluation was carried out covering about 750 ha. The Division staff also made 30 advisory visits on request of growers, participated as resource persons in one

day training programs for growers and training courses National Institute of Plantation Management.

## **5. EXTENSION ACTIVITIES**

Dr. L.L.W. Somasiri and Dr. N.A. Tennakoon participated as resource persons in a workshop on "Coconut Cultivation" held in Coconut Development Training Centre, Lunuwila.

Dr. L.L.W. Somasiri, Dr. N.A. Tennakoon and Mrs. D.M.D.I. Wijebandara participated as resource persons in one day programme on Fertilizer Usage held in Coconut Research Institute.

Dr. L.L.W. Somasiri and Dr. N.A. Tennakoon participated as resource persons in a training programme conducted by NIPM.

## **6. SEMINARS**

Dr. L.L.W. Somasiri delivered a lecture on Methodology on Research Prioritization at the workshop on Prioritization of the Coconut Research Institute Research Programme held at Camleot Hotel, Negombo on 21 February 2002 conducted by ISNAR, Netherlands.

Dr. N.A. Tennakoon delivered a lecture on Application of Symbiotic Microorganisms in Tropical Agriculture and Forestry at the In House Seminar, held in Coconut Research Institute on 15<sup>th</sup> May 2002.

Dr. N.A. Tennakoon delivered a lecture on the Research and Research Findings of the Soils & Plant Nutrition Division at the In House Seminar held in Coconut Research Institute on 4<sup>th</sup> December 2002.

## **7. ACKNOWLEDGEMENTS**

I sincerely thank the Acting Deputy Director (Research) Dr. L.L.W. Somasiri for his commitment and the Head and the staff of the Biometry Division for the assistance in designing field experiments, data recording and statistical analysis.

**REPORT OF THE CROP PROTECTION DIVISION**  
**Head - L C P Fernando, PhD**

**1. GENERAL**

During the year the highest priority was given to the development of management strategies for coconut mite, while other research studies of the Division progressed satisfactorily.

Bagging of infested young bunches with polyethylene bags containing 10 g of wettable sulphur for 10 days was found to reduce the pest population over 95%. The two-spotted spider mite *Tetranychus urticae* was identified as an alternative prey to breed the predatory mite *Neoseiulus paspalivorus* in the laboratory. The collaborative project with CABI Bioscience, U.K. to develop an integrated management programme for coconut mite with emphasis on the use of entomopathogenic fungus *Hirsutella thomposnii* was commenced with the assistance of Department of International Development, U.K. Samples of coconut mite were collected from different infested areas of the country by the scientists of CABI Bioscience to determine the relationship of the isolates in Sri Lanka with that of other countries.

A solution of 15% sucrose and 0.2% yeast was recommended as an alternative to toddy and sugarcane in pheromone traps for attract red weevil. The ingredients are easily available compared to toddy or sugarcane, and the solution attracted 30% more weevils than toddy. Field testing of the electronic device to detect red weevil infested palms confirmed that placing the sensor on bases of two lowermost fronds on opposite sides and at the opposite sides of the base of trunk could accurately detect the presence of larvae.

The causal agents of the leaf rot disease prevalent in the south region were identified as *Ceratostyis paradoxa*, *Colletotrichum* sp. and *Fusarium solani* and their pathogenicity on coconut has been proved in the laboratory.

The coconut mite continued to spread into Southern Puttalam, Anuradhapura, Kurunegala and Gampaha districts and has been reported for the first time in Batticaloa district. A total of nearly 60,000 ac were reported to be infested in the whole country. Pruning of bunches in newly infested areas and spraying of margosa mixture in other areas were continued as recommendations to manage the pest. A modified knapsack sprayer that could spray up to a height of about 40' from the ground was introduced. Quarantine regulations were imposed to prohibit transport of infested nuts and husks out of Anuradhapura and Polonnaruwa districts but the implementation has been unsatisfactory.

The Division continued to serve the growers by providing advice in managing pests and diseases and selling monocrotophos and pheromone for the management of red weevil.

## 2. RESEARCH PROJECTS

### PROJECT 15.1: STUDIES ON ACTIVITY PATTERNS OF LARVAL AND PUPAL PARASITOID SPECIES OF COCONUT CATERPILLAR (1995)

#### Experiment 15.1.19 Determination of the effectiveness of a single release of *Eriborus trochanteratus* and *Brachymeria nephandidis* in controlling coconut caterpillar in the field (2000)

The studies in the previous year showed that a single release of *Eriborus trochanteratus* and *Brachymeria nephandidis* at the ratios of 75:1 and 300:1 of pest: parasitoid respectively could effectively control coconut caterpillar. A pilot study was conducted in an infested estate at Battuluoya to confirm the findings. Both species were released once at the above ratios and recorded the pest and parasitoid numbers on 20 leaflets of 20 palms weekly until the pest was controlled. The results showed that the pest was controlled for three months after release of parasitoids and the parasitoid numbers increased each time when the pest was at the suitable stage in the life cycle for their attack (Fig.1).

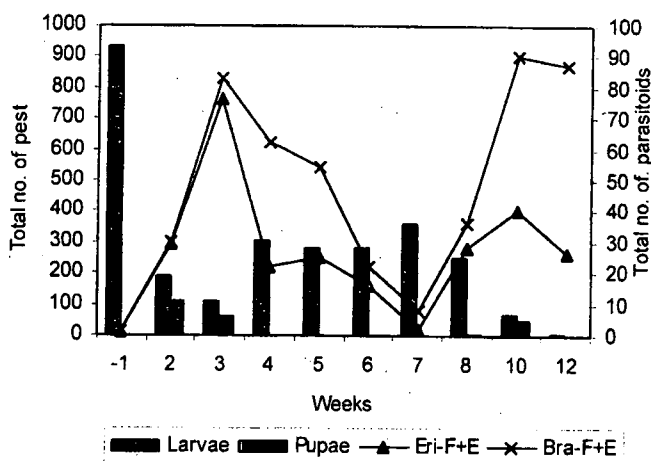


Fig. 1 Total numbers of pest and parasitoids in each interval after release of parasitoids

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

### PROJECT 26: IMPROVEMENT OF INTEGRATED MAMGEMENT PROGRAMME FOR RED WEEVIL (1998)

#### Experiment 26.1 Development of an electronic device for the detection of red weevil infested palms (1998)

Previous experiments showed the device developed was effective in detecting red weevil infested palms. The experiment envisaged determining suitable positions that the sensor of the detector needs to be placed on the palm to accurately detect the presence of larvae. In each tested palm the sensor was placed on the trunk at the ground level and every foot along the trunk up to the fronds and on the bases of the two lowermost fronds of the same side. The procedure was repeated on the opposite side of the palm. At each point

presence or absence of the sound was recorded. The testing was conducted on 41 infested palms. The results indicated that sensor placed on opposite sides of trunk at 2' above ground level and on bases of fronds was nearly 90% accurate in detecting the sound of grubs (Table 1). However placing the sensor on two lowermost leaf bases on opposite sides of the trunk is possible in palms of all ages compared to the 2' level above ground. To increase accuracy up to 100% it is recommended to place the sensor on the bases of two lowermost fronds at opposite sides and at the base of the trunk because 10% (4) of the palms that were not detected on the fronds alone were detected at ground level.

**Table 1 :** *The percentage of palms detected by the device along different distances on opposite sides of the trunk*

Position of the palm (feet)	Total number of palms tested at the position	Percentage palms detected
Base of palm	37	68
1'	34	71
2'	23	91
3'	9	78
Lowermost fronds	41	90
Fronds above lowermost	41	90
Base of palm and 2'	60	77
1' and 3'	43	72
Base and 3'	46	70

*L.C.P. Fernando, N. Nanayakkara (University of Moratuwa),  
K.F.G. Perera & W.W.F.N. Fernando*

### **Experiment 26.3 Identification of alternative food sources for mass trapping of red weevil using pheromone-food baited trap (2001)**

The current recommendation is to incorporate either toddy or pieces of sugarcane into the pheromone trap to enhance the degree of attraction for pheromone. But growers often complain that toddy and sugarcane are not readily available. Therefore the experiment was initiated with the objective of identifying easily available alternative food sources for toddy. Two materials i.e. 15% sucrose solution with 0.2% yeast and nut water from harvested nuts were compared with toddy. Results showed that sugar-yeast solution attracted higher number of weevils.

Treatment	Male	Female	Total
Toddy	11.2	23.3	34.5
Sugar-yeast	32.4	32.4	45.2
Nut water	19.6	19.6	27.7
LSD	NS	9.16	13.17

Based on these results, 15% sucrose solution with 0.2% yeast was recommended as a synergistic food source in the pheromone trap.

*I.R. Wickramananda, K.F.G. Perera, W.W.F.N. Fernando & R. Wijetunga*

**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 paspalivorus* (1999)**

The experiment commenced to determine the seasonal population fluctuation patterns of the coconut and predatory mites was continued in 6, 7 and 4 sites in Kalpitiya, Madurankuliya and Vanathavillu respectively. One young nut from each of five palms in each site was sampled at monthly intervals and the number of coconut mites and predatory mites on each nut was recorded. As in the previous years both populations varied over time in all sites. Populations of coconut mite peaked in May-June, May-July and October in Kalpitiya, Madurankuliya and Vanathavillu respectively (Table 2). The peaks of the predator populations which were in July-September, August-September in Kalpitiya and Madurankuliya respectively followed the peaks of the coconut mite indicating a relationship between the two populations. However, no such relationship was observed in Vanathavillu (Table 2). The distribution of predators on nuts was also highest during its' peak population periods. The study is in progress.

**Table 2 :** *Populations of coconut mite and predatory mite and the distribution of predatory mite on nuts during February to October, 2002.*

Month	Kalpitiya			Madurankuliya			Vanathavillu		
	Mean no. pest	Mean no. predator/ nut	% nuts with predator	Mean no. pest	Mean no. predator/ nut	% nuts with predator	Mean no. pest	Mean no. predator/ nut	% nuts with predator
February	827	4.1	37	588	0.7	31	538	3.9	62
March	-	-	-	907	1.3	26	-	-	-
April	928	0.9	30	960	2.6	43	650	1.3	33
May	1109	2.9	47	1060	1.5	49	641	0.7	31
June	1256	2.4	50	1046	2.7	49	876	1.3	35
July	850	3.3	53	1104	2.6	49	402	2.9	50
August	870	4.3	73	756	3.8	54	931	4.9	45
September	805	3.7	60	1335	4.5	74	561	0.8	45
October	825	2.7	63	960	2.0	51	1297	2.5	40

*N.S. Aratchige, L.C.P. Fernando, K.A.S. Chandrasiri & P. Manoj*

**Experiment 27.18 Identification of suitable alternative hosts for rearing of *N. paspalivorus* (2001)**

Searching for a suitable alternative host for rearing the predatory mite in the laboratory continued. It was found that *N. paspalivorus* feeds on eggs and newly hatched nymphs of the two-spotted spider mite, *Tetranychus urticae* which is found on cassava and many other vegetable plants.

*N.S. Aratchige & S. Fernando*

**Experiment 27.19 Comparison of *T. urticae* and supplementary food sources on development and reproduction of *N. paspalivorus* (2001)**

A preliminary study was carried out to determine the effect of feeding *N. paspalivorus* with *T. urticae* and *T. urticae* along with coconut mite, coconut pollen, *Typha* pollen and bee

honey on fecundity of the predator. The newly hatched predator larvae were provided with above food on arenas and observed development and ovipositions up to 15 days after becoming adults. The predator developed satisfactorily on all the food sources and laid a mean number of 26, 10, 16, 2.5 and 4 eggs on *T. urticae* along with coconut mite, coconut pollen, *Typha* pollen and bee honey and *T. urticae* alone respectively. It was indicated that *Typha* pollen is more suitable as a supplementary food source. A further experiment needs to be carried out to confirm the life-time fecundity of *N. paspalivorus* on these food sources.

N.S. Aratchige & S. Fernando

#### **Experiment 27.22 Development of techniques to breed *N. paspalivorus* on *T. urticae* (2002)**

Breeding of *N. paspalivorus* on *T. urticae* and *Typha* pollen will involve breeding of *T. urticae*, collection and storage of *Typha* pollen and feeding of the predators on eggs and pollen in arenas. It was found that *T. urticae* could be conveniently bred on cassava cuttings planted on polyethylene tubes (5' long) filled with coir dust. Cassava plants with 4-6 leaves infested with adults of *T. urticae* gave rise to many hundreds of eggs in 10-12 days after infestation. These eggs were collected by washing the infested leaves in water and sieving through a set of sieves. Eggs along with pollen collected from the field were provided in arenas developed earlier to breed predatory mites. However, several shortcomings and difficulties such as fungal infections, separating eggs from fecal matter and escape of predators from arenas were experienced in the process. Further studies are continued to improve the techniques.

N.S. Aratchige

#### **Experiment 27.23 Evaluation of the effectiveness of *Hirsutella thompsonii* in the field (2002)**

The Ivory Coast isolate of *H. thompsonii* obtained from CAB International, U.K. caused 60% mortality of coconut mites in the laboratory, previously. Therefore a preliminary trial was conducted in an infested estate in Rajangane to determine its effectiveness in field conditions. Suspension of the fungus was prepared using mycelium and spores of the fungus grown on agar and mixing with water and few drops of Tween 80. One hundred milli litres of the suspension was sprayed to 5 month old bunches of 20 palms. Ten palms were sprayed with equal amount of water. The procedure was repeated on 10 palms previously sprayed, after two weeks. Two nuts from each palm were sampled at monthly intervals for 3 months and recorded the number of nuts infected with *H. thompsonii*. Out of the nuts sampled the fungus was present in 30%, 60% and 30%, 40%, 20% and 0% and 30%, 50% and 40% palms sprayed with the fungus once, twice and the unsprayed control respectively at one month, 2 months and 3 months after treatment. Although the fungus was present, mortality rates of coconut mites was insignificant. The presence of the fungus in palms received no fungal suspension may be either due to spread of the fungus from treated trees or natural presence of the local strain. Further studies initiated to ascertain the presence of local strain of the fungus and improve infectivity of the Ivory Coast strain.

L.C.P. Fernando, R. Silva & R. Caldera

### Experiment 27.24 Effect of bagging bunches with wettable sulphur in reducing coconut mite populations (2002)

An experiment was conducted at Palacholai estate, Madurnakuliya to investigate whether bagging of young bunches with sulphur could reduce the pest population. The third, fourth and fifth bunches of 12 infested palms were enclosed in gauge 400 polyethylene bags containing 10 g of sulphur WP(wettable powder). Bunches of another 6 infested palms were bagged without sulphur while another 6 infested palms were unbagged and used as controls. Bags with sulphur were removed from each of 6 palms on 5 and 10 days after bagging while bags without sulphur were also removed in 10 days. One nut from each bunch of the experimental palms was removed just after removal of bags and two months after removal. Number of live and dead mites in 4 patches on the perianth and nut surface and the number of predators were recorded. The results showed that enclosing bunches could cause high mortality of coconut mites. The highest mortality was recorded in bunches bagged with sulphur for 10 days (Table 3). All mites were dead in about 68% of those nuts. Even after 2 months a high mortality of 69.3% was recorded in those bunches indicating the effectiveness of the treatment in reducing the pest population drastically. The predators were not affected by the treatment considerably. The number of nut fall due to bagging was low. A total of 7 nuts had fallen in the bags kept for 10 days while in other treatments it was lesser than that.

**Table 3:** *The effect of bagging bunches with sulphur for five and ten days on the coconut mite population*

Time after bagging	Treatment	% dead mites	Mean no. predators
5 days	Bag with S	84.7	0.7
	Bag without S	69.8	1.9
	Unbagged	33.0	0.5
10 days	Bag with S	98.7	0.5
	Bag without S	87.3	1.1
	Unbagged	29.9	1.0
2 months	Bag with S	69.3	2.0
	Bag without S	43.7	0.8
	Unbagged	35.8	0.9

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

### Experiment 27.25 Re-evaluation of wettable sulphur against coconut mite under field conditions

Objective of the experiment was to re-evaluate the efficacy of spraying sulphur to manage coconut mite. Each of ten palms were sprayed with 0.1 % sulphur (80%WP) and 0.2 % sulphur (80%WP) using a modified knapsack sprayer at the rate of 1.5 l per palm. Another ten palms were sprayed with water as the control. Observations made on the percentage mortality of mites in the 4<sup>th</sup> and 5<sup>th</sup> bunches of the sprayed palms didn't show any significant difference between treatments up to three weeks after the first spraying (Table 4). However the spraying is being repeated every two months to assess the long- term effect of the above treatments on the final yield.

**Table 4:** *Percentage mortality of coconut mites in the perianth at different concentrations of sulphur*

Treatment	Pre count	1 day after treatment	1 week after treatment	2 weeks after treatment	3 weeks after treatment
Sulphur, 0.1%	29.30	35.00	42.00	38.8	56.1
Sulphur, 0.2%	32.50	24.60	50.00	56.1	31.0
Control	37.9	37.00	34.67	34.8	48.1

*I.R. Wickramananda, K.F.G Perera, & R. Wijetunga*

**Experiment 27.26 Evaluation of Neemarin 1500 and Safer's fatty acid salt against coconut mite (2002)**

Neemarin is a commercial formulation of neem containing 1500 ppm of azadirachtin. Safer's salt is a commercial product containing fatty acid salts which are active against other mites. Neemarin (4ml/l) and Safer's salt (3 ml/lit) were tested in the field by spraying the crown at the rate of 250 ml per palm using a hand sprayer. These products were compared with 2% neem oil and garlic mixture and untreated (control) palms. Each treatment was replicated in seven palms. Preliminary observations did not indicate a satisfactory effect on the mortality of mites inside the perianths of treated nuts. Repetition of the spraying was not possible due to the inconsistent rains prevailed in the experimental sites. The study will be continued in 2003.

*I.R. Wickramananda & N.G.Premasiri*

**Experiment 27.27 Evaluation of marshal 20% and chlorpyrifos 40% against coconut mite (2002).**

In the ongoing chemical screening trials, highly infested isolated palms are usually selected and sprayed to evaluate the efficacy of chemicals against coconut mite in the field. In this experiment a modified method was followed. Three blocks of infested palms each comprising approximately 60 palms were selected. Each of two blocks was sprayed with marshal 20% (4ml/l) and chlorpyrifos (2ml/l) respectively at the rate of 1.5 l per palm. Third block was left untreated. Observations were made on ten selected palms to assess the degree of damage on bunches. The spraying is being repeated bi-monthly. The experiment is in progress.

*I.R. Wickramananda, K.A.S.Chandrasiri and R. Wijetunga*

**Experiment. 27.28 Determination of the composition of migratory populations of coconut mite (2002).**

The objective of the experiment was to determine the stages of the migrating populations of coconut mite. Nuts from the 4<sup>th</sup> bunch of the infested palms were brought to the laboratory and kept overnight. In the following morning surfaces of the nuts were observed from 8.00 am to 10.00 am under the microscope to find the migrating populations. The majority of the mites leaving the perianth were adult females.

Methodologies were established to study the migratory populations in the field using sticky traps made of vaseline pasted cards and parafilm. A field experiment was designed to observe the migratory populations directly in the field using the established methods.

I.R. Wickramananda

**Experiment 27. 29 Determination of the life cycle of coconut mite (2002)**

Newly hatched eggs were placed on immature leaf tissue pieces in Petri dishes. The development of the emerging larvae was monitored. It was observed that the life cycle of the mite had the following stages in the life history. Determination of the exact period and the sizes of each stage is in progress.

Egg → Larva → 1<sup>st</sup> resting stage → Nymph → 2<sup>nd</sup> resting stage → Adult

I.R. Wickramananda

**Experiment 27. 30 Development of a digital image processing system to count coconut mites (2002)**

For various studies related to coconut mite, it is required to assess the population of mites in nut samples. This is done by washing the population in a nut using a detergent solution and counting the number of mites in a small sample from the wash. This is both tedious and time consuming. This can be erroneous too as the counting has to be done manually soon after the sample is prepared. But this process could be easily carried out by an image obtained with a digital camera. After the image of the population is obtained, the counting could be done later at the computer. The method could be further improved by using a computer-based package to count the mites. Therefore this study was initiated with the objective of developing a computer-based technique to count the coconut mite in a digital image. Preliminary images successfully obtained with a digital camera were processed in the computer for the development of the soft ware. The study is in progress.

I.R. Wickramananda & M. Alahakoon (University of Peradeniya)

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

**Experiment 28.1 Population dynamics of the burrowing nematode *Radopholus similis* (2001)**

The study initiated to determine the fluctuation pattern of the burrowing nematode populations in the roots and soil in the root zone of LSD-affected palms and apparently healthy palms in the same blocks in Walpita, Arachchikattuwa and Bandirippuwa estates were continued at 3-monthly intervals. Burrowing nematodes were found in all soil samples throughout the period, but not in the roots. Out of the three sampling occasions in March, June and September they were found only in March and June and also not in all the palms sampled. A mean number of 3.8, 0, 6.2 and 1, 2, 1 *R. similis* were recorded in affected palms at Arachchikattuwa, Bandirippuwa estate and Walpita in March and June respectively. A mean number of 0, 1.5, 7 and 0, 1, 0 *R. similis* were recorded in healthy palms in the same locations and during same periods respectively. The presence of *R. similis* in apparently healthy palms was questionable and therefore a further study was initiated to determine

whether roots of seedlings planted in affected fields and roots of palms from unaffected fields are free from *R. similis*. Each of 5 seedlings from sites already being sampled and each of 15 palms in three sites free from LSD in Nawagattegama, Kurunegala and Kegalle were selected and sampled in June and September. Only one nematode from a seedling in Bandirippuwa estate in June and a palm in Kurunegala in September were found indicating a very low incidence. The study is being continued.

*L.C.P. Fernando, P.H.A.P Siriwardena, W.W.F.N. Fernando & R. Wijetunga*

#### **Experiment 28.2 Association of *Fusarium* spp. and nematodes in LSD (2002)**

A preliminary study was conducted to find out whether sap contents of LSD affected palms and unaffected palms have any difference. Tissues from the trunk and roots of each of 15 affected and healthy palms were obtained and combined. The cell sap was extracted and thin layer chromatography was carried out on the two samples. A difference between the two samples was observed. Further studies are being continued to ascertain the difference.

*C.S. Ranasinghe, L.C.P. Fernando & P.H.A.P Siriwardena*

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

##### **Experiment B26.5.3 Proving pathogenicity of fungi associated with leaf rot disease (2002)**

It was confirmed from the samples identified by CAB International that the fungi associated with leaf rot disease are sp., *Fusarium solani* and *Ceratosystis paradoxa*. An experiment was conducted to prove pathogenicity of these fungi. Spore suspensions ( $10 \times 10^4$  spores) of 3, 7 and 6 day old cultures of *F. solani*, *Colletotrichum* and *C. paradoxa* were prepared and 100 drops of each solution separately and in combinations of *Colletotrichum* and *C. paradoxa*, *C. paradoxa* and *F. solani*, *Colletotrichum* and *F. solani* and all 3 fungi were placed on very tender coconut leaves. Water was used as the control. The leaves were kept in high humidity for 3 days and the presence of lesions produced by each fungus was recorded. *C. paradoxa*, *Colletotrichum*, *F. solani*, *Colletotrichum* and *C. paradoxa*, *C. paradoxa* and *F. solani*, *Colletotrichum* and *F. solani* and all 3 fungi together produced 100%, 48%, 29%, 76%, 44%, 72% and 26% lesions respectively. The control treatment did not produce any lesions. The respective fungi were re-isolated from the lesions proving all fungi are pathogenic. It is concluded that all 3 fungi are responsible for producing symptoms of leaf rot disease while *C. paradoxa* is the most virulent and prominent species that produced larger lesions than other two.

Since it is necessary to prove pathogenicity of these fungi in field conditions 100 ml of each suspension of  $10 \times 10^4$  spores was drenched into the bud region of each of 6 seedlings, 3 times at bi-weekly intervals. Seedlings in each treatment was enclosed in polyethylene covers and provided with high humidity. However, seedlings did not produce symptoms up to 3 months after treatment. Further studies on seedlings are being carried out.

*L.C.P Fernando, P.Manoj, K.F.G. Perera & N.G Premasiri*

### 3. CROP PROTECTION SERVICES

#### Incidences of pests and diseases

One hundred and eighty five pest incidences reported during the year. Appropriate control measures were recommended.

**Table 5:** *Reported pest and disease incidences in different provinces during 2001*

Pest	WP	NWP	SP	NCP	EP	UP	SGP	CP	NP	Total
Red weevil	1	5	-	1	-	1	-	-	-	8
Black beetle	3	1	-	-	-	-	-	-	-	4
Coconut caterpillar	1	6	5	-	54	-	7	-	-	73
Coconut scale	-	2	-	-	-	-	-	-	-	2
Mites	1	79	-	9	3	-	-	-	1	93
Minor pests	-	3	-	-	-	-	1	-	-	4
Diseases	-	-	1	-	-	-	-	-	-	1

#### Biological and chemical control

- Coconut caterpillar: Infestations were successfully controlled by timely surveillance, continuous monitoring and release of parasitoids. The number of parasitoids released is given in Table 5.
- Synthesis and sale of red weevil pheromone: Pheromone synthesis in the CRI laboratory continued and a total of 3690 vials were sold to the growers and CCB regional offices.
- Chemical control: A total of 240 l of monocrotophos was issued to growers to control red weevil.

**Table 6:** *Release of parasitoids in different provinces for the management of coconut caterpillar*

Parasitoid	Western	North western	Southern	Eastern	Sabaragamuwa	Total
<i>Eriborus trochanteratus</i>	350	23000	1750	3900	2400	31400
<i>Bracon hebetor</i>	3500	157500	3000	52750	6000	222750
<i>Goniozus nephantidis</i>	0	26100	1000	6500	250	33850
<i>Brachymeria nephantidis</i>	1150	77700	7000	13200	6850	105900
Total	5000	284300	12750	76350	15500	393900

### 4. TRAINING AND EXTENSION ACTIVITIES

#### Extension activities

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.

### **Training activities**

One student from NAITA was trained in the Division for 4 months.

## **5. ACKNOWLEDGEMENTS**

The staff of Crop Protection Division is greatly acknowledged for their cooperation and assistance in research and other activities during the year. Sincere thanks are extended to head and staff of the Biometry Division for the assistance given in designing experiments and analysis of data.

**REPORT OF THE BIOMETRY DIVISION**  
**Head – D T Mathes, FIS**

**1. GENERAL**

The division continued to assist the staff in statistical consultancy and computer related activities. The experiments on different frequencies of harvesting of coconuts, under different agroclimatic zones showed promising results. The work on "Impact assessment and adaptation to climate change in the plantation sector" funded by International START Secretariat, USA was continued during the year. This is a collaborative study with Agronomy and Plant Physiology Divisions. The meteorological stations at Bandirippuwa, Ratmalagara, Ambakelle, and Bogaswewa were maintained satisfactorily.

**2. Assistance in the use of Computers and Computing**

1. Continuous assistance was provided to all divisions on the use of application of packages and System software.

*J D J S Kularatna & S S Rajapakse*

2. Co-ordinated the work in maintaining the Personal Management System in the Establishment Division.

*S S Rajapakse*

3. Assistance was provided for the installation of hardware and software. Co-ordinated activities of computers in the Institute.

*S S Rajapakse*

4. Computerization of all the weather variables recorded at different meteorological stations continued throughout the year. The computerized data were sent to the Meteorology Department, Colombo, every month.

*T S G Peiris, J D J S Kularatna, Kingsly Herath and P Fernando,*

5. Computerizing & processing of information of the Medical Aid Scheme was continued.

*J D J S Kularatna*

**3. BIOMETRICAL ASSISTANCE**

Assistance to the research staff was provided by way of statistical consultancy, selection of lands, layout of experimental designs, design of field surveys and questionnaires, analysis and interpretation of data.

Undergraduates from various universities were provided with special assistance in respect to their projects. In addition several postgraduate theses were supervised.

#### 4. RESEARCH PROJECTS

### PROJECT 13 : INFLUENCE OF HARVESTING PRACTICE ON NUT PRODUCTION (1997)

#### Experiment No. 13.0.1 Frequency of harvesting

Since the beginning of 1990 the calibration trial at Walpita research substation was redesigned to evaluate the impact of harvesting at monthly intervals on coconut yield as compared to harvesting at two monthly intervals. In view of the promising results shown from this trial, two additional trials were established at Ratmalagara and Poththukulama research substations. The two experiments at Ratmalagara and Poththukulama comprised of four frequencies of harvesting; Viz. harvesting at 30, 60, 120 day intervals and not harvesting but collecting fallen nuts. Serious difficulty was experienced in getting a reliable recording of nuts from the fourth treatment as there is no harvesting being done. Hence recording of nuts from this treatment was dispensed with.

##### (a) Results of the experiment at Walpita Research Substation

The number of nuts and copra yield per hectare are shown in Table 1.

Table 1. *Number of nuts and copra yield*

Frequency of harvesting	Number of nuts per/ha/yr (1 ha =150 palms)		Copra yield kg/ha/yr	
	Ave. 1993-2001	2002	Ave. 1993-2001	2002
Monthly	14542	11306	3127	2297
Two monthly	11159	8707	2271	1652
Increase (No. of nuts)	3383	2599	856	645
% increase	30.3	29.8	37.7	39.0

Monthly harvesting recorded a 30% higher number of nuts/ha/yr when compared to two monthly harvesting. The absolute increase during the year is 17 nuts per palm. The overall average yields during the period 1993 to 2001 showed a similar yield difference between the two harvesting intervals.

##### (b) Results of the experiment at Ratmalagara research substation

The impact of frequency of harvesting on yield is described in Table 2.

**Table 2.** *Average number of nuts and fallen nuts*

Frequency of harvesting	Nuts/ha/year (including fallen nuts)				% fallen nuts			
	2000	2001	2002	Ave	2000	2001	2002	Ave.
30 days	12900	13800	10975	12558	2.8	1.6	3.9	2.8
60 days	9825	11225	9475	10175	16.0	4.5	16.4	12.3
120 days	9075	10675	9574	9775	35.8	33.3	45.2	38.1

The average values given in table 2 describe the overall results for the period 2000 to 2002. There is clear evidence that harvesting at 30 day intervals showing a higher yield as compared to the other harvesting frequencies. Year 2002 showed a 15.8% more yield for 30 day harvesting as against 60 day harvesting. The average position over the three-year period is 23.4%. During the year 2002 harvesting at 60-day intervals showed 16.4 % nut fall when compared to 3.9% shown for monthly harvesting.

(c) Results of the experiment at Poththukulama research substation

Number of nuts recorded for the three frequencies of harvesting are shown in Table 3. The year 2002 showed a 15.2% higher yields for 30 day harvesting compared to harvesting at 60 day intervals. This difference for the 3 year average is 17.3%.

**Table 3.** *Average number of nuts and fallen nuts*

Frequency of harvesting	Nuts/ha/year (including fallen nuts)				% fallen nuts			
	2000	2001	2002	Ave.	2000	2001	2002	Ave.
30 days	14500	14650	10400	13183	1.1	2.4	5.8	3.1
60 days	12050	12650	9025	11241	9.9	10.9	22.2	14.3
120 days	8775	11650	8525	9650	30.0	39.3	58.9	42.7

The average fallen nuts during the year 2002 for monthly harvesting is 5.8% while that for the two monthly harvesting is 22.2%.

On the whole the three experiments clearly suggest the nature of benefits that could be achieved by harvesting nuts at monthly intervals.

*D T Mathes, Ranjith Fernando, W M L G Fernando,  
Kingsly Herath, W E Fernando and W B P Fernando*

**Project 20.1 APPLICATION OF CLIMATOLOGY IN COCONUT RESEARCH**

**Experiment 20.1.2 Assessment of Impacts of and adaptation to climate variation for plantation sector in Sri Lanka with special reference to tea and coconut.**

This project funded by UNEP/GEF commenced in July 2002. During this period daily rainfall data from 27 locations and daily minimum & maximum air temperature from

six stations from 1932-2001 within the coconut growing areas were collected from the Department of Meteorology and computerized into Excel worksheets. Data were quantity controlled. The periods of available data over each selected station is shown in Table 4.

**Table 4.** Available data over the selected stations in each agro-ecological region

AGRO - ECO.	STATION	PERIOD		
		RAINFALL	MAX. TEM	MIN. TEM
IL1	HORAKELLE	1932-2001		
	KURUNEGALA	1932-2001	1932-2001	1932-2001
	PALUGASWEWA	1932-2001		
	AMBAKELLE	1958-2001		
	BANDIRIPPUWA	1935-2001	1965-2001	1965-2001
	RATMALGARA	1939-2001		
IL3	NIKAWERATIYA	1941-2001		
	POLONTALAWA	1954-2001		
	RIDIBENDIELA	1937-2001		
	WARIYAPOLA	1932-2001		
	MEDIYAWA	1932-1999		
WL3	HUNUMULLA	1941-2000		
	KATUNAYAKE	1961-2001	1961-2001	1961-2001
	RAGAMA	1932-1999		
	WALPITA	1941-2001		
	PASYALA	1945-2001		
WL4	BADDEGAMA	1932-2001		
	GALLE	1932-2001	1932-2001	1932-2001
	KALUTARA	1932-2001		
	KEKANADURA	1932-2001		
WL2	POLGAHAWELA	1932-1988		
	AMBANPITIYA	1932-2001		
	KEGALLE	1932-1963		
DL3	PUTTALAM	1932-2001	1932-2001	1932-2001
	ANAMADUWA	1934-2001		
DL5	HAMBANTOTA	1932-2001	1932-2001	1932-2001
		1932-2001		

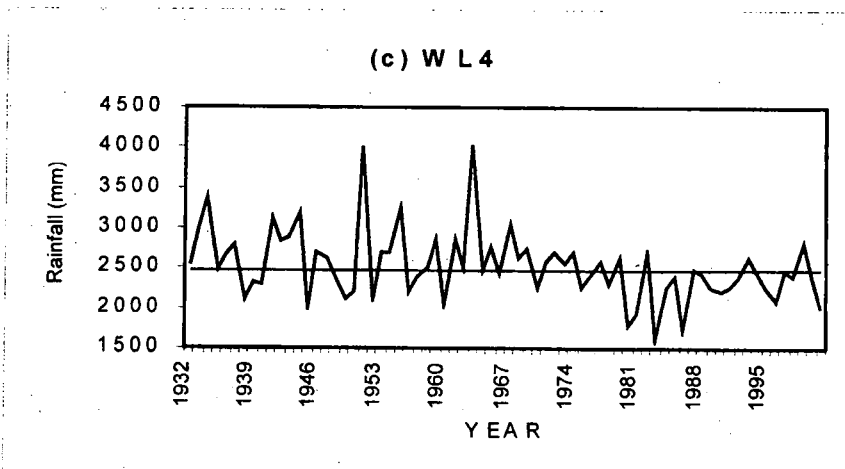
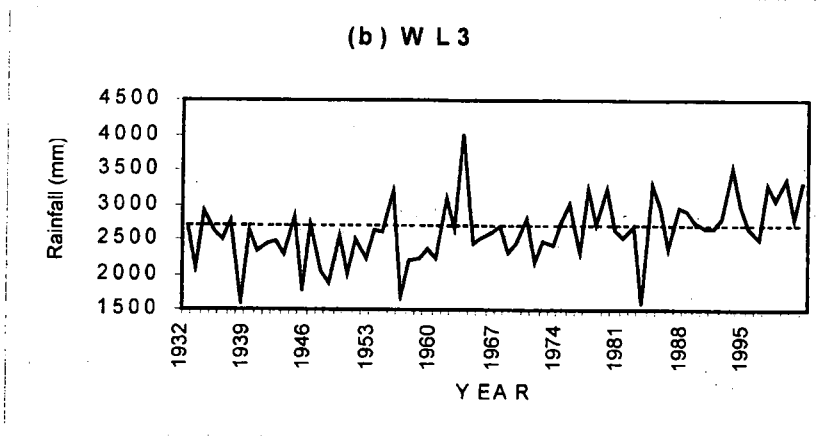
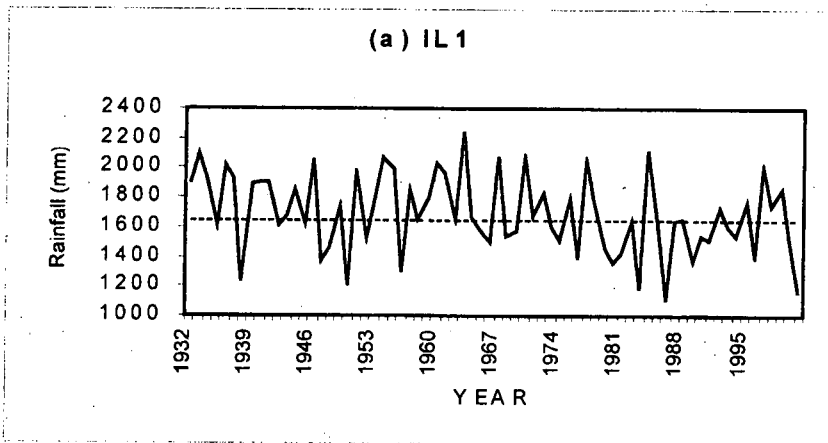
(L1 - Low country wet intermediate region; IL3 - Low country dry intermediate region; WL3, WL4 - Low country lower wet regions; WL2 - Low country moderately wet region; DL3 - Low country moderately dry region; DL5 - Low country higher dry region)

**(a) Trend in annual rainfall**

The temporal behavior of the annual and seasonal climate in IL1, WL3 and WL4 were analyzed using the spatial averaged data of the locations within a region. There is a greater variability of annual rainfall between locations within a region than between agro-ecological regions. The annual rainfall variability in IL1 is lower (CV=15.6%) than that in WL4 and WL3. The annual rainfall variability in the three regions are shown in Figures 1(a) - 1(c).

**Figure 1a–1c. Temporal variability of Annual Rainfall**

(Dotted line represents the 1961-1990 average)



The annual variability in rainfall was compared with the average for the period 1961-1990 as recommended by the Intergovernmental Panel on Climate Change (IPCC).

In both IL1 & WL4 regions, annual rainfall was above the 1961-1990 average (baseline) in most of years prior to 1970 and thereafter it showed below the baseline average. In WL3 region temporal behavior with respect to baseline data is different from other two regions. Trend analysis for annual data found that there was a significant increment trend in WL3 and significant decreasing trend in other two regions (Table 5).

**Table 5. Rate of annual increase (b) in mm/year**

Rainfall	Agro-ecological Regions		
	IL1	WL3	WL4
Annual	-3.9	9.47	-7.43
First Inter Monsoon - FIM ( March - April)	-1.5	1.74	-2.23
South West Monsoon – SWM (May – September)	ns	5.04	ns
Second Inter Monsoon – SIM ( October – November)	ns	ns	ns
North East Monsoon - NEM ( December – February)	ns	1.95	-1.62

(All the coefficients are significant at 5%), ns – Not significant

The results in Table 5 indicate that there was a significant reduction in rainfall in IL1 for FIM period. A decreasing trend however was found for both FIM and NEM in WL4. Significant increasing trends were shown for the annual rainfall in all the seasons in WL3 except in SIM.

#### (b) Trends in annual air temperature

All three regions showed significant increasing trends for maximum, minimum, mean and diurnal air temperature (Table 6). The annual rate of increase is higher for maximum air temperature in all three regions.

The results indicate that in all regions maximum temperature increment is highly responsible for warming of regions annually than that of the minimum temperature. To identify temporal behavior of maximum temperature within the seasons, linear trend analysis was carried out on seasonal basis (Table 7).

**Table 6: Rate of annual increase (b) in °C/year**

Temperature	Agro-ecological Regions		
	IL1	WL3	WL4
Maximum	0.017	0.018	0.018
Minimum	0.003	0.017	0.005
Mean	0.010	0.017	0.012
Diurnal	0.014	0.001	0.012

(All the coefficients are significant at 5%)

**Table 7:** Rate of annual increase of maximum temperature in  $^{\circ}\text{C}/\text{year}$

Season	Agro-ecological Regions		
	IL1	WL3	WL4
First Inter Monsoon - FIM ( March - April)	0.023	0.033	0.021
South West Monsoon - SWM (May – September)	0.014	0.029	0.016
Second Inter Monsoon - SIM ( October – November)	0.019	0.020	0.013
North East Monsoon - NEM ( December – February)	0.020	0.021	0.025

(All the coefficients are significant at 5%)

The annual increment of seasonal maximum temperature is higher in FIM period in IL1 and WL3. These results confirm that the impact of climate change on coconut should be studied separately for agro-ecological zones.

*T S G Peiris, W E R C Fernando, and C H Piyasiri*

## 5. EXTENSION ACTIVITIES

- Lectures were conducted for trainees attending courses organized by the Coconut Research Institute and National Institute of Plantation Management.
- Trainees from different Institutions were assigned to this Division from time to time.
- Visitors and students from Universities were briefed on the work of the Division.

## 6. AGRO-METEOROLOGY

The four meteorological stations at Bandirippuwa Estate, Ratmalagara Estate, Isolated Seed Garden and Maduru Oya Seed Garden at Bogaswewa were maintained. At Bandirippuwa, daily recordings were taken throughout the year on rainfall, air temperature (at 8.30 and 15.30 hrs), evaporation, relative humidity (morning and afternoon), sunshine hours and soil temperature (at six different depths.)

### 6.1 Climate in Bandirippuwa Estate

- Rainfall (Table 8)** All months of the year experienced rainfall. The total rainfall for the year was 1779.0 mm. This rainfall is somewhat in par with the average recorded for the period 92-2001. A substantial increase in rainfall is shown for 2002 when compared to 2001. The months, January, February, July, August and September showed low rainfall. Month of October experienced a rainfall of 606.1 mm.
- Temperature (Table 8)** The monthly maximum temperature ranged from  $30.4^{\circ}\text{C}$  (August) to  $34.0^{\circ}\text{C}$  (February) while monthly minimum temperature ranged from  $21.8^{\circ}\text{C}$  (February) to  $24.9^{\circ}\text{C}$  (July). In general a higher temperature was recorded for the year 2002.
- Sunshine (Table 8)** Sunshine hours ranged from 5.4 (October) to 8.8 hrs./day (February). The average for the year was 7.0 hrs./day. The year showed reduced sunshine hours compared to 2001. This was perhaps due to increased number of rainy days observed during the year.

- (d) **Evaporation.(Table 8)** The lowest and the highest evaporation was recorded in November and March with values 3.1 and 4.9 respectively. The average for the year was being 4.0 mm.
- (e) **Relative Humidity (Table 8)** The average relative humidity in the morning fluctuated around 82% during the year. In the afternoon it varied around 74%.

**Table 8: Meteorological Data (Bandirippuwa Estate)**

	Rainfall (mm)			Temperature (C <sup>0</sup> )		Evaporati on (mm)	Relative Humidity (%)		Sunshine (Hrs)	Wind Velocity (Km/h)
	2001	92-2001 Ave.	2002	Max.	Min.		a.m.	p.m.		
	January	83.1	66.2	5.2	32.6		21.8	4.4		
February	40.4	65.8	23.2	34.0	21.8	4.9	74	62	8.8	5.5
March	26.2	55.8	165.0	33.2	22.6	4.9	79	65	8.0	3.7
April	266.6	214.0	258.5	32.5	22.7	4.3	81	73	7.8	3.0
May	43.4	243.4	240.7	31.9	24.2	3.5	82	81	6.2	4.4
June	37.4	121.4	87.8	30.5	24.4	3.6	84	80	6.6	4.9
July	18.3	79.3	4.0	30.5	24.9	4.0	84	77	7.7	5.7
August	5.1	81.9	48.7	30.4	24.4	4.1	83	77	7.3	5.4
September	164.8	193.4	34.7	31.4	24.2	4.3	77	70	7.7	0.0
October	142.0	320.7	606.1	30.5	22.3	3.2	87	77	5.4	0.0
November	170.9	294.1	213.6	30.8	22.8	3.1	88	82	5.6	0.0
December	56.8	94.2	91.9	30.8	22.3	3.5	84	76	6.0	0.0
<b>Total</b>	<b>1055.0</b>	<b>1830.2</b>	<b>1779.4</b>	<b>31.6</b>	<b>23.2</b>	<b>4.0</b>	<b>82</b>	<b>74</b>	<b>7.0</b>	<b>4.7</b>

## 6.2 Rainfall in Ratmalagara Estate

All months during the year experienced rainfall (Table 9). The total rainfall was 1800.4 mm. This was greater than that experienced in 2001 and also compared to previous 10 year period. Low rainfall was observed for the months of January, February, June, July, August, and September.

## 6.3 Rainfall in Isolated Seed Garden

All the months except July recorded rainfall, with January, March, June, August and September experiencing low rainfall (Table 9). The total rainfall for the year was 1644.3 mm., as against 964.6 mm., recorded in 2001. The total rainfall was higher than that recorded during the last 10 years period.

## 6.4 Rainfall in Maduru Oya Seed Garden

Except July, rest of the months experienced rainfall. The total rainfall recorded for the year was 1657.1 mm., which was lower than that recorded for 2001. Heavy rainfall was observed for the month of December amounting to 529.5 mm. (Table 9)

**Table 9: Rainfall (mm) at Ratmalagara, Isolated Seed Garden and Maduru oya**

	Ratmalagara Estate			Isolated Seed Garden			Maduru Oya	
	2001	92-01 Ave.	2002	2001	92-01 Ave.	2002	2001	2002
Jan.	116.2	49.1	12.4	90.5	56.8	9.5	307.2	215.0
Feb	46.1	57.6	25.1	63.2	55.8	84.0	127.2	138.5
Mar.	0.0	39.2	80.9	0.0	49.8	23.6	1.7	23.0
Apr.	231.6	204.8	330.0	262.6	181.7	406.8	242.4	175.2
May	112.8	202.4	159.7	15.8	169.7	162.4	0.0	11.2
Jun.	25.0	87.6	73.8	46.6	80.0	70.8	49.0	5.9
Jul.	5.7	49.0	4.8	2.9	43.8	0.0	59.0	0.0
Aug.	10.3	49.5	9.6	7.1	34.5	10.1	0.0	8.2
Sep.	187.6	154.4	54.7	134.3	124.1	71.3	50.9	74.1
Oct.	243.4	345.2	445.5	137.7	265.8	453.3	201.0	197.5
Nov.	301.9	366.1	456.3	171.2	287.5	220.5	280.5	279.0
Dec.	50.5	103.1	147.6	32.7	132.9	132.0	463.1	529.5
<b>Total</b>	<b>133101</b>	<b>1708.0</b>	<b>1800.4</b>	<b>964.6</b>	<b>1482.4</b>	<b>1644.3</b>	<b>1782.0</b>	<b>1657.1</b>

**REPORT OF THE TISSUE CULTURE DIVISION**  
**Head - L K Weerakoon, Ph D**

**1. GENERAL**

During the year, greater attention was given to studies on fundamental aspects of plant regeneration through somatic embryogenesis.

Twenty-seven tissue-cultured coconut plants were planted at Bandirippuwa Estate and Pallama seed garden to evaluate their performance in the field. The growth of the tissue-cultured plants established previously at Bandirippuwa Estate was found to be satisfactory and flowering was observed in two of the palms. Fifteen more tissue-cultured plants were fully acclimatized and ready for field planting.

Soluble proteins were extracted from a series of inflorescences of different maturity and the profiles of these proteins are being studied with the aim of identifying a possible protein marker to assess the morphogenic potential of inflorescence tissues.

A protocol was developed for viable protoplast isolation from immature inflorescence tissues, using enzyme mixtures. An effective sterilization method for *in vitro* culture of endosperm tissues was developed and several culture media are being tested for induction of callus in the cultured endosperm explants.

Investigations on pollen and ovule culture for the production of double haploid plants were continued. The most suitable development stage for ovule culture was identified and suitable culture conditions for callogenesis were defined.

A total of 233 dikiri embryos were cultured using an upgraded embryo culture protocol. With the new protocol, the germination rate of embryos was found to be satisfactory and a considerable number of ungerminated embryos could also be recovered by application of gibberellic acid (GA<sub>3</sub>). The growth of *in vitro*-raised dikiri plants was found to be satisfactory. About 20 dikiri plants are ready for field planting whereas 33 plants are at the final stage of acclimatization.

The growth parameters of the palms (that survived the stress conditions caused by different concentrations of PEG) that had been established at Lenawa Estate were measured.

Under the germplasm exchange programme, embryos of 4 coconut varieties namely, Laccadive Ordinary, Indian West Coast Tall, Banawali Green Round and Andaman Ordinary were brought from India. Embryo cultures were initiated with this material in order to propagate these varieties under *in vitro* conditions.

High frequency of plant regeneration from *Paulownia fortunei* (a fast-growing timber crop) was achieved by culture of nodal segments on MS medium (Murashige and Skoog medium) with appropriate supplement of growth regulators. More than 75 *in vitro*-raised *Paulownia fortunei* plants were successfully acclimatized using hydroponics technique.

## 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)

The project funded by the DFID and IPGRI on mass propagation of *dikiri* coconut was successfully completed. During the year, a total of 233 *dikiri* embryos were cultured using the COGENT upgraded coconut embryo culture protocol. The germination rate of embryos was found to be satisfactory and it varied from batch to batch (87.4 – 63.6 %). The ungerminated embryos as well as the embryos that did not show any signs of growth after sprouting were treated with GA<sub>3</sub> (0.35 µM). A considerable number of these embryos could be recovered by this treatment. The growth of *in vitro*-raised *dikiri* plants was found to be satisfactory. One hundred and seventy eight *dikiri* plants have already been transferred to soil out of which 112 survived. About 20 plants are ready for field planting whereas 33 plants are at the final stage of acclimatization. Over 200 embryos are still growing in culture and they will be transferred to soil in due course.

*L K Weerakoon, T R Gunathilake, K P I E Ambagala and E S Santha*

##### Experiment 18.1.2: Screening coconut germplasm for drought-tolerance using *in vitro* techniques (1986)

The growth parameters of the palms (that survived the stress conditions caused by different concentrations of PEG) that had been established at Lenawa Estate were measured.

*L K Weerakoon, E S Santha and K P I E Ambagala*

##### Experiment 18.1.7: Germplasm exchange program

Under the germplasm exchange programme with India, over 700 embryos of 4 coconut varieties namely, Laccadive Ordinary, Indian West Coast Tall, Banawali Green Round and Andaman Ordinary were brought from India (Table 1). Embryos were initially cultured in sterile water and after bringing them to the Tissue Culture Laboratory at CRI, they were transferred to the standard growth medium (modified Eeuwens Y3 medium).

**Table 1.** *Establishment of embryo cultures with coconut germplasm brought from India*

Coconut variety	Number of embryos discarded due to contamination	Number of embryos growing in culture
Laccadive Ordinary	29	191
Indian West Coast Tall	18	182
Banawali Green Round	11	121
Andaman Ordinary	06	175

*L K Weerakoon, K P I E Ambagala, T R Gunathilake,  
E S Santha and J M D T Everard*

## 18.2. Studies on clonal propagation of coconut

### Experiment 18. 2. 1. *In vitro* culture of immature zygotic embryos of coconut

The effect of three polyamines namely, spermine, spermidine and putrescine on induction of somatic embryos in immature embryo-derived callus was studied. The medium 72 was used as the basal medium and different levels of the 3 polyamines in combination with ABA (5  $\mu$ M) were tested. The preliminary results did not indicate any significant improvement of somatic embryogenesis by the application of the 3 polyamines.

In order to increase somatic embryo multiplication, the possibility of inducing secondary embryogenesis from immature embryo explants is being tested.

Sixteen clonal plants derived from immature embryo callus were planted in the field. The performance of the clonal plants, which were planted in the field in the previous years was found to be satisfactory.

*L K Weerakoon, S C Fernando, E S Santha, and K P I E Ambagala*

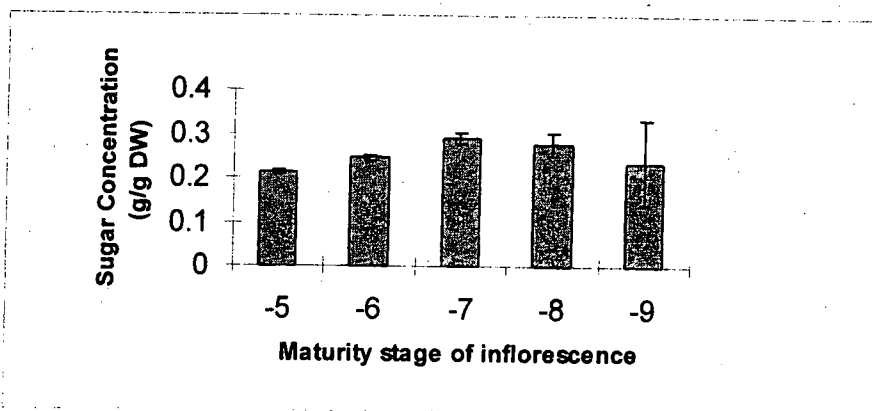
### Experiment 18. 2. 4. Culture of floral meristem explants (1995)

Identification of a suitable biochemical marker for selecting the most responsive developmental stage of immature inflorescence for *in vitro* culture would lead to consistent callus production at a high frequency. Thus biochemical studies were continued further to find any correlation between the biochemical characteristics of the explant and its morphogenic potential. Based on the results of previous studies (Annual report of CRI, 2001), the contents of total sugar and starch were determined in inflorescences of 5 developmental stages (-5 to -9 stages, considering the youngest open inflorescence as 0). The callusing frequency of the explants corresponding to these maturity stages was also studied. The variation in the levels of starch and total sugar in inflorescence tissues at different stages of maturity are shown in figures 1 and 2.

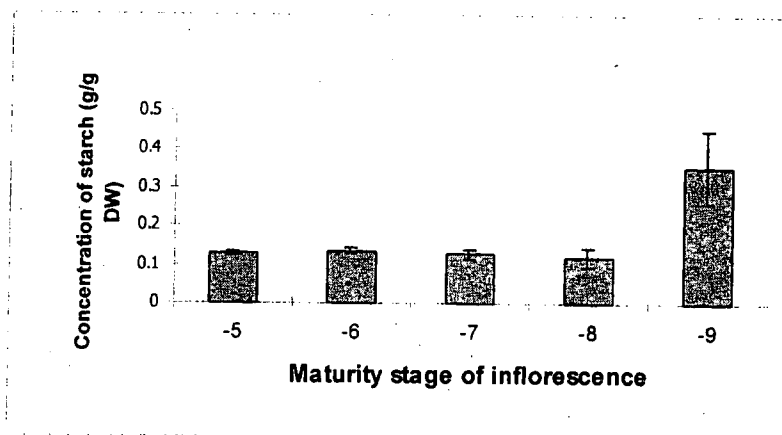
In regard to total sugar content, a gradual increase was observed from -5 to -7 stages and a declining trend was observed thereafter. The starch content was found to be low in -5 to -8 stages whereas a sharp increase in starch content was observed in -9 stage.

Regarding callusing frequency, explants derived from -6 to -8 stages showed a higher callusing frequency when compared to the other stages. Thus higher accumulation of total sugar in these developmental stages might have some significance in morphogenesis, especially as an energy source. Hence, total sugar content might be a possible biochemical marker for assessing the morphogenic potential of inflorescence explants. Analysis of sugar profiles of inflorescence tissues of different maturity stages is underway to generate more information on biochemical markers.

Proteins could also be a possible marker for selecting the most responsive developmental stage of immature inflorescence for *in vitro* culture. Thus soluble proteins were extracted from a series of inflorescences of different maturity (from -1 to -13 stages). The profiles of these proteins are being analyzed using SDS-PAGE technique with the aim of identifying a possible protein marker to assess the morphogenic potential of these tissues.



**Figure 1:** Variation of total sugar concentration with the maturity stage of inflorescence



**Figure 2:** Variation of starch concentration with the maturity stage of inflorescence

Histological analysis of immature inflorescence tissues at different stages of maturity is in progress.

One plant derived from immature inflorescence callus was planted at Bandirippuwa Estate.

*H D D Bandupriya and L K Weerakoon*

#### **Experiment 18. 2. 5. Culture of plumule explants (1997)**

Initiation of callus from plumule explants of coconut was continued. The mean callusing frequency in plumule explants produced during the year (30 %) was lower than that of previous years (above 50 %). The effect of picloram (50-100  $\mu$ M),  $\text{AgNO}_3$  (5  $\mu$ M), high sucrose content (12 %) and pH of the medium (5.0-6.0) on callusing frequency was studied. Substitution of 2,4-D (100  $\mu$ M) with picloram (50-100  $\mu$ M) resulted in a slight increase (about 40 %) in callusing frequency. However, the other treatments did not have any positive effect on callusing. Further studies are needed to find the cause/s for low callusing frequency observed.

Embryogenic callus derived from plumule explants was used for studies on somatic embryogenesis. Previous studies revealed that application of high agar concentration-induced water stress, AgNO<sub>3</sub> (5 µM) or cytokinin (5 µM 2iP) in combination with ABA (5 µM) significantly improved plant regeneration frequency when compared to the application of ABA alone. Further studies on the synergistic effect of high agar concentration-induced water stress, AgNO<sub>3</sub> (5 µM) and cytokinin (2iP, BAP, kinetin, TDZ, CPPU) in combination with ABA are in progress.

Ten plants regenerated from plumule-derived callus were planted in the field.

*S C Fernando and L K Weerakoon*

#### **Experiment 18. 2. 7. Studies on coconut anther, pollen and ovule culture (1997)**

Ovules obtained from inflorescences of -1 to -6 stages (considering the youngest open inflorescence as 0) were cultured into callus induction medium to identify the most suitable developmental stage for callus induction. The results revealed that the most suitable developmental stage for callus induction was -4 stage. Thus ovule explants at -4 stage were used for further studies on optimization of callusing frequency. Experiments are in progress to study the effect of different levels of sucrose, pH and auxins (IAA, NAA, picloram and 2,4-D) on callogenesis in ovule explants.

It was possible to induce somatic embryo formation in ovule-derived callus by application of 5 µM ABA in combination with 10 µM AgNO<sub>3</sub>. A few of the somatic embryos sprouted in culture to produce shoot-like structures. Further experiments are underway to improve somatic embryogenesis from ovule explants.

Histological analysis of callus, somatic embryos and shoot-like structures derived from ovule explants was initiated.

*P I P Perera, L K Weerakoon and S C Fernando*

#### **Experiment 18.2.11. Studies on protoplast culture of coconut (2002)**

Attempts were made to isolate viable protoplasts from immature inflorescence tissues. The rachillae of immature inflorescences (6-8 months before splitting) were used as the explants. The effect of different enzyme mixtures, pre-plasmolysing media, osmotica and digestion times on protoplast isolation was studied. Based on the results of all the preliminary experiments, a protocol was developed for viable protoplast isolation. It yielded viable (> 85 %) protoplasts (2 x 10<sup>5</sup> protoplasts per gram tissue) of different sizes (10-70 µm).

Moreover, as the use of more mature inflorescences for culturing reduces the damage to the mother palm, isolation of protoplasts from pollen mother cells was also attempted. Anthers of inflorescences (2 months before splitting) were used for the study. The developed enzyme mixture was suitable for protoplast isolation from pollen mother cells. However, further studies are needed to find a method for separation of protoplasts/ pollen mother cells from tissue debris.

The presence of raphids in suspensions of protoplasts isolated from coconut tissues, made the separation of protoplasts from tissue debris by centrifugation difficult. Therefore,

attempts were also made to isolate protoplasts from embryogenic callus of coconut. The above protocol was found to be suitable for isolation of protoplasts from embryogenic callus.

The protoplasts isolated from various tissues were cultured in media supplemented with various combinations of hormones (2,4-D and BAP) and antioxidants (charcoal and PVP). However, suitable conditions for protoplast division are yet to be identified. Further studies to increase the protoplast yield and develop suitable conditions for protoplast culture are in progress.

*S C Fernando*

#### **Experiment 18.2.12. Studies on endosperm culture of coconut (2002)**

The solid endosperm of coconut, stores a substantial amount of oil. Callus induced from coconut endosperm could possibly be an alternate source of fatty acids. Therefore, studies on endosperm culture of local varieties of coconut were initiated. During the year, much emphasis was placed on development of an effective sterilization procedure for in vitro culture of endosperm tissues and selection of a suitable culture media for callus induction.

Nine to fourteen-month old Sri Lanka Tall coconuts were used for the study. Initially, endosperm was excised from the micropylar (M), equatorial (E) and antipodal (A) regions of the nut and washed under running water for 1 hour. Then the tissues were dipped in 70 % alcohol for 3 minutes followed by treatment with different concentrations of Ca (OCl)<sub>2</sub> (5, 10 and 20 % ) for different durations (30 and 60 minutes). Finally, tissues were cut into small pieces (2 mm thick) cultured in vitro.

In the following experiments, dehusked nuts were rinsed in a detergent solution and endosperm was excised in the laminar flow hood. The tissues were then cultured with or without sterilizing in 5 % calcium hypochlorite.

For callus induction, 2 basal media (72 and Y3; liquid and solid) with hormones (100 µM 2,4-D , 28.5 µM IAA and 2.2 µM BAP , 10 µM kinetin and 200 µM 2,4-D) and without hormones were tested. Endosperm tissues (excised from M, E and A regions of the nut) were cultured in the above media for callus induction.

The results revealed that sterilization of endosperm tissues in calcium hypochlorite (5, 10 or 20%) for 30 or 60 minutes was equally effective. However, cultures could also be initiated successfully by excising the endosperm inside the laminar flow hood without using any chemical agents. Tissues taken from antipodal region showed necrosis within 1-2 weeks of culturing. No callusing was observed in tissues excised from 10-14 month-old nuts. The endosperm tissues obtained from micropylar region of 9 month-old nuts (excised inside a laminar flow hood without any chemical treatment) that were cultured in solid Y3 medium supplemented with 28.5 µM IAA+2.2 µM BAP showed callus initiation after four weeks of culture. Further studies are in progress to multiply callus initiated from coconut endosperm.

*S C Fernando*

## Experiment 18. 2. 13. Studies on the quality of *in vitro*-raised coconut plants (2002)

Generally, *In vitro*-raised coconut plants exhibit slow growth during acclimatization. Previous studies have revealed that leaf anatomy of *in vitro*-raised coconut plants differ from nursery-raised seedlings. However, no such studies have been undertaken on root anatomy of *in vitro*-raised coconut plants. As the root system plays a vital role in providing nutrients and water to the plant, studies on root morphology and anatomy of *in vitro*-raised coconut plants could provide valuable information to improve the growth of *in vitro*-raised plants during acclimatization. Thus a preliminary study was conducted to compare the root system of *in vitro* and *ex vitro*-raised coconut plants. The roots of embryo-cultured plants grown in solid and liquid media (prior to acclimatization), embryo-cultured plants during acclimatization (acclimatized using hydroponics technique and in river sand and compost (1:1) potting mixture) and embryo-cultured plants at field planting stage were used for the study. The roots of germinating seed nuts and nursery-raised seedlings at field planting stage were used as controls. The roots were washed with tap water and hand sections were taken at 0.5, 1.5 and 2.5 cm from the root tip. The sections were stained in safranin for 10 minutes and observed under the microscope.

The study revealed that generally, roots of germinating seed nuts and nursery-raised seedlings were thicker than those of embryo-cultured plants. However, anatomy of roots collected from *ex-vitro* and *in vitro* grown plants was similar except for the presence of air cavities in the pith of roots in plants grown in liquid culture medium as well as in plants acclimatized by hydroponics. The difference in the pith (presence of cavities) of roots grown in liquid media and hydroponics might be due to poor aeration under these conditions. However, the anatomy of roots initiated on those plants during acclimatization in the potting mixture was comparable to that of nursery-raised seedlings.

Furthermore, another preliminary study was conducted to evaluate the effect of acclimatization procedure on plant quality. Five to six month-old, embryo-cultured plants were used for the study. Plants were removed from the test tubes and their growth measurements (shoot height, number of leaves, number of primary roots and presence of secondary roots) were taken. Plants were then washed thoroughly and acclimatized for three months using one of the three following procedures.

- 1) Control: plants grown in standard potting mixture (soil: river sand-1:1)
- 2) Application of hormones: plants grown in standard potting mixture after application of rooting hormone (commercial preparation, Sector)
- 3) Hydroponics: plants grown in hydroponics (in a nutrient solution)

After three months of acclimatization, shoot height, number of newly emerged leaves, number of primary roots, root and shoot fresh weight and dry weight (after drying at 100 °C for 48 hours) of plants were measured. Data collected from eight samples (per treatment) were analyzed using ANOVA.

**Table 2 :** *Growth performance of plants acclimatized by different procedures*

Treatment	No of newly emerged leaves	Plant height (cm)	Total number of primary roots	Shoot DW (g)	Root DW (g)	Root DW / Shoot DW
Control	2.4	44.3	4.3	2.56	0.44	0.16
Application of hormones	2.0	45.2	3.7	2.49	0.57	0.22
Hydroponics	2.0	40.7	3.4	2.32	0.59	0.26
Significance	NS	NS	NS	NS	NS	LSD = 0.07
CV (%)	21.7	23.2	25.9	34.3	41.5	27.5

DW = Dry weight; NS = Not significant.

Results showed that none of the treatments had a significant effect on plant height, number of leaves, number of primary roots, shoot dry weight or root dry weight of plants during the first three months of acclimatization. However root to shoot dry weight ratio of plants grown using hydroponics was significantly higher than that of control plants. Even though this did not show any positive effect on plant height or number of leaves during the first three months of acclimatization, it might be effective during later periods of acclimatization.

Therefore at present, plants acclimatized for three months according to the given procedures are maintained in potting mixture of un-sterilized top soil, dried cow dung and coir dust (2:2:1) for further evaluation after 6 months of acclimatization.

*S C Fernando, C J Senarathna and K P I E Ambagala*

### Experiment 18. 2. 14. Micropropagation of high-value crops (2002)

Suitable culture conditions for micropropagation of *Paulownia fortunei* (a fast-growing timber crop) were developed. High frequency of plant regeneration was achieved by culture of nodal segments of *Paulownia fortunei* on MS medium (Murashige and Skoog medium) supplemented with BAP (5  $\mu$ M). More than 75 *in vitro*-raised *Paulownia fortunei* plants were successfully acclimatized using hydroponics technique.

*L K Weerakoon 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 the assistance given in designing experiments and statistical analysis of data. Special thanks are extended to the Head and the staff of the Plant Physiology Division for their assistance in biochemical analysis of various explants of coconut.

**REPORT OF THE COCONUT PROCESSING RESEARCH DIVISION**  
**Officer in Charge - C Jayasekara, Ph D**

**GENERAL**

The research program of the division was based on development of kernel based value added products. Experiments were carried out to develop a coconut paste to minimize the domestic wastage of coconut and increase the number of coconuts going to the industry. Further studies are being carried out to scale up the process to industrial scale and to develop value added products from the paste.

Studies were conducted to incorporate coconut flour, obtained from coconut residue, into bakery foods (bread and buns) and it was found that up to 15 % coconut flour can be added without affecting the quality of bread and buns.

Technology was developed to extend the shelf life of bottled *Penipol* up to one year.

Two formulations of natural and artificial lime flavored beverages were developed with seasoned nut water. The taste and appearance of the products were acceptable and microbiologically safe. Further trials are being continued to improve the shelf life and the acceptability of the products.

Experiments were conducted to improve shelf life of scraped coconut packed in polythene bags at low temperature.

Experiments were carried out to modify the Ceylon Copra Kiln for the use of charcoal powder as fuel.

Studies on retting process of coconut fiber to improve the quality of coir fiber was started and further experiments are being carried out to identify organisms involved in retting process to develop a consortium.

**PROJECT 41.0: Research on development of kernel based products**

**Experiment 1: Development of Coconut Paste**

The objective of this project is to reduce the domestic wastage of coconut and increase the number of coconuts going to the industry. In domestic scale, coconut residue remaining after milk extraction is wasted. This residue is rich in proteins, fat and dietary fibre. Use of coconut in a form of a paste (creamed coconut) was developed. The composition of coconut residue is given in Table 1.

**Table 1.** *Composition of coconut residue*

Moisture %	Fat %	Protein %	Mineral %	Dietary fibre %	Other carbohydrates %
3.6	10.9	12.1	3.1	60.9	9.4

## Preparation of coconut paste

Scraped coconut was dried in the oven until the moisture content reached 2 %. Then it was ground in a domestic electric grinder until it gave a fine paste. The optimum moisture content was determined by preparing the paste at different moisture content (Table 2). When the moisture content is about 2 % fine paste could be obtained.

**Table 2.** *The moisture content and the creaming ability of coconut*

Moisture content %	Quality of the paste
10 %	Not good
7 %	Not good
5 %	Particles are not fine
Less than 3 %	Fine paste

Therefore it can be concluded that moisture content of coconut should be reduced to about 2 % to make a fine paste.

Different methods of drying can be used to dry the scraped coconut. Approximate time required to reach 2 % moisture is given in Table 3.

**Table 3.** *Quality of paste with different drying methods at different times*

Drying method	Time	Quality of paste
Hot air oven at 100 °C (200 g)	1.5 hours	Caramelized
Hot air oven at 80 °C (200 g)	1.5 hours	Good
Domestic oven (at low level , 200 g)	1.5 hours	Good
Sun-drying	2 hours	Good
Micro wave drying (100 g)	2 minutes	Good

The times required depend on the amount of the coconut and the capacity of the oven. Drying at higher temperatures (100 °C) is not suitable, as it tends to caramelize.

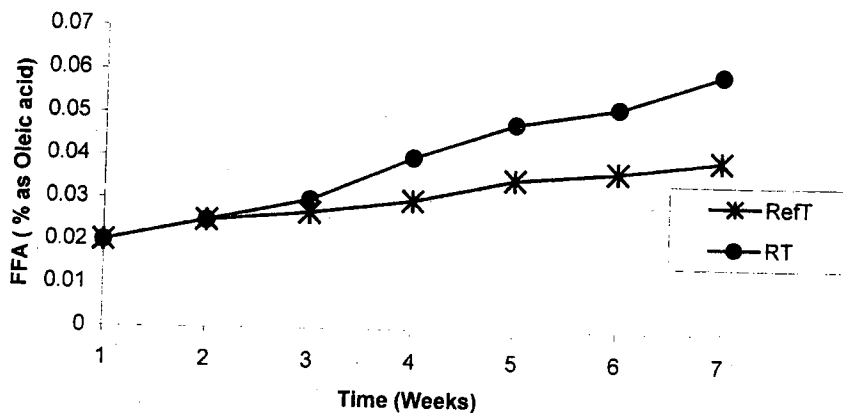
## Usage of coconut paste

Coconut paste can be used in all culinary purposes by dissolving in warm water and ratios of coconut paste to water for different purposes (see table 4). According to the table it can be concluded that 1:7 water ratio is good for making thick milk and 1:10 for thin milk.

**Table 4.** *Amount of water and quality of milk*

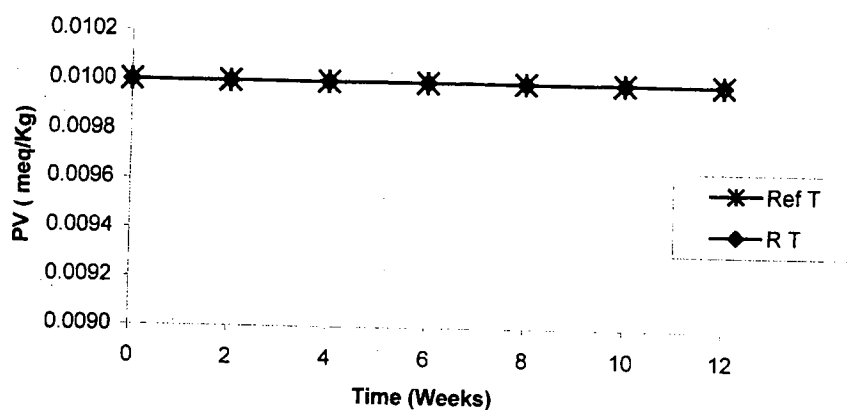
Ratio - Coconut paste : water	Quality of milk
1:1	Too thick
1:2	Too thick
1: 5	Moderately thick
1:7	Good
1:10	Thin
1:12	Too thin

## Storage of coconut paste



**Figure 1.** Variation of FFA at Room Temperature (RT) & Refrigerated Temperature (Ref.T) on storage

Prepared coconut paste was packed in PET/LDPE bags stored at room temperature and refrigerated temperature and during 3 months of storage, the paste was evaluated for Free fatty acid and Peroxide value at 2-week intervals, using AOAC (1990) method. It was found that free fatty acid increases from 0.02 to 0.06 at room temperature and 0.02 to 0.04 at refrigerated temperature. This is clearly shown in the graph below.



**Figure 2.** Variation of Peroxide Value (PV) at Room Temperature (RT) and Refrigerated Temperature (Ref.T) on storage

In a fatty food free fatty acid levels increase with time due to hydrolytic reactions catalysed by lipases of food or microorganisms. The moisture content and other catalytic agents are the factors causing the hydrolytic rancidity and the free fatty acids formed on

hydrolysis are due to fragmentation of long chain fatty acids to short chain fatty acids. However, the increment of free fatty acids of coconut paste during 3 months of storage is very low (0.04 %) compared to that of other foods. This is because the temperature of paste rises to 80 °C during grinding process and this rise extends the shelf life of the paste by delaying the rancidity development as enzymes and microbes responsible for rancidity development are destroyed.

No change was noticed in the Peroxide Value within the storage period at both storage conditions. This fact is demonstrated in Fig.2.

These levels of change did not affect on sensory properties considerably. Traditional food products such as *milk rice*, *watalappan* and *curries* like *polos*, chicken and fish prepared with coconut paste and coconut milk were evaluated by a tasting panel of 30 panelists. No considerable difference was observed between coconut paste and coconut milk.

*P. Gunatilaka, C. Yalagama and M. Jayasundera*

### **Experiment 2 : Studies on development and storage of bottled "Peni pol" (Coconut Caramel Spread)**

*Penipol*" (Coconut Caramel Spread) is a coconut based product basically consisting of grated coconut, caramelized sugar or treacle, salt and few selected spices. This is used as an ingredient or 'sweet filler' in the preparation of sweet foods like '*Laveria*', '*Imbul Kiribath*', pancake etc. However, *panipol* cannot be kept for more than two days without refrigeration because of rancidity development and microbial spoilage. Main objective of this study was to develop an instant product by applying the bottling technology, which extends the shelf stability of food products. Preliminary experiments on determination of best proportion of raw materials showed that best coconut to sugar ratio was 2.5 to 2.0 for an accepted product.

**Table 5.** *Chemical properties of Penipol*

Parameter	Value
Total Soluble Solids	65 <sup>0</sup>
PH	5.5
Water activity	0.8
Moisture	27.68 %wb
Protein	2.59 %wb
Fat	21.54 %wb
Fiber	1.3 %wb
Total ash	0.6 %wb
Carbohydrate	46.89 %wb

Wb-wet basis

Prepared *Penipol* with tocopherol was filled into pre sterilized jars, while hot and were sealed. These were subjected to different levels of heat treatments on boiling water bath and kept for one month for microbiological analysis. Microbiological analysis revealed that bottled *Penipol* heated at 100 °C for 30 min. is adequate to achieve the commercial sterility because it was found no living microorganisms in the sample.

Storage changes in bottled *Penipol* were monitored at two months intervals from the date of preparation for a period of one year by determining Peroxide value, free fatty acids values and sensory evaluation.

During one year of storage free fatty acids levels increases from 0.02 to 0.07 % whereas peroxide value remains unchanged. But sensory evaluation indicates that, this increment in free fatty acids does not affect on sensory properties. When compared with other fatty foods this increment is very low. This is because tocopherol at 100ppm level, combine with heat treatment adequate to overcome rancidity development for the period of one year.

The median values of sensory attributes of preserved *Penipol* during storage at ambient temperature are shown in table 6.

**Table 6.** *Sensory attributes of preserved Penipol during storage at ambient temperature*

Characteristics	Preserved Penipol Storage period (Months)							F ratio
	Fresh	2	4	6	8	10	12	
Colour	4.6	4.6	4.6	4.6	4.5	4.6	4.6	0.25 <sup>NS</sup>
Appearance	4.7	4.7	4.7	4.6	4.7	4.7	4.7	0.69 <sup>NS</sup>
Taste	4.5	4.5	4.5	4.5	4.5	4.5	4.5	0.61 <sup>NS</sup>
Smell	4.3	4.3	4.3	4.3	4.3	4.3	4.3	0.55 <sup>NS</sup>
Overall acceptance	4.5	4.5	4.5	4.5	4.4	4.5	4.5	0.25 <sup>NS</sup>

NS- Non significant

Statistical analysis of sensory evaluation shows that there is no significant differences between freshly prepared *Penipol* and preserved *Penipol* up to one year of storage. This indicates bottled *Penipol* pasteurized at 100 °C minimum for 30 min. was acceptable.

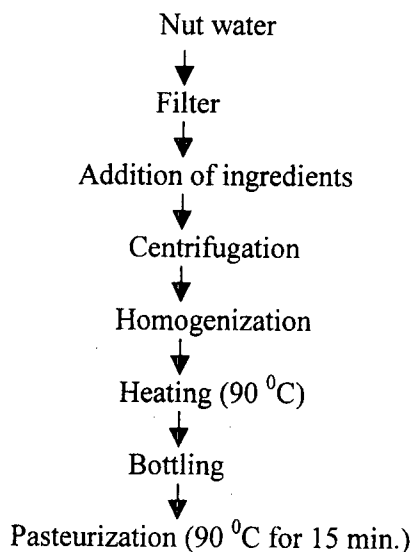
*K.D.P.P.Gunathilake, A.N.Kumara*

### **Experiment 3: Preparation of beverages out of seasoned coconut (*Cocos nucifera*) water**

Seasoned nut water is the water in a coconut about 1-2 months after plucking. It is a by-product of the coconut industry, especially where desiccated and copra processing take place. Sri Lanka, about 2.5 billion nuts produce annually, from which about 65 % is used as fresh consumption and rest is used in other processing industries. Around 220.6 million liters of nut water was thrown away via above two industries. Seasoned nut water is reported to contain 0.74 % oil, 0.55 % protein, 2.56 % sugars with a lot of potassium and sodium salt. It is further enriched with vitamin (Sison, 1977). Seasoned nut water can be used to manufacture of various products like soft drinks, food jelly, yeast, alcohol, nata de coco, dextran, vinegar and ethyl acetate. Main objective of this study was to develop a palatable beverage, storable at room temperature using seasoned nut water.

Two formulations of natural and artificial lime flavoured beverages were developed with trial and error. Preliminary trials were done to identify suitable stabilizer, centrifugation and homogenization pressure. It was found that Carboxy Methyl Cellulose (CMC) at 0.4 % as stabilizer, centrifugation of filtered nut water at 5000 rpm and homogenization of nut water

with other ingredients at 11000 rpm will give a satisfactorily stable product compare with other levels tested. Beverage include sugar 10<sup>0</sup> brix, citric acid 0.075 %, CMC 0.4 %, SO<sub>2</sub> 70 ppm, ascorbic acid 0.015, Sodium citrate 0.001 %, pH 4.3 and Titratable acidity 0.11 %. Beverage manufacturing steps are shown in the figure 1.



**Table 7.** *Probability levels of sensory attributes of beverage and the best one with each attribute within three months storage period*

Month	Sensory attributes	Probability	Best beverage	
			Commercial	Natural
1 <sup>st</sup> month	Colour	0.96	*	*
	Favour	0.02		*
	Aroma	0.13	*	*
	Sweetness	0.05	*	*
	Overall acceptability	0.01		*
2 <sup>nd</sup> month	Colour	0.22	*	*
	Favour	0.87	*	*
	Aroma	0.78	*	*
	Sweetness	0.48	*	*
	Overall acceptability	0.63	*	*
3 <sup>rd</sup> month	Colour	0.40	*	*
	Favour	0.04		*
	Aroma	0.64	*	*
	Sweetness	0.06	*	*
	Overall acceptability	0.02		*

Probability value (P<0.05) significantly different

Total plate count was conducted to determine the adequacy of heat treatment and it was found that microbial count was nil in tested samples.

Sensory evaluation was done to find out the best formulation and to find out changes during three months storage period.

Flavour and overall acceptability were significantly different at 1<sup>st</sup> and 3<sup>rd</sup> months of two flavours. Highest median value was scored the natural lime flavour. Further studies are being continued to improve flavour and colour of the beverage.

*K.D.P.P.Gunathilake, W.Bandara*

#### **Experiment 4. Preservation of Fresh Coconut (*Cocos nucifera* L.) Gratings by Combined Preservation Techniques**

The main objective of this experiment is to develop a method to extend the shelf life of fresh grated coconut to make it available as ready to use pack. Based on preliminary experiment in 2001, 3 % salt as humectant, 0.3 % citric acid and 0.1 % sodium citrate as acidulant were selected. 3 % salt reduces the water activity up to 0.94 without affecting the organoleptic properties and citric acid at 0.3 % reduces the pH up to 4.5. Vitamin E (α-tocopherol) and BHA (Butylated Hydroxy Anisole) at 0.02 % as percentage of fat were tested as antioxidants. Sodium benzoate at 0.05 % was used as preservative. Two packing materials PET/Al foil/LDPE and Nylon/LDPE/covered with paper were tested. Low Temperature (5±2 °C) was used as a hurdle for this experiment. The effects of two packaging materials, on product stability at cold condition are shown in the table.

**Table 8.** *Effect of packing materials on physical properties of preserved coconut gratings (with BHA) during storage at 5±2 °C and 44±3 % RH*

Pack	Period (weeks)	TBA Mg. mal/kg	FFA %	Colour	
				L value	b value
PET/Al /LDPE	0	0.12	0.04	72.91	7.26
	2	0.20	0.96	74.92	6.81
	4	0.22	1.51	74.69	6.57
Nylon/ LDPE	2	0.21	0.04	75.93	6.58
	4	0.24	1.66	74.74	6.51

This study revealed that pouches made out of aluminum foil laminated with PET and LDPE were found to be suitable for storage of the product at 5±2 °C and 44±3 % RH without affecting organoleptic properties compare with nylon/LDPE. In sensory evaluation, according to the estimated medians of sensory data there was no significant difference in all the quality attributes of the fresh and preserved coconut samples. Further studies are being continuing at ambient level preservation.

*K.D.P.P.Gunathilake and L.Dassanayake*

### Experiment 5. Development of a dehydrated food product from young coconut kernel

Sri Lanka, as a major coconut exporter in the world market, there is a need for Sri Lanka to devote more intensive research and development efforts on utilization and product diversification in coconut. There is a feasibility to develop and diversify young coconut kernel of 7-9 months old as value added product like dehydrated snack product. The main objective of this study is to develop a snack out of young coconut meat.

In first stage, Suitable pre treatments were determined. In this case the scooped kernels strips were immersed in three different concentration levels of selected chemical solutions namely potassium metabisulphite (0.04 %, 0.06 %, 0.1 %), calcium chloride solution (0.1 %, 0.3 %, 0.5 %) and Sodium bicarbonate (0.025 %, 0.05 %, 0.1 %). Treated samples were cooked in 25 °C sugar syrup for 15 min. and dried at 60 °C for 8 hours.

Based on observations of colour, appearance of dried materials kernels immersed in 0.1 % Calcium Chloride gave an acceptable crispy product. Further studies are being continuing.

*K.D.P.P.Gunathilake, L.Kumarasinghe*

### Experiment 6: Studies on coconut residue enriched bakery foods

Defatted coconut can be used to make coconut flour which has a high protein content. Experiment was carried out to study the feasibility to add defatted coconut flour obtained from coconut milk manufactory to bakery products such as bread and buns in various proportions. Coconut flour was blended with wheat flour to a uniform mixture in the ratios of 0 %, 5 %, 10 % and 20 %. The blended flour samples were given to a bakery to make the products with normal procedure of baking. The trial was carried out with triplicate. The samples were presented to three panels consisting of 30 panelists. Results are given in table 11.

**Table 9.** *Properties of Coconut flour enriched bread*

Composition of bread	Moisture %	Oil	Dietary (Total dietary fiber) %
Control	33.7	2.3	17.7
5 % Coconut flour	31.7	5.4	21.3
10 % coconut Flour	30.7	6.5	24.3
15 % coconut flour	28.8	7.2	28.5
20 % coconut flour	27.0	8.4	30.2

**Table 10.** *Properties of Coconut flour enriched bun*

Composition of buns	Moisture %	Oil %	Dietary fiber %
Control	36.5	8.4	16.2
5 % Coconut flour	35.1	10.4	19.2
10 % coconut Flour	34.2	9.3	18.9
15 % coconut flour	32.1	10.6	27.5
20 % coconut flour	30.2	11.0	28.3

**Table 11. Quality of coconut flour enriched buns and bread**

Buns/Bread	Texture	Appearance	Taste
Control (Bread)	Soft	Good	Good
5 % bread	Soft	Good	Good
10 % bread	Soft	Good	Good
15 % bread	Neither soft nor hard	Good	Good
25 % bread	Hard	Not good	Good
Control (Bun)	Soft	Good	Good
5 % bun	Soft	Good	Good
10 % bun	Soft	Good	Good
15 % bun	Neither soft nor hard	Good	Good
25 % bun	Hard	Not good	Good

According to the table 7 and 8 content of dietary fiber is high in coconut flour enriched products. The taste of the product is acceptable in all range of proportions. But texture is affected when the ratio is about 15 %. But the taste is always good. So it can be concluded that coconut flour can be incorporated to bakery products to enrich the quality of wheat bread and buns up to 15 %.

*C. Yalegama, M. Jayasundera, P. Gunathilaka*

## **Project 41.0 Improvement of Copra drying process and quality of copra**

### **41.1 Improvement of Copra drying process**

The Ceylon Copra Kiln was modified by experimenting for the use of charcoal powder, understanding heat generation and heat distribution patterns in the kiln and working out the most appropriate height between charcoal bed and the copra drying platform to achieve the highest efficiency of drying, convenience of operation and minimum PAH contamination. Based on the trials carried out the most suitable firing chamber height was assessed to be either 3 feet or 4 feet. There was no significant difference between the 2 heights ( $P > 0.05$ ). The firing chamber of 4 feet in height was selected for further trials. Length and width of the firing chamber were 12 feet and 6 feet 4 inches respectively. Thousand five hundred coconuts were used for each trial. Three firings with different amounts of charcoal (45 Kg for 1<sup>st</sup> firing, 45 Kg for 2<sup>nd</sup> firing and 30 Kg for 3<sup>rd</sup> firing) were used.

The copra produced was graded on the basis of current grading system for copra from shell- fired kiln. Yield percentage of all grades of copra is given in table 12.

**Table 12. Mean percentage yields of copra**

Grade	Mean yield percentage
1	90±3
2	8±2
3	2±1

*M. Jayasundera, U. Samarajeewa, A.R Kulatunga and M. Rajapakse*

#### 41.2 Storage studies on moisture equilibration of copra under ambient conditions

Copra produced in the above experiment was stored under ambient conditions and examined for moisture equilibration for 3 weeks. It was observed that the moisture gain or loss occurs from copra depending on the relative humidity of the atmosphere to maintain a moisture percentage of  $7 \pm 1$ .

*M. Jayasundera, U. Samarajeewa, A.R Kulatunga and M. Rajapakse*

#### 41.3 Storage studies on moisture equilibration of copra under laboratory relative humidity conditions

Copra was stored in the laboratory under different relative humidity conditions to observe the shelf life. Dried copra kernels stored in air tight boxes at RH 100 % (over water) and RH 70 % (over saturated sodium chloride solution) continued to absorb moisture leading to microbial spoilage and also dried kernels stored in air tight boxes at ambient temperature developed mold. Dried copra kernels stored in open boxes under ambient conditions (66-81 %) maintained  $6.5 \pm 0.5$  % moisture and remained with little or no mold growth up to 60 days. It was observed that there was a reduction in moisture when dried kernels were stored above 33 % of RH (saturated magnesium chloride).

*M. Jayasundera, U. Samarajeewa, A. R Kulatunga and M. Rajapakse*

#### 41.4 Studies on spread of insect infestation on storage

Insect infested copra cups from some of the trials were stored along with uninfected cups in gunny bags for 3 weeks under ambient conditions and spread of insects and mould growth during storage were examined. It was observed that the number of insect infested cups didn't increase on storage of copra. However, in the already infested cups the number of holes created by the insects increased over the period. Penicillium species (non-aflatoxin producers) spread in to all the cups on storage.

*M. Jayasundera, U. Samarajeewa, A. R Kulatunga and M. Rajapakse*

#### 41.5 Estimation of oil yield, FFA % and moisture % of oil

Coconut oil was expelled from grade 1 copra produced, with the use of a mini-expeller screw press. Oil yields, moisture % and FFA % of oils were estimated. Mean oil yield % at the time of expulsion was  $75.0 \pm 0.30$ , mean oil yield % after sedimentation was  $58.4 \pm 0.46$  mean FFA % of oil was  $0.3 \pm 0.05$  and mean moisture percentage of oil was less than  $0.3 \pm 0.01$ .

*M. Jayasundera, U. Samarajeewa, A. R Kulatunga and M. Rajapakse*

## **OUTSIDE FUNDED PROJECTS**

- 7.0 Studies on the retting process of coconut fibre to improve the quality of coir fibre**
- 7.1 Comparison of microbial community in fresh water, brackish water and saline water retting pits**

The objective of this experiment is to study the microorganisms present in fresh water, brackish water and saline water retting pits and to establish an artificial microbial consortium to accelerate the retting process. Eight sampling sites were selected for this study which comprised three fresh water and brackish water retting pits from the north western province and three saline water retting pits from the southern province. Sampling was done at three week intervals and the ret liquor collected was subjected to both microbiological and physicochemical character analysis. Many bacteria and a few fungi were isolated. The most dominating organism in all the three types of water was found to be a spore-forming *Bacillus*. And among the fungi, *Mucor* and *Aspergillus* were found to be dominating. These organisms have been identified upto genus level. The species level identification and study of enzymatic activity of these organisms are being done.

*F. Farook, A. Tennakoon, A. R. Kulatunga and A. Milroy*

### **4. Service and extension activities**

As service functions division provided to NERD with analysis of coconut oil and press cake of the NERD oil extraction machine. Twenty school programmes were conducted to popularize the coconut paste.

### **5. Patent**

The patent was obtained for the domestic milk extraction machine in 2002

### **6. Other activities**

1. Division completed the local and foreign consultancies during the year which was funded by ADB personnel development project. Prof. U. Samarajeewa, local consultant worked on improvements on existing copra kiln and Mr. Werner Beansch, foreign consultant, worked on new kernel based product development.
2. Mrs. Yalegama and P. Gunathilaka participated in a Live Television programme on "3 to 5" on domestic usage of coconut paste.

## 7. ACKNOWLEDGEMENTS

The assistance and co-operation of the laboratory staff including Mahinda Rajapaksa of Coconut Processing Research Institute is greatly acknowledged. Thanks are due to Dr. (Miss) S. Ranasinghe, Head /Plant Physiology Division and Dr. L.L.W. Somasiri, Head/ Soils and Plant Nutrition for the co-operation extended during the work. The funds given by CESS for retting studies is gratefully acknowledged. Guidance given by the Prof. U. Samarajeewa ,University of Peradeniya and Werner Baensch, gtz consultant, Germany are greatly acknowledged. Thanks are also due to Dr. Graham Wichmann, LEFO Institute for Food research and Development for offering placement for a Two months training with no cost.

**REPORT OF THE PLANT PHYSIOLOGY DIVISION**  
**Head – C S Ranasinghe, Ph D**

**1. SUMMARY**

The divisional research programme was mainly focused on determining the mechanism of drought tolerance in different varieties of coconut palms under field and plant house conditions, physiology and biochemistry of Leaf Scorch Decline (LSD) and Coconut Rapid Decline (CRD) affected palms, sustainability of yield stimulation of toddy by ethrel and improving the shelf-life of tender king coconuts up to six weeks.

Plant house experiment conducted for screening coconut palms for their drought tolerance indicated that the overall performance for the entire period (wet and dry) was best in CRIC 65 compared to Dwarf Green, Tall x Tall and San Ramon. However, San Ramon was the best performer under simulated drought. Further, the evaluation of diurnal performance of CRIC65, Tall x Tall and Tall x San Ramon seedlings revealed that the Tall x San Ramon variety performs better under water limited conditions than other two cultivars.

When a five cm thick layer of coir dust is applied as a mulch ground cover in coconut palms grown in drought prone soils, the palms showed an improved water status compared to palms with bare land or live ground cover during the dry period. The effect was consistent for five years.

Application of 3.0 ml of 2.5% ethrel at the axis of the tapping spadix increased the daily toddy yield, yield per spadix and sugar content in the sap consistently for a period of five years. The yield increase was 31%, 44%, 13%, 30% and 25% during the first, second, third, fourth and fifth year, respectively.

The protocol for quality preservation of tender king coconuts for a period of one month was disseminated to 18 exporters during the year. To refine the existing protocol for enhancing the shelf- life up to six weeks, vacuum packing treatment was started.

**2. RESEARCH PROJECTS**

**PROJECT 13: TODDY TAPPING**

**Experiment 13.4: Chemical stimulation of toddy. Bandirippuwa Estate, Lunuwila (1996).**

This study investigated the effect of ethrel on the yield and sugar content of coconut inflorescence sap and its sustainability. The experiment was a completely randomized design with 12 replicates per treatment. A small piece of cotton wool soaked in a 3 ml solution of Ethrel (Ethepon), at a concentration of 2.5%, was placed at the axis of the tapping spadix (inside the outer bract). The application was done once per spadix and on the first day of slicing. The volume of toddy per palm was measured daily, and sugar and nutrient content of toddy was measured monthly. Untreated palms were used as control.

Application of 3.0 ml of 2.5% ethrel at the axis of the tapping spadix increased the yield of fresh toddy per day and per spadix through out the experimental period of five years,

the total mean increase being 19%. The stimulatory effect was less and not significant in the third year compared to the first, second, fourth and fifth years (Table 1). Ethrel application increased the sucrose and total sugar contents in the sap consistently over five years (Table 2). The experiment was terminated.

**Table 1 :** *Effect of application of ethrel (2.5% E) on the yield of fresh sap during past five years*

Treatment	Yield of sap (L/spadix)					
	1 <sup>st</sup> yr	2 <sup>nd</sup> yr	3 <sup>rd</sup> yr	4 <sup>th</sup> yr	5 <sup>th</sup> yr	
2.5% E	20.8 <sup>a</sup>	18.0 <sup>a</sup>	14.13 <sup>a</sup>	19.70 <sup>a</sup>	27.82 <sup>a</sup>	1025 <sup>a</sup>
Control	15.9 <sup>b</sup>	12.5 <sup>b</sup>	12.39 <sup>a</sup>	15.12 <sup>b</sup>	20.23 <sup>b</sup>	750 <sup>b</sup>
% increase	31%	44%	13%	30%		25%

means with the same letters are not statistically significant within a column at  $p < 0.05$ )

**Table 2 :** *Effect of application of ethrel (2.5% E) on sugar content in fresh sap during past five years*

Treatment	Sugar content (g/100ml)					
	1 <sup>st</sup> yr	2 <sup>nd</sup> yr	3 <sup>rd</sup> yr	4 <sup>th</sup> yr	5 <sup>th</sup> yr	
	Total sugars	Total sugars	Total sugars	Total sugars	Total sugars	Sucrose
2.5% E	16.90 <sup>a</sup>	16.24 <sup>a</sup>	16.82 <sup>a</sup>	17.82 <sup>a</sup>	16.64 <sup>a</sup>	14.88 <sup>a</sup>
Control	13.96 <sup>b</sup>	14.20 <sup>b</sup>	14.06 <sup>b</sup>	12.64 <sup>b</sup>	14.08 <sup>b</sup>	12.01 <sup>b</sup>

means with the same letters are not statistically significant within a column at  $p < 0.05$ )

*C S Ranasinghe, W P K K Fernando, P S A de Saram, , A Jayatillake*

**Experiment 13.5: Identification of plant materials as natural anti-ferments for the collection of fresh toddy. Bandirippuwa Estate, Lunuwila (2001).**

This study was conducted with the objective of determining the ability of some plant materials to arrest fermentation of fresh toddy. The following plant materials were added to collection pots every day. In the control pots, toddy was collected without adding anti-ferments. The sugar content, pH and the alcohol percentage of the collected sap were measured.

**Treatments:** (for approximately a litre of fresh toddy)

- T1 – fresh coconut husk (50 g)
- T2 – tender papaya (75 g)
- T3 – vanillin powder (0.35 g)
- T4 – hal bark (5 g)
- T5 – Control

The pH value was highest in fresh toddy collected with fresh husk and hal bark. It was significantly higher than papaya and vanillin treatments and the control. Nevertheless, acidification of fresh toddy by micro-organisms was reduced in toddy treated with hal bark and fresh husk. Similarly, conversion of sucrose to reducing sugars (glucose and fructose) and alcohols was also reduced by hal bark and fresh husk treatments. Based on this data it

seems that pieces of fresh husk also can be used as antiferment for collection of fresh toddy and this may possibly due to high polyphenol content in the fresh husk (Table 3).

**Table 3 :** *Effect of application of different anti-ferments in the collection pots on pH, sugar (g per 100 ml), ethanol (%) and mannitol (%) content of fresh toddy*

Treat	pH	Sucrose	Glucose	Fructose	Raffinose	Ethanol	Mannitol
F. husk	5.0 <sup>b</sup>	9.1 <sup>b</sup>	2.3 <sup>b</sup>	2.5 <sup>b</sup>	0.24 <sup>a</sup>	0.72 <sup>ab</sup>	0.28 <sup>bc</sup>
papaya	4.5 <sup>c</sup>	7.7 <sup>bc</sup>	2.8 <sup>b</sup>	3.0 <sup>ab</sup>	0.41 <sup>a</sup>	0.40 <sup>ab</sup>	0.86 <sup>a</sup>
vanillin	4.4 <sup>c</sup>	7.5 <sup>bc</sup>	2.6 <sup>b</sup>	2.9 <sup>b</sup>	0.31 <sup>a</sup>	0.72 <sup>ab</sup>	0.71 <sup>a</sup>
Hal bark	6.0 <sup>a</sup>	13.9 <sup>a</sup>	0.87 <sup>c</sup>	0.86 <sup>c</sup>	0.15 <sup>a</sup>	0.18 <sup>b</sup>	0.16 <sup>c</sup>
control	4.2 <sup>c</sup>	5.3 <sup>c</sup>	4.3 <sup>a</sup>	4.2 <sup>a</sup>	0.38 <sup>a</sup>	1.12 <sup>a</sup>	0.64 <sup>ab</sup>

means with the same letters are not statistically significant within a column at  $p < 0.05$

*C S Ranasinghe, W P K K Fernando, A Jayatillake*

**Experiment 13.6: Effect of 'tapping stimulus' on the differentiation of female flowers in unopened coconut inflorescences. Bandirippuwa Estate, Lunuwila (1996).**

This experiment was conducted with a view to determine whether the 'tapping process' acts as a stimulant for female flower differentiation in successive spadices. Twelve numbers each of DG x Tall palms and Tall x Tall palms were used for the study. The following treatments were tested and number of female flowers in emerging inflorescences was counted.

- T1- Continuous nut production
- T2- Periodic nut and toddy production in alternate spadices

There was no difference in the total number of female flowers produced in the nut producing bunches between T1 and T2, during the first year of tapping. When the tapping discontinued after one year and allowed to produce nuts, the total number of female flowers produced in T2 palms was double compared to T1 in DG x Tall palms. This stimulatory effect was observed consistently during two consecutive years after tapping. However, there was no such stimulation in Tall x Tall palms.

*C S Ranasinghe, L R S Silva*

**PROJECT 22: POST-HARVEST HANDLING OF TENDER KING COCONUTS AND BODIRI FOR QUALITY PRESERVATION.**

**Experiment 22.3: Development of a post-harvest technology to improve shelf-life of tender king coconut (1999).**

The protocol for quality preservation of tender king coconuts for a period of one month was disseminated to 18 exporters during the year. Experiments were commenced to improve the existing protocol for enhancing the shelf- life of tender king coconuts up to six weeks. Vacuum packing of nuts in polythene bags of different gauge size and colour (clear or black) is being tested. Different surface sterilizing methods of nut surface are also being tested to replace Benomyl treatment.

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W P K K Fernando, M Gunawardane*

## PROJECT B-17: WATER RELATIONS OF THE COCONUT PALM

### Experiment B-17.2 : Importance of root to shoot communication in drying soil: role of abscisic acid in drought tolerance in coconut (1997).

An experiment was carried out to determine the physiological performance of Tall x Tall, Tall x San Ramon and Dwarf Green x Tall seedlings under plant house conditions at three different soil moisture regimes. The experiment was a Randomized Complete Block Design (RCBD) with 8 replicates per treatment. Three different soil water status were obtained by changing the frequency of watering as follows.

Moisture treatment	Water status	Watering frequency
T1	Field Capacity (FC)	Everyday
T2	Moderate Stress (MS)	at 15 days intervals (MS)
T3	Severe Stress (SS)	at 20 days intervals (SS)

The variation in rate of photosynthesis, transpiration, stomatal diffusive resistance, leaf water potential and relative water content was reported in Annual Report 2001. In the present year, abscisic acid (ABA) content in the xylem sap of the three varieties under three soil moisture regimes was compared.

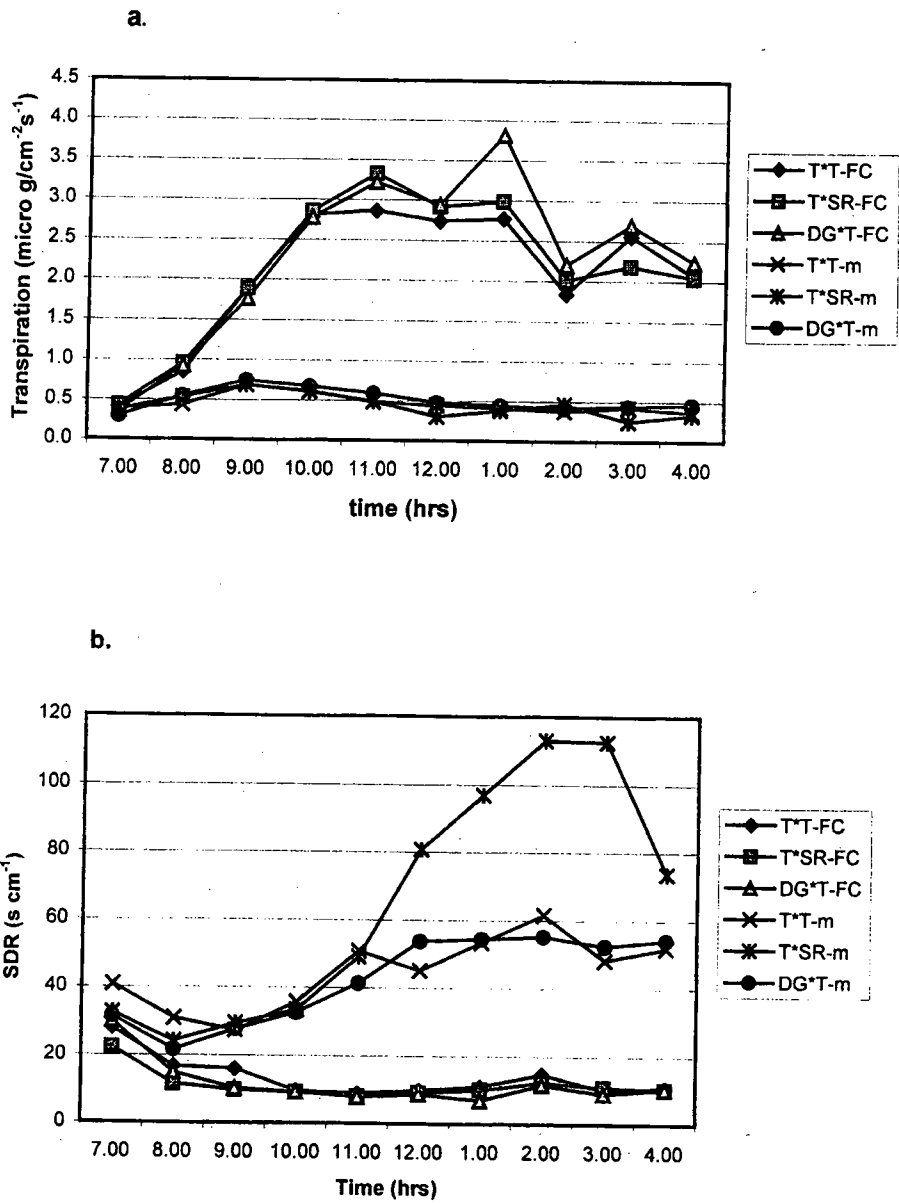
In all three varieties, the ABA content in the xylem sap was highest when the plants were grown under moderate water stress (T2). The seedlings grown under severe water stress accumulated higher ABA content than the seedlings at field capacity, and lower ABA content than the seedlings at moderate water stress. This suggests that when the soil is drying, ABA is accumulated in the roots and this message is communicated to leaves via the xylem sap through ABA for increasing stomatal resistance and conserving water. However, when the seedlings are grown under severe water stress, it seems that ABA is not the only biochemical agent for controlling stomatal closure in coconut. There may be other antitranspirant agents involved in coconut as it is reported for other plant species (Table 4).

**Table 4:** *Abscic acid (ABA) content (ng/ml) of three varieties under different water status*

Variety	Field Capacity	Moderate Stress	Severe stress
Tall x Tall	0.06	26.5	10.76
Tall x San Ramon	2.3	18.86	14.64
Dwarf Green x Tall	1.65	16.63	12.39

The diurnal variation in the rate of transpiration ( $Tr$ ) and stomatal diffusive resistance ( $Rs$ ) of the three varieties at field capacity and moderate water stress was measured from 7.00 to 16.00 hrs at hourly intervals. The objective of this study was to ascertain the differences in pattern of stomatal opening / closure in the three varieties under wet and dry conditions. At field capacity,  $Tr$  of the three varieties showed a similar pattern of variation during the day. There was a sharp increase in  $Tr$  from 7.00 to 11.00 hr and the rates were almost constant until 13.00 hr. The  $Tr$  decreased thereafter in all three varieties. At moderate water stress,  $Tr$  was significantly reduced during the day compared to unstressed condition. The highest  $Tr$  was shown around 9.00 hr and decreased thereafter indicating a very early stomatal closure under moderate water stress conditions (Fig. 1a).

The  $R_s$  was significantly higher in water-stressed seedlings compared to the seedlings at field capacity in all three varieties. Tall x San Ramon showed higher  $R_s$  compared to Tall x Tall and DG X Tall from 12.00 hr onwards under water stressed condition, for which the reason has to be elucidated (Fig. 1b).



**Fig 1:** Diurnal variation in the (a) rate of transpiration and (b) stomatal diffusive resistance (SDR) of three coconut varieties (Tall x Tall, Tall x San Ramon and Dwarf Green x Tall) under two soil water regimes (FC- Field Capacity, M-moderate water stress).

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**Experiment B-17.5: Effect of different ground cover management systems on the growth of coconut palms in Andigama soil series at RE (1997).**

The effect of different ground cover management systems on the water status of coconut palms grown in shallow soils was studied. The following treatments were imposed:

- T<sub>1</sub> - Dead mulch in the manure circle; rest of the land bare (MCDM/CSB)
- T<sub>2</sub> - Dead mulch in the manure circle; rest of the land grass cover (*B. brizantha*) slashed every 6 months (MCDM/CSGC)
- T<sub>3</sub> - Dead mulch in the manure circle; rest of the land uncontrolled grass cover (*B. brizantha*) (MCDM/CSGU)
- T<sub>4</sub> - Dead mulch in the manure circle; rest of the land *Pueraria* cover (MCDM/CSP)
- T<sub>5</sub> - Dead mulch in the manure circle; rest of the land 6" thick coir dust cover (MCDM/CSCD)

Dead mulch (DM): 12 coconut fronds without petioles / yr

Rate of transpiration and stomatal diffusive resistance of the palms were measured during wet and dry periods. There was a significant difference in the rate of transpiration between wet and dry periods (status), but the treatment effect and the treat x status interaction were not statistically significant. The difference in stomatal diffusive resistance was significant among the treatments and between wet and dry periods (status). The interaction of treat x status was also significant for stomatal diffusive resistance. However, the highest rate of transpiration and lowest stomatal diffusive resistance were shown by the palms with coir dust treatment (T<sub>5</sub>), indicating improved water status of those palms compared to control and other treatment palms during the dry period (Table 5).

**Table 5:** Effect of different ground cover treatments on rate of transpiration, stomatal diffusive resistance and leaf water potential of coconut palms during wet and dry periods of the year

Treatment	Rate of Transpiration ( $\mu\text{g cm}^{-2} \text{s}^{-1}$ )		Stomatal diffusive resistance ( $\text{s cm}^{-1}$ )	
	Wet	Dry	Wet	Dry
Bare land	4.142	0.979	3.92	36.19
Grass-controlled	4.249	0.655	4.03	54.30
Grass-uncontrolled	2.991	1.348	4.85	29.13
Puero cover	3.547	0.811	6.71	48.48
Coir dust cover	4.243	1.821	4.53	27.50
Significance				
Treatment	ns		P=0.008	
Status	P=0.001		P=0.0001	
Treat x status.	ns		P=0.0117	
LSD	Status = 0.508		Treat x Status = 12.33	

The economic analysis also revealed that application of 6" thick coir dust cover (T<sub>5</sub>) is economically viable even with 25% increase in coir dust price and 25% decrease in coconut price compared to the prices in 2002 (Jayalath *et al.*, unpublished). The experiment was terminated.

*C S Ranasinghe, R D N Premasiri, L R S Silva*

**Experiment B-17.6: Screening coconut palms (*Cocos nucifera* L.) for drought tolerance using physiological, biochemical and molecular traits (2001).**

The objective of the experiment was to screen available varieties, forms and accessions of coconut for their drought tolerance using physiological, biochemical and some molecular traits and also to identify a suitable representative parameter/s that can be easily measurable.

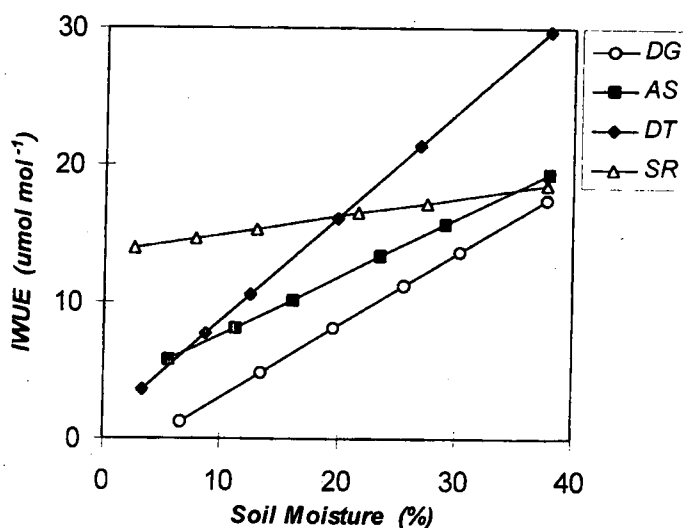
Seedlings of four coconut varieties were grown in pots in the plant house environment for the initial evaluation prior to field-testing. It was conducted as a Randomized complete block design (RCBD) with 3 blocks, 4 coconut varieties (Dwarf Green [DG], Ambakelle Special [AS], Dwarf Green x Tall [DT], San Ramon [SR]), 2 water treatments (Field Capacity, Drying by withholding water for 9 weeks) with 3 seedlings per plot resulting a total of 72 seedlings. Treatments were randomly allocated for plots in each block considering both variety and the water treatment together as a treatment combination.

The intrinsic water use efficiency (IWUE), which is the assimilation per unit change in stomatal conductance ( $g_s$ ) ( $IWUE = \text{Rate of Photosynthesis} / g_s$ ) was calculated for each variety and regressed against the available soil moisture at the time. The obtained regression coefficients (b) were then subjected to the analysis of variance (ANOVA) for the identification of differences among varieties under moisture stress.

DT showed the highest regression coefficient of 0.759 that indicated a rapid reduction in IWUE over depleting soil moisture content. Therefore, DT appears more sensitive to changes in soil moisture content. In contrast, SR was at the other extreme having the lowest regression coefficient of 0.132, hence, exhibiting more stable performance out of four varieties tested with respect to IWUE under soil moisture stress. Coefficients for both AS and DG were in between showing the intermediate performance (Table 6 and Fig. 2).

**Table 6:** *Regression equations for IWUE vs. soil moisture percentage for each variety for the moisture stress period (Same letters indicate no significant difference according to DNMR test)*

Variety	Regression equation ( $y = b x + c$ )	SE of b	$R^2$
DG	$y = 0.524^b x - 2.255$	0.02	0.94
AS	$y = 0.424^b x + 3.294$	0.02	0.96
DT	$y = 0.759^a x - 0.995$	0.02	0.94
SR	$y = 0.132^c x + 13.58$	0.01	0.96



**Fig. 2** Regression lines for IWUE vs. soil moisture percentage for each variety during the moisture stress period

Other important parameters such as the rate of photosynthesis, stomatal conductance, rate of transpiration, leaf relative water content and dark-adapted leaf chlorophyll fluorescence ( $F_v / F_m$ ) showed a pattern much similar to the above. Therefore, according to the preliminary plant house experiment, SR appeared more tolerant to moisture stress while DT showed the least. Field established 13 coconut varieties and 25 accessions are being evaluated using the same technique under natural moisture stress conditions.

*A Nainanayake*

## PROJECT : GERMINATION OF COCONUTS

### Experiment B-: The effect of seasoning of coconuts on germination (2002).

This experiment was started with a view to determine whether seasoning of nuts before laying in the nursery has any effect on germination of the nut and seedling quality. The experiment was a completely randomized block design. Thousand number of Tall x Tall seedlings were obtained from Isolated Seed Garden. The following treatments were imposed.

- T1- Laying of coconuts without seasoning
- T2- Laying of coconuts with one month seasoning

The time taken for germination is being recorded. The variation in seedling vigor (leaf area development) and chlorophyll content of seedlings will be compared between two treatments.

### Experiment B-: The effect of orientation of the nut during seasoning on the germination (2002).

This experiment was started with the objective of determining whether the orientation of nuts during seasoning has any effect on germination of the nut and seedling quality. The experiment was a Randomized Complete Block Design. Five hundred seedlings of Tall x

Tall were obtained from Isolated Seed Garden, seasoned in the nursery (horizontally) for one month and laid in the nursery imposing following treatments.

- T1- Laying of coconuts with same orientation as it was during seasoning (horizontally)
- T2- Laying of coconuts with 90° rotation as it was during seasoning (horizontally)
- T3 Laying of coconuts with 180° rotation as it was during seasoning (horizontally)
- T4 Laying of coconuts vertically

The time taken for germination is being recorded. The variation in seedling vigor (leaf area development) and chlorophyll content of seedlings will be compared between four treatments.

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**PROJECT 24: LEAF SCORCH DECLINE OF COCONUT PALM**

**Experiment 24.5: Investigations on leaf micronutrients of Leaf Scorch Decline (LSD) affected palms.**

In LSD-affected palms, the leaf Zn content was lower than apparently healthy palms (CRI Ann Report, 1999). Therefore, the affected palms at Bandirippuwa and Walpita estates were root fed with 100 ml of 1% ZnSO<sub>4</sub> solution at bimonthly intervals for a period of one year to determine the effect of Zn on expression of LSD symptoms. However, the root feeding of 1% ZnSO<sub>4</sub> solution did not show any significant improvement of Zn levels in the 14<sup>th</sup> frond of coconut palms. Therefore, a preliminary study was carried out to determine a more efficient method to apply Zn for LSD-affected palms. The following treatment methods were evaluated.

T1	Root feeding of ZnSO <sub>4</sub> (5% ZnSO <sub>4</sub> , 20 ml per palm)
T2	Trunk feeding of ZnSO <sub>4</sub> (5% ZnSO <sub>4</sub> , 20ml per palm)
T3	Leaf spraying of ZnSO <sub>4</sub> (1% ZnSO <sub>4</sub> , 600ml sprayed to 14 <sup>th</sup> frond)
T4	Axial application of ZnSO <sub>4</sub> (8% ZnSO <sub>4</sub> , 12.5 ml applied to 14 <sup>th</sup> frond)

The zinc content of the 14<sup>th</sup> frond, before and after each treatment application was determined. The results showed that spraying (T3) and axial application (T4) of ZnSO<sub>4</sub> are more effective methods in increasing the zinc content in leaves than the other two methods (Table 7). Further studies will be carried out to evaluate the better use of leaf spraying method for applying ZnSO<sub>4</sub> on LSD affected palms.

**Table 7:** Zn content (ppm) of mild-LSD, moderate-LSD and healthy coconut palms before (initial) and after treatment applications, ARF: after root feeding, ATF: after trunk feeding, AS: after spraying, AAT: after axial treatment.

Stage	Root Feeding		Trunk Feeding		Spraying		Axial application	
	Initial	ARF	Initial	ATF	Initial	AS	Initial	AAT
Mild	19.98	20.35	23.03	23.1	20.67	177.8	27.6	303.1
Moderate	20.55	20.9	23.5	25.7	22.13	245	23.97	74.5
Healthy	24.33	24.8	25.5	25.5	24.48	229.8	27.3	258.45

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## **5. TRAINING AND EXTENSION ACTIVITIES**

Mr K R E M Fernando, Lab and Field Assistant of Coconut Research Institute completed a six-month research project on 'Encourage toddy tapping for better income' (in sinhala) for the certificate course of National Institute of Plantation Management, Colombo, under the supervision of Dr C S Ranasinghe.

R M D M Ratnayake, a final year student of Technical College, Kuliyaipitiya completed a three-month research project on 'Information on toddy tapping' (in sinhala), under the supervision of Dr C S Ranasinghe.

Research and technical staff participated as resource personnel in many training programmes for Agriculture teachers and students, Agriculture extension officers and Coconut Development Officers.

## **8. ACKNOWLEDGEMENT**

The co-operation and assistance extended by the staff of the Plant Physiology Division in conducting experiments, data collection and in compiling this report is gratefully acknowledged. Sincere thanks are due to Head and staff of Biometry Division for the assistance in analysis of data.

**MULTI-DISCIPLINARY PROJECT**  
**Project Coordinator – C S Ranasinghe, Ph D**

**PROJECT 17 : COCONUT RAPID DECLINE (CRD)**

**Divisions that participated:**

Plant Physiology Division  
Crop Protection Division  
Soils and Plant Nutrition Division  
Biometry Division  
Genetics and Plant Nutrition Division  
Survey group (Plant Physiology Division, Crop Protection Division)

**General**

The vegetative, reproductive and physiological parameters of Coconut Rapid Decline (CRD)-affected palms of different severity stages were quantified. The multidisciplinary research programme was continued to determine the effects of different treatments on the progression of CRD symptoms. The Food and Agriculture Organization (FAO) has been providing financial and expert assistance to test whether CRD is associated with phytoplasma, virus or viroids since 2001. A survey conducted at Makandura Seed Garden to determine the occurrence and distribution of CRD revealed that there are about 900 affected palms both as clusters or individual palms. However, the cause and remedial measures of CRD are yet to be identified.

**Experiment 1: Quantification of the changes in vegetative, reproductive and physiological parameters in coconut palms affected by CRD (2002)**

Fifteen-years-old, CRD-affected coconut palms in Makandura Seed Garden (MSG) were used for the study. The 'affected' palms were grouped into three categories based on the severity of symptoms determined by average number of drooping fronds, S<sub>1</sub>; incipient stage, S<sub>2</sub>; moderate stage, S<sub>3</sub>; severe stage. Twelve apparently healthy palms (S<sub>0</sub>) and 24 affected palms of above-mentioned three severity stages were used in the study.

**Leaf canopy and trunk characters**

There was a significant reduction in the total number of fronds in CRD-affected palms irrespective of the stage of severity, compared to healthy palms (Table 1). Circumference of the trunk just below the crown and 30 cm below the crown was also reduced significantly in CRD-affected palms as against the healthy palms. Further, the circumference of the trunk just below the crown of moderate- and severe-CRD affected palms was significantly lower than the CRD affected palms at incipient stage (Table 1).

**Table 01:** *Total number of fronds/palm, trunk circumference (just below the crown and 30 cm below the crown) of healthy palms (S<sub>0</sub>) and CRD affected palms: Incipient (S<sub>1</sub>), Moderate (S<sub>2</sub>) and Severe (S<sub>3</sub>)*

Stage of the palm	Total number of fronds /palm	Trunk circumference (cm)	
		Just below the crown	30 cm below the crown
S <sub>0</sub>	31 a	84.94 a	82.90 a
S <sub>1</sub>	20 b	67.14 b	66.95 b
S <sub>2</sub>	20 b	65.01 c	67.41 b
S <sub>3</sub>	20 b	61.83 c	62.77 c

Values with the same letters are not statistically significant within a column (\*\*\*)  $p < 0.05$

### Nut and inflorescence characters

Number of nuts per bunch, total number of female flowers produced per bunch, circumference in both polar and equatorial directions of unopened spadix were significantly reduced in CRD-affected palms compared to healthy palms. However, there was no significant difference in these characters among the severity stages, except for the number of nuts. The palms at severe-CRD stage yielded significantly lower number of nuts than palms at incipient or moderate-CRD stage (Table 2).

**Table 02:** *Number of nuts per bunch, female flowers produced per bunch and circumference in both polar and equatorial directions of unopened spadix of healthy and CRD affected palms*

Stage of the palm	No. of nuts / bunch	No. of female flowers produced/bunch	Unopened spadix characters Circumference (cm)	
			Polar	Equatorial
S <sub>0</sub>	8 a	35 a	94.44 a	25.17 a
S <sub>1</sub>	5 b	13 b	62.70 b	16.22 b
S <sub>2</sub>	4 b	10 b	63.58 b	16.89 b
S <sub>3</sub>	2 c	7 b	58.73 b	16.31 b

The nut weight of CRD-affected palms was significantly lower than healthy palms, irrespective of the stage of severity. However, the circumference in both polar and equatorial directions of the nuts at incipient and moderate stages was similar to healthy palms. In severe-CRD stage, the circumferences were significantly reduced compared to incipient and moderate CRD affected palms (Table 3).

**Table. 03:** *Weight/ nut and circumferences of the nuts of healthy palms (S<sub>0</sub>) and different stages of CRD affected palms: Incipient (S<sub>1</sub>), Moderate (S<sub>2</sub>) and Severe (S<sub>3</sub>)*

Stage of the palm	Weight/Nut (Kg)	Nut circumference (cm)	
		Polar	Equatorial
S <sub>0</sub>	1.736a	31.34 a	53.58 a
S <sub>1</sub>	1.130b	29.42 a	50.86 a
S <sub>2</sub>	1.059 b	25.43 a	44.45 a
S <sub>3</sub>	1.027 b	20.52 b	35.91 b

The weight of husked nut, husk (fresh and dry), shell, and kernel (fresh and dry) of CRD affected palms were significantly lower than healthy palms. There was no significant difference in weights among the severity stages (Table 4 and 5). Similarly, the volume of nut water of CRD affected palms was significantly lower than healthy palms (Table 5).

**Table. 04** *Weight of fruit components: Husked nut, fresh and dry husk and shell of healthy palms ( $S_0$ ) and different stages of CRD affected palms: Incipient ( $S_1$ ), Moderate ( $S_2$ ) and Severe ( $S_3$ )*

Stage of the palm	Husked nut weight (g)	Husk weight (g)		Shell weight (g)
		Fresh	Dry	
$S_0$	750a	908a	359a	218a
$S_1$	439b	735b	269b	142b
$S_2$	465b	590c	261b	151b
$S_3$	424b	600c	243b	163b

**Table 05:** *Weight of solid endosperm (kernel) and volume of liquid endosperm (nut water) of healthy palms ( $S_0$ ) and different stages of CRD affected palms: Incipient ( $S_1$ ), Moderate ( $S_2$ ) and Severe ( $S_3$ )*

Stage of the palm	Kernel weight (g)		Vol. of nut water (ml)
	Fresh	Dry	
$S_0$	373a	206a	225.42a
$S_1$	223b	109b	73.67b
$S_2$	236b	122b	78.09b
$S_3$	206b	117b	57.10b

### Physiological parameters

Healthy palms showed the highest rate of transpiration and it was significantly higher than CRD affected palms at any stage of symptom development. Further, the transpiration rate of severe CRD palms was significantly lower than incipient and moderate CRD affected palms (Table 6). The reciprocal pattern was observed for stomatal diffusive resistance and the differences were statistically significant. At the incipient stage, the stomatal resistance of the palms was similar to healthy palms, but with the advancing severity, moderate and severe CRD palms showed a higher stomatal resistance than healthy and incipient CRD palms (Table 6). Leaf chlorophyll content of healthy palms was also significantly higher than CRD-affected palms, but there was no significant difference among the severity stages (Table. 6).

**Table. 06** *Rate of transpiration ( $\mu\text{g cm}^{-2} \text{s}^{-1}$ ), stomatal diffusive resistance ( $\text{s cm}^{-1}$ ) and total chlorophyll content (mg/g fresh weight) of healthy palms ( $S_0$ ) and different stages of CRD affected palms: Initial ( $S_1$ ), Moderate ( $S_2$ ) and Severe ( $S_3$ ).*

Stage of the palm	Transpiration	Stomatal diffusive resistance	Chlorophyll content
$S_0$	2.73 a	5.30 a	3.13 a
$S_1$	2.11 b	11.43 ab	2.73 b
$S_2$	1.54 b	15.71 bc	2.81 b
$S_3$	1.48 c	21.47 c	2.68 b

## **Experiment 2: Investigations to identify the cause/s of CRD (MSG, 2000).**

The experiment was continued at Makandura Seed Garden with the objective to find out the effect of different treatments on the progress of CRD symptoms. It was a Completely Randomized Block Design (RCBD) with 12 palms per treatment, and the application of treatments was started in August 2000.

The following treatments were applied.

- T1- micronutrients (0.46 g CuSO<sub>4</sub> and 0.76 ZnSO<sub>4</sub> / palm, root feeding at bimonthly intervals)
- T2 - common salt (1 kg / palm / year, surface application in the manure circle)
- T3 - fungicide (Topsin 0.2% solution, 20 L / palm, drenching the manure circle at four monthly intervals)
- T4 - nematicide (Nemacur 5% Granules, 50 g / palm, surface application in the manure circle at four monthly intervals)
- T5 - fungicide + nematicide (T3 + T4)
- T6 - oxytetracycline-OTC (5g / 5ml / palm, trunk injection at four monthly intervals)
- T7 - control (affected palms without treatment)

### **Data collection:**

To assess the progress of symptoms the following data was collected.

1. Number of healthy, drooped and broken fronds in the canopy – at three monthly intervals
2. Nut numbers and weight, and circumference of nuts - at two monthly intervals
3. Trunk circumference at canopy level - at six monthly intervals
4. Circumference of unopened spadix (polar and equatorial) - at six monthly intervals
5. Leaf nutrient levels - at six monthly intervals
6. Chlorophyll content, stomatal resistance and transpiration of leaves - at three monthly intervals
7. Photographs of affected palms - at three monthly intervals

### **Canopy characteristics**

The number of functional green fronds (non-drooping) was significantly higher in common salt and OTC treated palms than control and other treatments. The highest number of total fronds in the canopy was also observed in common salt treated palms and it is significantly higher than other treatment palms. However, the lowest numbers of functional green fronds and the total fronds were observed in micro-nutrient treated palms (Table. 1).

**Table 7:** *Number of functional green fronds (FGF, non drooping) and total number of fronds (TF) in CRD- affected palms in response to different treatments (after two years of treatment application)*

Treatments	Number of fronds	
	FGF	TF
Micronutrients	14.68 <sup>c</sup>	15.54 <sup>d</sup>
Common Salt	21.06 <sup>a</sup>	22.04 <sup>a</sup>
Topsin (Fungicide)	18.17 <sup>b</sup>	19.73 <sup>c</sup>
Nemacur (Nematicide)	14.54 <sup>b</sup>	15.98 <sup>d</sup>
Topsin + Nemacur	19.45 <sup>ab</sup>	20.15 <sup>bc</sup>
Oxytetracycline	20.31 <sup>a</sup>	21.65 <sup>ab</sup>
Control	18.15 <sup>b</sup>	20.04 <sup>bc</sup>
Severity	*	Ns
Trt.	***	***
Sev*Trt	***	***

### Trunk characteristics

Significant differences in circumference of trunks at the canopy level and 30 cm below the canopy level were not observed among the treatments two years after two years of treatment application.

### Physiological and biochemical characters

There was no difference in the rate of transpiration and stomatal diffusive resistance between treated and non-treated palms after two years of treatment application. However, complementing the canopy observations the highest rate of transpiration was observed in palms treated with common salt.

**Table 8:** *Rate of transpiration ( $\mu\text{g cm}^{-2} \text{s}^{-1}$ ) and stomatal diffusive resistance ( $\text{s cm}^{-1}$ ) of CRD-affected palms in response to different treatments*

Treatment	Rate of transpiration	Stomatal diffusive resistance
Micronutrients	1.807	33.304
Common Salt	2.194	28.437
Topsin (Fungicide)	1.893	26.345
Nemacur (Nematicide)	1.767	32.469
Topsin + Nemacur	1.513	38.458
Oxytetracycline	1.973	22.775
Control	1.644	30.123
Severity	Ns	*
Trt.	Ns	Ns
Sev*Trt	Ns	Ns

A new experiment was started at MSG with application of half strength oxytetracycline (OTC) solution (2.5 g per 5 ml per palm) in February 2002. Treatment application was done at three monthly intervals and the progress of the disorder was monitored as the variation in rate of transpiration and stomatal diffusive resistance against the control palms.

The rate of transpiration of CRD affected palms was significantly lower and the stomatal diffusive resistance was significantly higher than healthy palms during the year irrespective of the treatment application. However, the percentage reduction in transpiration was low during wet months (June) than the dry months (February and September) (Table 9). The experiment is in progress.

**Table 9:** Rate of transpiration ( $\mu\text{g cm}^{-2}\text{s}^{-1}$ ) and the stomatal diffusive resistance ( $\text{s cm}^{-1}$ ) of CRD-affected and healthy palms at MSG following application of oxytetracycline

	Rate of transpiration ( $\mu\text{g cm}^{-2}\text{s}^{-1}$ )			Stomatal diffusive resistance ( $\text{s cm}^{-1}$ )		
	Feb-2002	June-2002	Sep-2002	Feb-2002	June-2002	Sep-2002
CRD	1.522	3.378	1.433	28.793	5.606	17.648
Healthy	3.247	4.970	2.738	16.000	3.722	8.106
Sig: treat		***			ns	
time		***			**	
Treat x time		ns			ns	

Values are means of twelve replicates

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L C P Fernando, C Hapuarachchi, S P Manoj, P H A P Siriwardane, W W F N Fernando, N  
G Pemasiri (CPD), D T Mathes, S S Rajapakse (Biometry), D M D I Wijebandara, R Silva  
(SPND), R Jayatillake (GPBD).*

### **Experiment 3: Investigation of causative agent of CRD using molecular diagnostic techniques**

Financial and expert assistance were received from the Food and Agricultural Organization (FAO) to continue molecular work with the objective of determining the association of phytoplasma, virus or viroid with CRD.

Investigation on the presence of phytoplasma in Coconut Rapid Decline (CRD) affected palms was continued. Different tissues of CRD-affected palms were sampled from Makandura Seed-Garden and healthy palms were sampled from Rathmalagara sub-research station for nucleic acid extraction.

#### **Trunk Shavings:**

Total nucleic acid was extracted from trunk shavings obtained at four meter and 5 meter height from the base of the palm from opposite sides of the trunk from ten affected palms, including the previously positive palm and ten healthy palms. Two nested PCR reactions carried out with nucleic acid from trunk shavings as template DNA and phytoplasma specific primers combinations P1/P7 and LY16Sf/LY1623r and P1/P7 and R16F2n/R16R2, both of which previously yielded positive signals, failed to produce positive results this time neither from the other diseased and healthy palms analyzed nor from the previously positive diseased palm. The same nucleic acids were further tested with two other new primer combinations; primer combination R16mF2/R16mR1 and R16F2n/R16R2 and primer combination R16mF2/R16mR1 and rU3/fU5, but failed to produce positive signals.

### **Roots:**

Roots of the same affected and healthy palms; roots without lesions and roots with lesions separately, were sampled, total nucleic acid was extracted and subjected to PCR amplification with all previously tested primer combinations. Phytoplasma specific signals of the expected product size were obtained for two affected palms and two healthy palms analyzed with the primer combination R16mF2/R16mR1 and rU3/fU5. A recently designed highly phytoplasma specific PCR primer pair, Pc339/P1694, was also used in the PCR with nucleic acid from root samples. This primer pair yielded positive signals only from one healthy palm that previously gave positive signal with R16mF2/R16mR1 and rU3/fU5 when nucleic acids from root samples were analysed.

### **Fresh heart tissues:**

Total nucleic acid was also extracted from fresh heart tissues from five affected palms following the phytoplasma DNA enrichment procedure. This DNA was subjected to PCR analysis with primer pair PC339/P1694 and obtained positive results for two out of five affected palms, but the expected product sizes were different indicating a non-specific amplification.

Positive PCR products from root samples were then sequenced at the University of Adelaide, Australia. It was revealed that the sequence was almost identical to the 16S rDNA of a large number of Bacteria, *Bacillus megaterium* and a number of other species, generally listed as gram positive. Some are listed as soil-borne. As the sequence came from the roots and was similar to soil borne bacterial sequences, and not similarity to phytoplasmas as found in the BLAST search, it can be concluded that the result obtained was negative for phytoplasma. **Therefore it can be reasonably concluded that phytoplasma are not associated with the CRD.**

The CRD affected palms were analysed for the presence of virus and viroid at the Coconut Research Institute. None of the experiments carried out and repeated many times for investigation of the association of viroids with CRD became positive. **Therefore it can be concluded with high precision that viroids are not associated with CRD and hence viroid are not the causative of the CRD.**

During the year FAO consultant Professor John Randles of the university of Adelaide visited CRISL and worked with the project staff of CRISL. During his visit several modifications to the virus/viroid detection methods were done and staff was trained on the use of new methodology. However no positive results were obtained todate.

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W B S Fernando, A A Fernando,*

# **REPORT OF THE EXTENSION SERVICES DIVISION**

**Head - P A H Nimal Appuhamy, M Sc**

## **1. GENERAL**

The Division implemented various programmes to build up an effective interaction among stakeholders, researchers and extension personnel. These programmes mainly focus on the transfer of sustainable technologies and information in the coconut sector. A significant increase was observed in the number of stakeholders who received various services under these programmes.

At the beginning of the year, the division coordinated the Institute activities implemented under the 100-day crash programme declared by the government. The division heavily involved in several educational and mass media campaigns under this programme to promote the adoption of technologies in the sector.

The Division involved in several working sessions and workshops to strengthen CRI linkages with stakeholders and partner organizations conducted by the International Services for National Agricultural Research (ISNAR) under the ADB financial support.

## **2. OTHER ACTIVITIES**

Mr. J K J P Jayawardena, Assistant Extension Officer completed collaborative activities with GPB division in the preparation of a catalogue of conservation of germplasm financed by COGENT.

Mrs. H D N H Fonseka, Assistant Extension Officer, commenced postgraduate studies at the Postgraduate Institute of Agriculture, Peradeniya, in June.

Mr. C S Herath, Extension Officer and Mr. J K S P Jayawardene, Assistant Extension Officer attended two-day workshop for young social scientist conducted by the National Science Foundation on 19 and 20 July.

## **3. ESTATE/FARM DEVELOPMENT SERVICES**

### **3.1. Persuasive Extension Programmes (PEP)**

Persuasive Extension Programme (PEP) implemented by the division to promote the adoption of new technologies in the coconut estate sector was successfully continued in this year too. Those who purchased coconut lands and land owners who expect to invest for the development of their lands request the services of PEP. During the year under review 63 estates were inspected and provided with estate development plans based on their requirements. The total extent covered in the year was 12275 ac. The implementation of proposed estate development activities were also monitored.

### **3.2 Technical support services**

Two discussions were held with the Chairman and the Deputy Chairman of NLDB regarding the possibility of providing technical support services to improve the productivity of their coconut farms. Several technical support programmes agreed will be implemented in

the year 2003. Plantation companies such as Kegalle Plantations, Namunukula Plantations and Agalawatta Plantations were also provided with technical support services on requests.

#### 4. TRAINING PROGRAMMES

##### 4.1 One day Training Programme

This is the most popular training programme conducted by the Institute for the benefit of coconut growers and managing staff of private sector estates. During the year seven one-day programmes, one in each month, were conducted from May to November. The total number of participants for the seven programmes was 741. These programmes covered different technical aspects of cultivation and estate management.

Details of one-day training programmes conducted during the year under review are given below.

ProNo.	Date	Venue	Subject Area	No.of Partici
01	24 May	Isolated Seed Garden, Ambakelle	Replanting of Coconut	130
02	28 June	Ratmalagara Estate	Soil and Moisture Conservation	100
03	26 July	Bandirippuwa Estate	Fertilizer application	124
04	23 August	Walpita Estate	Intercropping under coconut	110
05	27 Septem	Bandirippuwa Estate	Pest and Diseases of coconut	100
06	25 October	Ratmalagara Estate	Rehabilitation of low yield in coconut estates	96
07	22 Novem.	Bandirippuwq Estate	Estate and Labour Management	81

A certificate was issued to all trainees who attended the full series of this training.

##### 4.1.1 Manager Training Programme

An intensive practical training programme was completed for 25 educated youth as managers of coconut estates. These trained youth were in high demand for employment in private sector coconut estates. Out of the 25 trained youths, 22 trainees have already been employed in coconut estates in different coconut growing areas and the other three are self-employed. Due to existing demand for trained youths for coconut estate management, arrangements are being made to conduct training for the next batch in the year 2003.

##### 4.2 Other Training Programmes

4.3.1.1 On the request made by the Chilaw Plantations Co. Ltd, two months intensive residential practical training programme was conducted for five assistant superintendents recruited by them, from 16 August to 16 October on cost recovery basis.

- 4.3.2 Training Programme on Intercropping under coconut was conducted for 60 Agriculture Development and Research Assistants in the Puttalam District on 02 September.
- 4.3.3 Two training programmes were conducted for managers of coconut farms of NLDB on planting, soil moisture conservation and Intercropping under coconut on 16 September and 02 December respectively on cost recovery basis.
- 4.3.4 The Institute conducted a week training programme at Athrugiriya for 60 newly recruited estate manager organized by NIPM from 28 October.
- 4.3.5 Two day residential training programme was conducted for 20 field officers and 15 farmers of the "HADABIMA" Authority on 16 and 17 December.

## 5. SEMINARS FIELD DAYS AND WORKSHOPS

- 5.1 Under the 100-day programme declared by the government, the Institute conducted four field days in order to educate and update the technical knowledge of CCB extension personnel. CCB extension field workers are expected to transfer this knowledge to coconut growers and guide them to increase the productivity of their lands. Four special extension publications were also issued based on the technical needs of different coconut growing areas. Thousand copies of each publication were issued to CCB staff at the following field days to be distributed among coconut growers in their farmer educational programmes.
 

First field day was conducted at Narmal watta, Weeraketiya on 22 January. CCB field extensions workers of Galle, Matara and Hambantota regions and coconut growers in surrounding areas participated.

Second field day was conducted at Dummalasuriya and Ratmalagara on 29 January with the participation of CCB extension personnel from Marawila, Kuliypitiya, Kurunegala and Gampaha regions.

The next field day was conducted at Rathne Farm, Thirippane, Anuradhapura with the participation of CCB extension personnel and coconut growers on 12 February. Estate management practices to reduce the effect of drought were demonstrated. Over 70 coconut growers participated in this field programme.

The last field programme was conducted at Matale for the benefit CCB extension field staff of Matale and Kegalle regions on 19 February.
- 5.2 On the request of Farmer Organizations and Govi Niyamakas in Nochchiyagama area a field day was conducted at Anuradapura on 14 March. Over 50 coconut growers participated.
- 5.3 A series of workshops were conducted to strengthen CRI linkages with partner organizations and stakeholders with the guidance of International Services for National Research System (ISNAR) under the ADB funded project. The Division played a major role in organizing and conducting workshops with CCB, private sector

extension organizations, coconut growers, plantation companies, coconut processors and related industries.

- 5.4 Two seminars were conducted for coconut growers, Grama Niladaries and Gove Niyamakas in Hanguranketha and Walapane areas to promote the coconut cultivation on 25 April and 25 June respectively.
- 5.5 On the request CCB, a field day was conducted for 35 superintendents of company estates at Mahayaya Estate on 04 July.
- 5.6 A seminar was conducted for CCB extension personnel from Marawila and Kuliypitiya regions on the ground water potential studies conducted by CRI.

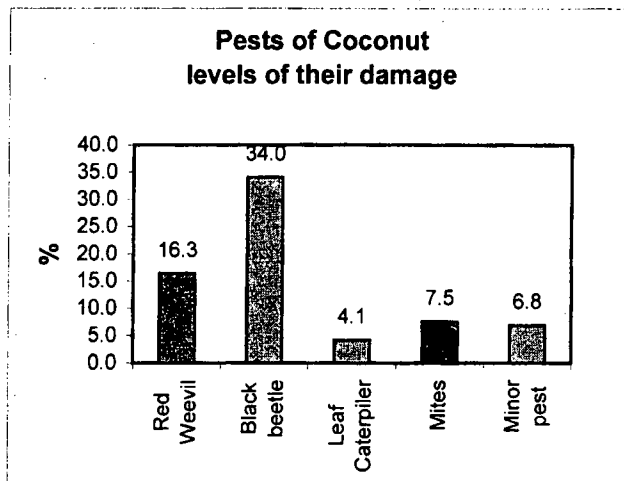
## 6. PARTICIPATOR RESEARCH AND STUDIES

### 6.1 Study to assess the level of technology adoption

A survey was conducted to assess the level of technology adoption by coconut growers, who attended CRI training programmes during the last five years. The analysis of data reveal the following adoption levels in different farmer categories.

<i>Type of technology</i>	<i>Percentage of adoption</i>	
	<i>Small holdings Between 0 – 20 ac</i>	<i>Estate sector More than 20 ac</i>
<b>1. Application of inorganic fertilizer</b>		
a. Regular application	23	56
b. Irregular application	43	37
c. No application	34	07
<b>2. Application of organic manure</b>		
a. Applied	32	30
b. Not applied	68	70
<b>3. Mulching the manure circle</b>		
a. Mulching is practiced	32	77
b. No mulch	68	22
<b>4. Burial of coconut husks in pits</b>		
a. Practiced	34	71
b. Not practiced	65	30
<b>5. Intercropping under coconut</b>		
a. Practiced	56.5	41.5
b. Not practiced	43.5	58.5

The study also revealed that the most damaging coconut pest in the sector is Black beetle and the second is Red Weevil. The level of coconut pest damages are shown below.



## 7. EDUCATIONAL PROGRAMMES AND STUDY TOURS

7.1 The Division conducted comprehensive educational programmes for the benefit of GCE (O/L) and GCE (A/L) students in order to provide necessary information for their projects work. During the year under review 55 such educational programmes were conducted.

7.2 A significant increase in the number of school children and students from other educational institutions visited this Institute for their educational purpose. Based on their requirements several educational programmes were conducted. During the year 4550 school children participated from 56 schools and 475 students and undergraduates from Agricultural schools and Universities.

## 8. ADVISORY ACTIVITIES

A significant increase was observed in the number of coconut growers, processes and representatives of plantation companies who visited the division seeking technical advice. During the year, 165 growers visited the division to obtain technical advice for their field problems. The division gave high priority to provide advisory assistance on the identification and control coconut mite, which is slowly spreading to other coconut growing areas.

Over five hundred people obtained technical advice for their problems relating to coconut cultivation and industries through the telephone line dedicated for this purpose.

To build up effective interaction with stakeholders and to transfer technology and information in electronic means, the division maintains a separate e-mail connection with effect from November.

Advisory field visits were also made to assist growers in their specific field problems. Twenty field visits were made during the year.

The number of letters received requesting technical advice and information has increased. These letters were replied promptly with relevant literature.

## 9. PRINTING AND PUBLICATIONS

The printing section of the division undertook major printing requirements of the Institute. In addition to the divisional printing requirements, the printing section completed about 60 different printing works of other divisions.

During the year the following publications were printed and issued by the division.

1. CRI Annual Reports, 2000 and 2001
2. Short CRI Annual Reports 2000 and 2001
3. CRI Annual Reports in three languages for the parliament 350 copies, 1998, 1999, 2000 and 2001
4. COCOS vol. 14
5. Pol Pawath vol. 18
6. Coconut Bulletin vol. 12
7. CRI Newsletter vol. 3 No. 2
8. Seven booklets on several technical areas in 150 copies for the one-day training programme.
9. Advisory circulars-New circulars-Sinhala-3B  
Tamil A 2, A3, A6, B4  
Reprinting - A3, A6, B3, B4, B5 (Sinhala and English)
10. Preparation and printing of four separate booklets for field days conducted under the 100 day programmes.
11. Handouts to popularize coconut cream.
12. CRI report of ISNAR on Organization Performance Assessment
13. Printing of certificates for Managers Training Programme and One day Training Programme
14. Four colour Sinhala and Tamil posters on the use of "Magosa Mixture" in 1000 copies each.
15. A colour folder was printed in 10,000 copies and distributed among CDOO on the preparation and use of "Magosa Mixture" for the control of coconut mite.

## 10. EXHIBITIONS

The division participated in the following exhibitions to educate growers, students and the general public.

1. Siyane Educational Exhibitions at the Teachers Training College, Veyangoda on 10 and 11 July.
2. Navodaya Lanka Exhibition held at Plonnaruwa from 22 to 28 October.
3. Educational Exhibition at St. Peter's Collage, Iranawila on 26 October.

## 11. MEDIA PROGRAMMES AND AUDIO VISUAL MATERIALS

- 11.1. The following mass media programmes were implemented to educate coconut growers and the general public on the current issues in the coconut sector.

### 11.1.1 Television Programmes

A video programme was produced and edited on the preparation and use of coconut cream to minimize coconut waste in house hold consumption. This programme was telecast on Rupavahini, Sirasa TV and ITN.

Live TV programme on Rupavahini on the preparation of coconut cream was telecast 12 June

A news item was given on Rupavahini and ITN on coconut tapering disease on 25 July

A video news items was prepared and telecast on Rupavahini, Sirasa TV on the use of modified Napsack sprayer to spray coconut palms up to the height of 40 feet with "Magosa Mixture" for mite control 21 August.

A comprehensive TV coverage on mite control activities and CRI research programmes were telecast on ETV and ITN on 06 November.

A TV, radio and advertising commercials were prepared with the help of an advertising agent on the preparation and use coconut cream and telecast on Rupavahini in news peak hours and in house wives programmes as a paid advertisement during the month of December. The same radio advertisement also broadcast on Sirasa Radio during the same period.

The Head of Extension Services Division participated in a live TV Programme on Rupavahini to promote coconut cultivation in home garderns on 02 December.

A TV programme was prepared and telecast on Rupavahini and ITN to introduce polybagging of coconut bunches with sulphur to control coconut mite effectively on 20 December.

**ANNUAL REPORT OF THE LIBRARY**  
**Actg. Librarian - P A H Nimal Appuhamy, M Sc.**

**1. GENERAL**

The library extended regular and satisfactory services to its staff throughout the year and also extended a satisfactory service to outside researches to cater the information needs on their requests.

**2. ACQUISITIONS**

**2.1 Collection of books**

Acquiring books were very limited due to the lack of funds. 09 books were received from the ADB project. The total stock recorded 5666 books as at 31 Dec. 2002.

**2.2 Serials**

The total number of serial titles received during the year was 56. Twelve titles were received on subscription and the others were received either on complimentary basis or on exchange. The full allocation for the books and periodicals used to renew the 2003 subscription renewal.

**2.3 Special collection on coconut**

276 references were newly added to the database of literature on coconut. British Library Lending Service was the major foreign source for acquiring coconut literature.

**3. Services**

**Interlibrary Loan Service**

Under this service 101 articles were requested from AGRINET member libraries of which 85 were received. Total number of articles requested from the BLDSC including literature on coconut was 25 of which 23 were received. From 70 requests for articles received from member libraries, 60 were provided

**SDCP Service**

Selective dissemination of Content Page service was offered at a personalized level to compensate for the inadequate number of journal titles received during the year. Under this service, the library disseminated contents pages of 11 journal titles to member libraries and our users were furnished with the content pages of 21 journal titles.

## **Contribution to National Bibliographies and Database**

Contributions were made towards the compilation of the following integrated databases.

NATIONAL union Catalogue - Sri Lanka National Library and Documentation Centre SLNLDC

National Agriculture Bibliography - CARP

**REPORT OF THE ESTATE MANAGEMENT DIVISION**  
**Manager (Estates) – Frank Jayasinghe, B.Sc**

**1. SUMMERY**

The following Research Sub Stations and Seed Gardens were maintained by the Division.

1. Bandirippuwa Estate, Lunuwila.
2. Ratmalagara Research Sub Station, Panirendawa.
3. Poththukulama Research Sub Station, Pallama.
4. Pallama Seed Garden, Pallama.
5. Walpita Research Sub Station, Walpita.
6. Isolated Seed Garden, Ambekelle.
7. Makandura Research Sub Station, Gonawila.
8. Maduruoya Seed Garden, Bogaswewa.
9. Dunkannawa Research Sub Station, Nattandiya.

All the above units covering 800.6 ha were satisfactory maintained. Maduruoya and Ambakelle seed gardens continued to supply seed nuts to fulfil the bulk of the seed nut requirements of the country. Fifty Thousand seed nuts were supplied from Ambekelle for the Coconut Rehabilitation Program in the North and East provinces. Pallama Seed Garden is yet under the development and may need few more years to supply seed nuts. The total coconut yield in all estates was 2,949,960 nuts registering a decline by 2,641,471 nuts or 47% compared to the previous year. The main contributory factor for this was the drought prevailed during the previous year. The reduction of the application of fertilizer by 50% due to financial constraints also made an impact on yield drop.

Replanting programme was carried out at Pallama Seed Garden, Maduruoya Seed Garden and Ratmalagara Research Sub Stations as scheduled and were able to cover 32.8 ha.

To get extra income an intercropping programme was initiated in Research Sub Stations, with banana, pineapple and cinnamon. The average rainfall received in all our Estates was 1625.5 mm.

The nine estates have a total of 75,651 bearing palms, 4263 partially bearing palms, 18,100 young palms and seedlings.

During the year 735,008 seed nuts were produced in Isolated Seed Garden and Maduruoya Seed Garden (Table - 3 ) and plus palm seed nuts were issued from the other estates. A total length of 3954 m of new fencing was done at Bandirippuwa Estate, Dunkannwa Research Sub Station and Pallma Seed Garden.

## 2. PERFORMANCE OF INDIVIDUAL UNITS

2.1	<b>Bandirippuwa Estate</b>	:	<b>Lunuwila</b>
	<b>Superintendent</b>	:	<b>Mr G.B.A.Wijesekara</b>
	<b>District</b>	:	<b>Puttlam</b>
	<b>Agro-ecological Zone</b>	:	<b>Wet Intermediate</b>
	<b>Extent</b>	:	<b>148.1 ha</b>

### **Rainfall :**

The total rainfall received was 1779 mm (Table – 2), which registers an increase by 68.6% and an increase of wet days by 16% when compared to last year. The rainfall distribution was fairly good.

### **Nut Yield :**

Decreased by 57.6% over the previous year. (Table – 1)

### **Planting :**

A coconut varieties planting project was launched in field No. 7 and intercrops of 1100 banana suckers, 3000 pineapple suckers and 900 Cinnamon plants were planted in field No. 4.

### **Fencing :**

726 meters of new fencing was done in 35 acre block. 600 meters of fencing was repaired.

### **Livestock :**

Herd strength was as follows.

Heifers	- 23
Stud bulls	- 03
Male calves	- 07
Female calves	- <u>12</u>
	<u>45</u>

### **Milk Production and sale :**

Total Milk production litres	-	8,122 Lit
Total income from milk	-	Rs. 54,178.54
Cost of Production (COP) and Nut Sale Average (NSA)		

COP was Rs. 9777 and NSA was Rs. 8,122 per 1000 nuts (Table 6)

**Sundry Income :**

Rs. 1,070,273.00 was collected by way of selling animals, trees etc.

<b>2.2 Ratmalagara Research Sub station</b>	<b>:</b>	<b>Panirendawa</b>
<b>Superintendent</b>	<b>:</b>	<b>Mr.A.N.Eknaligoda</b>
<b>District</b>	<b>:</b>	<b>Puttlam</b>
<b>Agro-ecological Zone</b>	<b>:</b>	<b>Intermediate Dry Zone</b>
<b>Extent</b>	<b>:</b>	<b>110.48 ha</b>

**Rainfall :**

The total rainfall received was 1,800 mm (Table 2), which recorded an increase by 37% and an increase of wet days by 20.7% when compared to the last year. The rainfall distribution was fairly good.

**Nut Yield :**

Decreased by 47% over the previous year. (Table 1)

**Livestock :**

Herd strength was as follows.

Heifers	- 22
Stud bulls	- 01
Cows	- 27
Male Calves	- <u>15</u>
	<u>65</u>

**Sundry Income :**

An income of Rs. 47,700.21 was collected by selling fruit, vegetables etc.

Also an income of Rs. 92,510.00 was collected by selling animals and unproductive trees.

**Planting :**

2000 banana suckers (1500 sour and 500 Kolikuttu) were planted in field No. 07 and 454 coconut seedlings (T x T) were planted in field No . 6.

Cost of Production (COP) and Nut Sale Average (NSA)

COP was Rs. 10576 and NSA was Rs. 10,910 per 1,000 nuts (Table 6)

**2.3 Ambakelle Seed Garden : Pallama**  
**Superintendent : Mr.U.W.B.A.Weragoda**  
**District : Puttlam**  
**Agro-ecological Zone : Intermediate Dry Zone**  
**Extent : 457.2 ha**

**Rainfall :**

The total rainfall received was 1,644.3 mm (Table 2), which registers an increase by 70.5% and an increase of wet days by 12% compare to the previous year. The rainfall distribution was uneven.

**Nut Yield :**

Decreased by 55% over the previous year. (Table 1)

**Livestock :**

Herd strength was as follows.

a) Buffaloes :-	Stud bulls	-	01
	Cows	-	10
	Heifers	-	06
	Male buffaloes	-	06
	Calves	-	<u>07</u>
	Total	-	<u>30</u>
b) Oxen :-	Cart ox	-	01
	Calf	-	<u>01</u>
			<u>02</u>

**Fencing :**

1,304 m of fencing was repaired.

**Intercropping :**

100 banana suckers were planted and another 83 banana suckers were kept, which are in the ready for planting

**Sundry Income :**

Rs. 486,462.85 was collected by sale of curd, coconut saplings, coconut shells, and by leasing cashew trees etc.

Cost of Production (COP) and Nut Sale Average (NSA)

COP was Rs. 9246 and NSA was Rs. 11,859 per 1000 nuts (Table 6)

<b>2.4 Maduruoya Seed Garden</b>	:	<b>Bogaswewa</b>
<b>Superintendent</b>	:	<b>Mr. W.M.U. Ratnayaka</b>
<b>District</b>	:	<b>Polonnaruwa</b>
<b>Agro-ecological Zone</b>	:	<b>Dry Zone</b>
<b>Extent</b>	:	<b>85 ha</b>

**Rainfall :**

The total rainfall received was 1,782 mm (Table 2), which register a decrease by 7% but an increase of wet days by 5.5% compared to the previous year. The rainfall distribution was fairly good.

**Nut Yield :**

Decreased by 01.6% over the previous year. (Table 1)

**Livestock :**

Herd strength was as follows.

a) Buffaloes :-	Male buffaloes	-	07
	Female buffaloes	-	<u>02</u>
	Total	-	<u>09</u>

**Replanting :**

8.3 ha were brought under coconut replanting.

**Sundry Income :**

Rs. 44,162.90 was collected by selling melon , vegetables and firewood.

**Fencing :**

774 m of new fencing was done and 1,300 m of fencing was repaired.

Cost of Production (COP) and Nut Sale Average (NSA)

COP was Rs. 6,110 and NSA was Rs. 816 per 1,000 nuts (Table 6)

<b>2.5 Pottukulama Research Sub Station</b>	:	<b>Pallama</b>
<b>Officer In Charge</b>	:	<b>Mr.D.L.J.Nethasinghe</b>
<b>District</b>	:	<b>Puttlam</b>
<b>Agro-ecological Zone</b>	:	<b>Intermediate Dry Zone</b>
<b>Extent</b>	:	<b>81.78 ha</b>

**Rainfall :**

The total rainfall received was 1,591.9 m.m (Table 2). Which registers an increase of 57.6% and an increase of wet days by 50%. Rain fall distribution was fairly good.

**Nut Yield :**

Decreased by 43.4% over the previous year. (Table 1)

**Livestock :**

Herd strength was as follows.

Cows	-	06
Oxen	-	23
Stud bulls	-	03
Buffaloes	-	01
Billy goats	-	60
Nanny goats	-	<u>14</u>
Total	-	<u>107</u>

**Fencing :**

1000 m of old fencing was repaired.

**Sundry Income :**

Rs. 160.00 was collected .

Cost of Production (COP) and Nut Sale Average (NSA)

COP was Rs. 6,238.00 and NSA was Rs. 6,987.00 per 1000 nuts (Table 6)

<b>2.6 Pallama Seed Garden</b>	:	<b>Pallama</b>
<b>Superintendent</b>	:	<b>Mr.W.S.M.A.Fernando</b>
<b>District</b>	:	<b>Kurunagala</b>
<b>Agro-ecological Zone</b>	:	<b>Intermediate Dry Zone</b>
<b>Extent</b>	:	<b>252.0 ha</b>

**Rainfall :**

The total rainfall received was 1,465.6 mm (Table 2). Which registers an increase of 57.6% and an increase of wet days by 32.7%. Rainfall distribution was fairly good.

**Nut Yield :**

Decreased by 48% over the previous year.

**Livestock :**

Herd strength was as follows.

Cows	-	11
Calves	-	28
Heifers	-	03
Stud bulls	-	<u>01</u>
Total	-	<u>43</u>

**Sundry Income :**

Rs. 391,610.00 was collected by selling unproductive palms and other trees. Also Rs.114,713 was collected by selling animals.

**Fencing :**

2,642 m of new fencing was done and 220 m of old fencing was repaired.

**Cost of Production (COP) and Nut Sale Average (NSA)**

COP was Rs. 12,358.00 and NSA was Rs. 10,714.00 per 1000 nuts (Table 6)

<b>2.6 Makandura Research Sub Station</b>	<b>:</b>	<b>Gonawila</b>
<b>Superintendent</b>	<b>:</b>	<b>Mr.I.A.N.Hemasiri</b>
<b>District</b>	<b>:</b>	<b>Kurunagala</b>
<b>Agro-ecological Zone</b>	<b>:</b>	<b>Intermediate Dry Zone</b>
<b>Extent</b>	<b>:</b>	<b>58.20 ha</b>

**Rainfall :**

The total rainfall received was 2,353.6 mm (Table 2), which registers an increase of 41.5% and an increase of wet days by 65.6%.

**Nut Yield :**

Decreased by 55.2% over the previous year. (Table 1)

**Livestock :**

Herd strength was as follows.

Cows	-	06
Heifers	-	03
Oxen	-	03
Stud bull	-	02
Buffaloes	-	29
Calves	-	<u>06</u>
Total	-	<u>49</u>

**Sundry Income :**

Rs. 30,530.00 was collected by selling milk.

**Fencing :**

5,280 m of old fencing was repaired.

Cost of Production (COP) and Nut Sale Average (NSA)

COP was Rs. 7,357 and NSA was Rs. 9,686 per 1,000 nuts (Table 6)

<b>2.6 Walpita Research Sub Station</b>	<b>:</b>	<b>Walpita</b>
<b>Officer In Charge</b>	<b>:</b>	<b>Mr.Harold Upali</b>
<b>District</b>	<b>:</b>	<b>Gampaha</b>
<b>Agro-ecological Zone</b>	<b>:</b>	<b>Wet Zone</b>
<b>Extent</b>	<b>:</b>	<b>17.8 ha</b>

**Rainfall :**

The total rainfall received was 2,208.8 mm (Table 2). Which registers an increase of 28.5% and an increase of wet days by 15.6%.

**Nut Yield :**

Decreased by 19% over the previous year. (Table 1)

**Livestock :**

Herd strength was as follows.

Cows	-	02
Calves	-	<u>01</u>
Total	-	<u>03</u>

**Sundry Income :**

Rs. 199,704.00 was collected by selling fruits, ginger, manioc, coffee, pepper, cocoa, cinnamon, milk, arecanuts, furaria etc.

**Fencing :**

500 m of new fencing was done and 500 m of fencing was repaired.

**Intercropping :**

4,000 pineapple suckers and 400 Kolikuttu plantain suckers were planted in Lattice B. 1,500 sour plantain suckers were planted in Lattice A.

Cost of Production (COP) and Nut Sale Average (NSA)

COP was Rs. 7,238 and NSA was Rs. 11,373 per 1000 nuts (Table 6)

<b>2.6 Dunkannawa Research Sub Station</b>	<b>:</b>	<b>Nattandiya</b>
<b>Officer In Charge</b>	<b>:</b>	<b>Mr. Newton Gamage</b>
<b>District</b>	<b>:</b>	<b>Puttalam</b>
<b>Agro-ecological Zone</b>	<b>:</b>	<b>Intermediate Wet Zone</b>
<b>Extent</b>	<b>:</b>	<b>10 ha</b>

**Rainfall :**

The total rainfall received was 1,560 mm (Table 2). Which registers an increase by 75.8% over the previous year and an increase of wet days by 56.8%

**Nut Yield :**

Increased by 69% over the previous year.

**Sundry Income :**

Rs. 7,350.00 was collected by selling trees, for firewood, coconut trunks and coconut saplings.

**Table 1. Total Nut production (1998 – 2002) and percentage Change in 2002 production over 2001**

Estate	1998	1999	2000	2001	2002	%
Bandirippuwa Estate	479,820	556,185	758,487	752,452	319,296	( - 57.6)
Ambakelle Seed Garden	1,213,893	1,473,458	1,396,565	1,475,761	662,854	(-55)
Poththukulama Research Station	680,984	816,737	834,061	777,906	440,222	(- 43.4)
Ratmalagara Research Station	445,928	526,947	658,968	760,946	405,305	(- 46.8)
Pallama seed Garden	441,376	592,661	640,343	680,946	354,060	(- 48)
Makandura Research Station	356,399	451,152	644,016	636,889	286,187	(- 55)
Maduruoya Seed Garden	158,994	210,234	297,328	346,507	344,623	(- 0.6)
Walputa Research Station	128,118	142,546	188,958	160,124	129,473	(- 19.2)
Dunkannawa Research Station	-	-	-	-	7,940	-
Total	3,905,602	4,769,920	5,418,716	5,591,431	2,949,960	(- 40.7)

**Table 2 . Rain fall (mm) and Number of Wet days - (2001 – 2002)**

Month	Bandirippuwa Estate		Isolated Seed Garden		Ratmalagara Research Sub Station		Poththukulama Reserch Sub Station	
	2001	2002	2001	2002	2001	2002	2001	2002
January	83.1(05)	5.2(02)	90.5(09)	9.5(03)	116.2(09)	12.4(02)	82.3(06)	-
February	40.4(06)	23.2(04)	63.2(07)	84.0(03)	46.1(03)	25.1(03)	61.4(02)	56.4(02)
March	26.2(01)	165.0(06)	-	23.6(03)	-	80.9(05)	-	20.0(04)
April	266.6(14)	258.5(14)	262.6(16)	406.8(21)	231.6(19)	330.0(20)	297.8(13)	460.4(23)
May	43.4(08)	240.7(15)	15.8(07)	162.4(13)	112.8(10)	159.7(18)	08.6(02)	137.1(09)
June	37.4(07)	87.8(08)	46.6(05)	70.8(07)	25.0(08)	73.8(09)	37.0(09)	54.6(06)
July	18.3(08)	04.0(01)	02.9(03)	-	05.7(03)	4.8(02)	02.5(01)	-
August	05.1(01)	48.7(04)	07.1(04)	10.1(03)	10.3(04)	9.6(03)	-	10.0(02)
September	164.8(12)	34.7(06)	134.3(10)	71.3(03)	102.3(12)	54.7(06)	162.0(09)	20.2(03)
October	142.0(14)	606.1(24)	137.7(11)	453.3(17)	243.4(13)	445.5(23)	111.6(07)	405.7(17)
November	170.9(10)	213.6(17)	171.2(05)	220.5(16)	301.9(13)	456.3(18)	167.2(10)	283.5(15)
December	56.8(06)	91.3(07)	32.7(08)	132.0(13)	50.5(06)	147.3(13)	79.8(7)	144(09)
Total	1055.0(91)	1779.4(108)	964.6(91)	1644.3(102)	1331(101)	1800.4(122)	1010.2(60)	1591.9(90)

Continued Table. 02

Month	Pallma Seed Garden		Makandura Research Sub Station		Maduruoya Seed Garden		Walpita Research Sub Station		Dunkanawa Research Sub Station	
	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
January	94(5)	5.0(01)	92.9(04)	19.6(02)	307.2(20)	215.(11)	116.7(04)	23.0(02)	-	-
February	35(2)	28.0(02)	145.5(04)	10.6(02)	127.2(05)	138.5(06)	91.8(06)	31.6(03)	-	-
March	-	30.5(03)	26.0(01)	153.2(06)	01.7(02)	23.0(03)	-	109.8(06)	-	-
April	310.5(16)	497.0(20)	437.(17)	576.0(18)	242.4(13)	175.2(18)	447.0(01)	514.8(20)	-	134.9(05)
May	17.5(02)	129.0(08)	57.9(05)	259.2(17)	-	11.2(02)	193.0(11)	275(17)	-	370.5(16)
June	38(03)	45.0(01)	32.6(05)	193.2(09)	49.0(02)	5.9(03)	84.4(07)	216.2(08)	-	210.3(13)
July	05(01)	-	-	8.5(04)	59.9(04)	-	364(05)	17.8(04)	-	-
August	07(02)	-	4.2(01)	69.5(03)	-	8.2(03)	11.2(03)	57.5(03)	-	-
September	175(08)	34(03)	241.3(09)	87.8(07)	50.9(04)	74.1(04)	219.3(11)	84.5(08)	-	16.3(3)
October	154.(08)	291(8(14)	256.9(11)	574.3(17)	201.0(11)	197.5(13)	156.6(13)	519.0(19)	-	42.6(04)
November	188(09)	264(14)	224.6(08)	315.8(19)	280.5(13)	279.0(15)	208.5(09)	276.3(16)	-	403.2(14)
December	80(05)	141.3(11)	143.8(02)	85.9(07)	463.1(18)	529.5(18)	94.2(06)	83.2(05)	-	235.1(09)
Total	1104(61)	1465.6(77)	1663.0(67)	2353.6(111)	1782.0(91)	1657.1(96)	1718.1(96)	2208.8	-	147.0(05)
									-	1559.9(69)

**Table 3. Coconut Extent and Census of palms**

Estate	Bandirippuwa Estate	Ratmalagara Research Sub Station	Isolated Seed Garden	Maduruoya Seed Garden	Poththukulama Research Sub Station	Walpita Research Sub Station	Makandura Research Sub Station	Pallama Seed Garden	Dunkaannawa Research Sub Station	Total
Extent (ha)	113	98.34	133.3	79.0	74.28	15.5	53.8	218.8	10	796
Bearing palms	8,197	12,526	17,875	5,751	10,491	1,806	5,021	11,176	326	72,843
Partial bearing palms upto 10 years	231	471	1,439	1,672	46	18	285	32	-	4,194
Young palms 2 years upto bearing	1,047	1,107	951	1,030	178	09	67	75	-	4,464
Seedlings upto 2 years	1,110	412	39	1,866	255			10,080	296	14,058
Weak palms	2,158	55	242	425	446	184	1,982	2,051	33	7,576
Vacancies	1,593	1633	5,726	3,408	2060	549	2,044	3,002	-	20,015
Planting Points	14,336	16,204	8,397	14,152	13,476	2,566	9,399	26,416	655	105,601

**Table 4.** *Physical Extent of Estates and Seed Garden (Extent – ha)*

Extent	Bandirippuwa Estate	Ratmalagara Research Sub Station	Isolated Seed Garden	Maduruoya Seed Garden	Poththukulama Research Sub Station	Walpita Research Sub Station	Makandura Research Sub Station	Pallama Seed Garden	Dunkannawa Research Sub Station	Total
Mature (ha)	113	98	120.8	35.0	74.28	15.5	52.8	188.0	2.0	699.60
Immature (ha)	21.0	26.0	12.5	44.0	05.00	-	1.0	176.0	5.6	291.10
Total coconut extent	134	124	133.3	79.0	79.28	15.5	53.8	364.0	7.6	990.48
Nursery	1.81	-	1.00	-	-	-	-	-	-	2.61
Other Crops	-	1.00	-	1.0	-	-	-	-	-	2.0
Jungle	-	03.24	322	1.0	-	-	-	-	-	338.24
Vacant Land	1.0	05.88	7.1	2.0	1.0	-	-	29.2	-	17.98
Reservation/Tank	-	-	3.0	8.0	-	0.5	2.4	1.0	3	21.11
Roads & Building	22.25	2.02	3.0	2.00	2.5	1.8	2.0	3.0	0.2	38.07
Total	159.06	136.4	602.7	175	82.78	17.8	58.2	397.2	13.2	2401.19

**Table 5** *Nut Production in Estates - 2002*

Pick	Bandirippuwa Estate	Ratmalagara Research Sub Station	Poththukulama Research Sub Station	Walpita Research Sub Station	Isolated Seed Garden	Makandura Research Sub Station	Maduruoya Seed Garden	Pallama Seed Garden	Dunkannawa Research Sub Station	Total
Pick - 1	56,727	70,025	78,439	18,910	156,794	52,993	31,183	61,928	1,218	528,217
Pick - 2	54,996	80,177	104,339	31,711	140,944	58,482	45,890	75,687	1,128	593,354
Pick - 3	58,705	76,717	79,789	25,428	97,102	48,843	65,585	62,341	900	515,410
Pick - 4	60,116	75,329	56,550	25,994	93,358	36,246	84,724	50,173	1,521	484,011
Pick - 5	50,812	65,084	47,281	18,622	103,408	49,290	61,971	57,376	2,131	455,975
Pick - 6	37,940	37,973	73,824	8,808	71,248	40,333	55,270	46,555	1,042	372,993
Total	319,296	405,305	440,220	129,473	662,854	286,187	344,623	354,060	7,940	2,949,960

**Table 6 . Crop Disposal COP and NSA – 2002**

Particulars	Bandirippuwa Estate	Ratmalagara Research Sub Station	Poththukulama Research Sub Station	Walpita Research Sub Station	Isolated Seed Garden	Makandura Research Sub Station	Maduruoya Seed Garden	Pallama Seed Garden	Dunkannawa Research Sub Station
Sold	174,860	340,798	364,028	124,854	84,085	25,966	51,325	264,250	-
Coconut Copra	65,600	29,692	22,358	200	55,680	225,651	4,621	18,981	-
Research Seed Nut	34,001	540	895	-	8,989	96	-	720	-
Staff Issue	-	-	-	-	11,586	-	211,030	-	-
Rejections	67,334	8,577	4,150	1,284	9,010	5,936	-	-	-
Awaiting Disposal	18,332	16,577	26,789	3,135	15,045	10,916	14,190	23,705	-
Others or Nursery	18,332	-	-	-	-	-	-	-	-
Total Nos of Nuts	-	-	250	-	-	-	-	-	-
Total Nos of Nuts	368,304	396,184	418,476	129,473	662,854	286,187	344,623	440,222	27,940-
COP (RS)/1,000 Nuts	9,777	10,576	6,238	7,238	9,246	7,299	6,110	12,358	-
NSA (RS) /1,000 Nuts	8,122	10,910	6,987	11,373	11,859	9,686	10,281	10,414	-

**Table 7 . Total Seed Nut Production in Two Seed Garden**

Seed Garden	2001	2002	Change
1. Ambakelle Seed Garden	1,007,000	482,663	- 52%
2. Maduruoya Seed Garden	252,718	252,345	- 0.2%
3. Other Plus Palms	18,625	-	-
Total	1,278,343	735,008	- 43.6%

**Table 8 . Sundry Income (Rs)**

Estate	Income (Rs)
Bandirippuwa Estate	1,070,273.00
Ambakelle Seed Garden	486,462.85
Poththukulama Research Station	53,441.00
Ratmalagara Research Station	140,210.00
Makandura Research Station	30,530.00
Maduruoya Seed Garden	44,162.90
Walpita Research Station	144,369.00
Pallma Seed Garden	506,323.00
Dulkanawa Research Station	7,350.00
<b>Total</b>	<b>2,483,120.85</b>

**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 and finance matters and related affairs including maintenance work.

**2. CADRE**

The staff position of the Coconut Research Institute at the end of December 2002, is given in Table 1:

**Table 1:** *Staff position as at 31/12/2002*

<b>Grade</b>	<b>Ungraded</b>	<b>Sp C1</b>	<b>C1 I</b>	<b>C1 II</b>	<b>C1 III</b>	<b>C1 IV</b>	<b>Total</b>
Executive	01	-	08	12	24	15	60
Technical	-	32	14	19	-	-	65
Inter meditates	-	05	-	03	-	-	08
Clerical and Allied	-	26	05	09	-	-	40
Operative	-	16	12	21	-	-	49
Driver	-	18	04	08	-	-	30
Minor	-	47	17	23	-	-	87
Watcher	12	-	-	-	-	-	12
<b>Grand Total</b>	<b>13</b>	<b>144</b>	<b>60</b>	<b>95</b>	<b>24</b>	<b>15</b>	<b>351</b>

**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 59 employees, amounting to Rs. 11,366,000.00

**Distress Loans:** Granted for 41 employees, amounting to Rs. 2,875,127.00

**Transport Loans:** Granted for 28 employees, amounting to Rs. 1,243,000.00

**Refrigerator Loans:** Granted for 11 employees, amounting to Rs. 132,000.00

**Loan relief to indebtedness**

**Loans:** Granted for 08 employees, amounting to Rs. 60,000.00

**Educational Loans:** Granted for 02 employees, amounting to Rs. 20,000.00

**Medical Aid:** Rs. 2,374,860.00 was reimbursed by the Medical Aid Scheme during the year 2002, and an amount of Rs. 541,596.00 was debited to 363 Members Saving Accounts.

The following medical clinics were conducted in the year

- \* Two days First Aid Training programme
- \* Dental clinic
- \* Blood Donation Programme
- \* Medical Check up conducted by Family Planing Associates.

### **3.2 Other facilities to employees**

- (a) Financial assistance was also granted to the Multi-purpose Co-operative Society, the Recreation Club, the Art Circle, the Day Care Center, the Death Donation Society and the Seva Vanitha Movement, during the year 2002.

## STAFF MATTERS

### 1. APPOINTMENTS

One appointment was made during the year 2002, and the details are given in Table 1.

**Table 1.** *Appointments made during the year 2002*

Name	Designation	Division/Unit	Date
Mr. R M U Chandranath	Accountant	Accounts unit	22.01.2002

### 2. RESIGNATIONS, RETIREMENTS, VACATION OF POSTS & TERMINATIONS OF SERVICES AND DEATHS

The details are given in Table 2:

**Table 2.**

Name	Designation	Division/Unit	Date
<b>Resignations:</b>			
Mrs. Anoma de Alwis	Chief Accountant	Accounts Unit	01.02.02
Mr. D Giridaran	Research Officer	Soils and Plant Nutrition Division	15.04.02
Mr. A J Wijeratne	Research Officer	Soils and Plant Nutrition Division	05.08.02
Mr. A Thawaratnerajah	Assistant Manager (Farm)	Estates Management Division	01.10.02
<b>Retirements:</b>			
Mr. W E J Tissera	Senior Lab/Field Assistant	Agronomy Division	31.01.02
Mr. R K Munasinghe	Senior Building Helper	Engineering Unit	24.05.02
Mr. M E R Fernando	Senior Field Officer	Biometry Division	08.08.02
Mr. P A P Appuhamy	Senior Electrician/Power House Operator/Plumber Fitter	Engineering Unit	24.08.02
Mr. M Bastian	Senior Technical Officer	Agronomy Division	28.12.02
<b>Vacation of Posts:</b>			
Mr. K M D Perera	Electrical Helper	Engineering Unit	09.04.02
<b>Deaths:</b>			
Mr. T W Fernando	Asst. Information Officer	Extension Services Division	01.01.02

### 3. PROMOTIONS

#### 3.1 PROMOTIONS IN NON-EXECUTIVE GRADES

Following Internal Promotions in Non-Executive Grades were implemented during the year 2002, as shown in Table 3. The effective date of these promotions was 01/01/2002.

**Table 3.** *Promotions in Non-Executive Grades during the year 2002*

Name	Designation	Division/Unit
<b>CLASS I - SPECIAL CLASS</b>		
<b>Technical Grade</b>		
Miss P H A P Siriwardena	Senior Technical Officer	Crop Protection Division
Mr. L M S R Jayathilake	Senior Technical Officer	Genetics and Plant Breeding Division
Mr. E M A Thilakarathne Banda	Senior Technical Officer	Soils and Plant Nutrition Division
<b>Intermediate Grade</b>		
Mrs. Anoma Herath	Senior Stenographer(E)	Soils and Plant Nutrition Division
<b>Clerical &amp; Allied Grade</b>		
Mrs. K P S Jayathilake	Senior Clerk/Typist	Establishment Unit
Mrs. A S M S Abeywickrama	Senior Accounts Clerk	Accounts Unit
<b>Minor Grade</b>		
Mr. J A D N Stanly	Senior Pollination Labourer	Estates Management Division
Mr W M E G Fernando	Senior Lab and Field Attendant	Crop Protection Division
Mr J H Premaratne	Senior Lab and Field Attendant	Biometry Division
<b>CLASS II - CLASS I</b>		
<b>Technical Grade</b>		
Mr. S Prabhath Manoj	Technical Officer	Crop Protection Division
Mr. P H P R de Silva	Technical Officer	Crop Protection Division
Mr. S S Rajapaksa	Technical Officer	Biometry Division
<b>Clerical Grade</b>		
Mr. Y H Wijesena	Clerk/Typist	Establishment Unit
Mr. N M H Wijewardena	Clerk/Typist	Establishment Unit

### Operative Grade

Mr W Gunasena	Lab and Field Assistant	Soils and Plant Nutrition Division
Mr. R A Swarnathilake	Lab and Field Assistant	Agronomy Division
Mr. D E V R Wijethunga	Lab and Field Assistant	Crop Protection Division

### Driver Grade

Mr R P Somasiri	Driver	Establishment Unit
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### Minor Grade

Mr H Kapila Prasanna	Lab and Field Attendant	Tissue Culture Division
Mrs. I B Dayawathi	Office Attendant	Establishment Unit
Mr E A Chandradasa	Lab and Field Attendant	Soils and Plant Nutrition Division
Mr K A S C N Fernando	Office Attendant	Extension Services Division
Mr. K M G C Kumarasinghe	Lab and Field Attendant	Crop Protection Division
Mr K S A C N Fernando	Office Attendant	Extension Services Division

## 3.1 PROMOTIONS IN EXECUTIVE GRADES

Following Promotions in Executive Grades were implemented during the year 2002, as shown in Table 4. The effective date of these promotions was 01/01/2002.

**Table 4.** *Promotions in Executive Grades during the year 2002*

### Executive Grade Class II to Class I

Name	Designation	Division	Effective Date
Mr. P A H N Appuhamy	Head/Extension Services Division	Extension Services Division	15.03.2001

## 4. TRANSFERS

Mr P A D R G Caldera, Lab and Field Assistant, from Soils and Plant Nutrition Division to Crop Protection Division, on 08 January.

Mr N M D Chandrasoma, Lab and Field Assistant, from Genetics and Plant Breeding Division to Soils and Plant Nutrition Division, on 01 February.

Mr. M R U Attanayake, Audit Clerk, from Estates Management Division to Accounts Unit, on 01 February.

Mr. J A H Nevil, Tractor Diver, from Bandirippuwa Estate to Maduruoya Seed Garden, on 01 February.

Mr H K A Newton, Tractor Diver, from Maduruoya Seed Garden to Bandirippuwa Estate, on 01 February.

Mr N Gamage, Senior Field Officer, from Isolated Seed Garden, Ambakelle to Dunkannawa Estate, on 01 February.

MR W M N G Wijethunga, Supervisor, from Pallama Seed Garden to, Isolated Seed Garden, Ambakelle on 01 March.

Mr T M Keerthiratne, Senior Supervisor, Poththukulama Research Sub Station to Ratmalagara Research Sub Station , on 01 April.

Mr W M N G Wijethunga, Supervisor, from Isolated Seed Garden, Ambakelle to Poththukulama Research Sub Station, on 02 April.

Mr A Sugathadasa, Supervisor, from Ratmalagara Research Sub Station to Isolated Seed Garden, Ambakelle, on 09 April.

Mr W C M Fernando, Tractor Driver, from Bandirippuwa Estate to Dunkannawa Estate, on 26 July.

Mr D P S K Hettiarachchi, Superintendent, from Bandirippuwa Estate to Poththukulama Research Sub Station, on 07 August.

Mr K K Anura Mendis, Lab and Field Attendant, from Biometry Division to Soils and Plant Nutrition Division, on 09 August.

Mr J H Premaratne, Lab and Field Attendant, from Soils & Plant Nutrition Division to Biometry Division, on 09 August.

Mr W H M Wickramasinghe, Watcher, from Pallama Seed Garden to Poththukulama Research Sub Station, on 25 August.

Mr G B A Wijesekara, Superintendent, from Poththukulama Research Sub Station to Bandirippuwa Estate, on 27 August.

Mr D L J Nettasinghe , Senior Field Officer, from Pallama Seed Garden to Poththukulama Research Sub Station, on 09 November.

Mr D P S K Hettiarachchi, Superintendent, from Poththukulama Research Sub Station to Dunkannawa Estate, on 29 November.

## 5. OVERSEAS STUDY LEAVE

**Table 5.** *Full pay leave in overseas*

Name	Designation	Period	Purpose	Institute
Mr. N A K de Silva	Research Officer	24/08/2002 - 23/08/2004	Postgraduate Training to M.Sc.	Cornell University USA
Mrs. N S Aratchige	Research Officer	15/10/2002 - 31/08/2005	Postgraduate Training to Ph.D.	University of Amsterdam, Netherlands

## 6. LOCAL STUDY LEAVE

**Table 6.** *Full pay leave in local*

Name	Designation	Period	Purpose	Institute
Mrs. H D N Fonseka	Asst. Extension Officer	25/09/2002 - 24/09/2003	Postgraduate Training to M.Sc.	Postgraduate Institute of Agriculture, Peradeniya

## **7. LOCAL TRAININGS (more than 3 days)**

Mrs. R M S Ratnayake,/Senior Draughtsman followed a Computer Course on Auto-Cad, at the Wayamba Development Authority 03 months from 27 January (on Sundays).

Mrs. D M D I Wijebandara/Research Officer, followed a Course on Micro Computer Interfacing Methods in Chemistry at the Postgraduate Institute of Science from 8 - 11 February

Mr. R D N Premasiri, Mr. S S Rajapaksa, Mr. G K Ekanayake, Mr. I E Ambagla, Mr. B S V J Perera, Mr. A R A N Kumara/Technical Officers attended a Workshop on Repair and Maintenance of Laboratory Equipment at the Postgraduate Institute of Science from 1-4 March.

Mr. D W J Jayakody/Foreman(Electrical), followed a Training Course on "Mechatronics of Construction Equipment", at the Institute for Construction Training Development, from 11-15 March.

Mr. S M Sirisoma, Mr. N M R Sarathchandra/ Book Keepers, followed a Course on " Computer Programming in VISUAL BASIC", at the Institute of Government Accounts and Finance, 6 months from 11 June (Two days per week, 5 p.m to 7 p.m.)

Mr. G D George/Senior Technical Officer, followed a Training Course on Laboratory Accreditation ,at the Sri Lanka Standards Institution, from 23-27 October.

Mr. W M U Ratnayake/Superintendent, followed a National Diploma in Plantation Management Course, at the National Institute of Plantation Management, from 2002-2003

## **8. OVERSEAS VISITS**

Dr. M T N Fernando/Senior Research Officer, participated the Project Implementation Meeting on the Assessment of Impacts and Adaptation to Climate Change in the Plantation Sector, held in Nairobi, Kenya, from 10 - 17 February.

Mr. A D Samarajeewa/Research Officer , attended the Workshop funded by ADB and IFAD to submit the work plan for project titled developing sustainable coconut based income generating technologies in poor rural communities in Sri Lanka and to visit village level project in Thailand as a part of the above workshop held on Vietnam and Thailand, from 24 February - 03 March.

Dr. (Miss) C S Ranasinghe/ Head, Plant Physiology Division participated the Climate Change Vulnerability and Adaptation ALACC Project development workshop at the Third world Academy of Science in Trieste Italy from 02 – 16 June

Dr. U P de S Waidyanatha/ Chairman, Coconut Research Board, attended the 11<sup>th</sup> International Coconut Genetic Resource Network Steering Committee Meeting held in Bangkok, Thailand from 24 June – 06 July.

Dr. T S G Peiris/ Principal Biometrician, participated at the International Workshop on Regional Integrated Assessment of Climatic Impacts held in Italy, from 14 – 22 September.

Mr. J M D T Everard/Head, Genetics and Plant Breeding Division participated the 2<sup>nd</sup> International Coconut Gene Bank Meeting and Collection of germplasm held in India, from 30 October – 16 November.

Mr. K P I E Abmagala/Technical Assistant, participated to assist the germplasm Exchange Programme held in India, from 03 – 14 November.

Dr.(Mrs) C Jayasekara /Director Participated at the south Asian Initiative Collaborative R GOB, MOA-NCAP, IFPRI workshop on “Agricultural Diversification in South Asia” from 19-26 November.

## **9. OVERSEAS TRAININGS**

Dr. M T N Fernando/Senior Research Officer, followed a short-term Training in Environment Economics Programme, held in Philippines from 01 - 28 April.

Mrs. L L W C Yalgama /Research Officer, followed a short-term training in Food Technology at the Food Technology Institute in Germany, from 14 October – 13 December .

Mrs. P D U C Dharmapala/Assistant Librarian, followed SAARC training programme in Information Technology, in India, from 02 December 2002 – 28. February 2003.

Mrs. P I P Perera/Research Officer , followed a short –term training in Biotechnology at IRD (Institute de Recherdhe pur le Development) , France from 01 December 2002 - 28 February 2003..

## 10. 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 2002.

Buses	-	03
Lorries	-	02
Vans	-	08
Cars	-	01
Cabs	-	13
Jeeps	-	06
Motor bicycles	-	45
Land Vehicles	-	23
Three Wheelers	-	01

## 11. FINANCE UNIT

Total budgetary allocation for this year is 111 million and out of which 102 million under recurrent and 9 million under capital expenditure. Income forecast for this year was 45 million. Therefore the government grant was 66 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.

## 12. 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 2002.

- Construction of 06 Nos toilets at Pallama Seed Garden
- Renovation to staff quarters BE/GR/III/04 at Bandirippuwa Estate
- Improvements to the Dairy Shed at Bandirippuwa Estate
- Construction of an Agro Well at Bandirippuwa Estate
- Construction of a Tractor Garage at Bandirippuwa Estate
- Construction of a Labour Rest Room at Maduru Oya Seed Garden
- Construction of a Tractor Garage at Maduru Oya Seed Garden
- Repairs to pavements of the Superintendent's Bungalow at Pallama Seed Garden
- Supply, Installation and Commissioning of a Submersible Water Pump at Bandirippuwa Estate
- Repairs to the OIC Bungalow at Dunkannawa Estate
- Construction of a Goat Shed at Poththukulama Estate
- Construction of Water Distribution System at Bandirippuwa Estate
- Supply, Installation and Commissioning of 300 KVA Generator at Bandirippuwa Estate
- Irrigation Development Works at Maduru Oya Seed Garden
- Supply of Furniture to the New Laboratory at Bandirippuwa Estate.
- Repair works to the Men's Hostel at Bandirippuwa Estate.

**STAFF PUBLICATIONS AND COMMUNICATIONS  
AT SCIENTIFIC MEETINGS**

**JOURNALS, PRESENTATIONS AT SEMINAR/WORKSHOPS AND SCIENTIFIC SESSIONS**

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- Ramziya, M S F. Samarajeewa, S R. and Ratnasiri, N G S C. (2002).**, Investigation of the factors influencing the quantity of fertilizer application in the Sri Lankan coconut sector. Proceedings of the 2<sup>nd</sup> Agricultural Symposium. Wayamba University of Sri Lanka. 4<sup>th</sup> June.2002.
- Ranasinghe, C S. Fernando, W P K K. Zaneer, S M M. Mubarak, A M. (2002).**, Analysis of residue levels in kernel and nut water of coconut palms(*Cocos nucifera L.*) injected with monocrotophos. *NSF Journal* (in press).
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**REPORT OF THE ACCOUNT UNIT  
FINANCIAL PERFORMANCE REPORT**

**R M U Chandranath, BSc Mgt.**

The Coconut Research Institute received funds from the consolidated fund for its maintenance. Its secondary income sources are three coconut seed gardens, five coconut estates, one research station, analytical and advisory services etc. Table 1 shows funds received from the treasury, total income generated through seed gardens and estates and CESS money received for the last five years.

**Table 1. Grants From Treasury , Cess , Donor Projects and Income From Operations**

Sources	Rs. Million				
	1998	1999	2000	2001	2002
Treasury	81.43	61.15	91.61	76.20	66.00
Income from Estates	30.55	38.77	27.71	41.95	35.18
Cess	2.57	38.36	45.17	17.88	14.88
Donor Funded Projects	1.27	4.34	2.15	4.70	7.23
<b>Total</b>	<b>115.82</b>	<b>142.62</b>	<b>166.64</b>	<b>140.72</b>	<b>123.29</b>

As shown in Table 1, the consolidated funds have decreased by 15% in the year 2002 compared with year 2001. The income generated by estate operations in 2002 was Rs. 35.18 million which was Rs. 6.78 million lesser than in the year 2001.

**Performance of the Estates and Seed Gardens in the years 2001 and 2002**

**Table 2. Nuts Production**

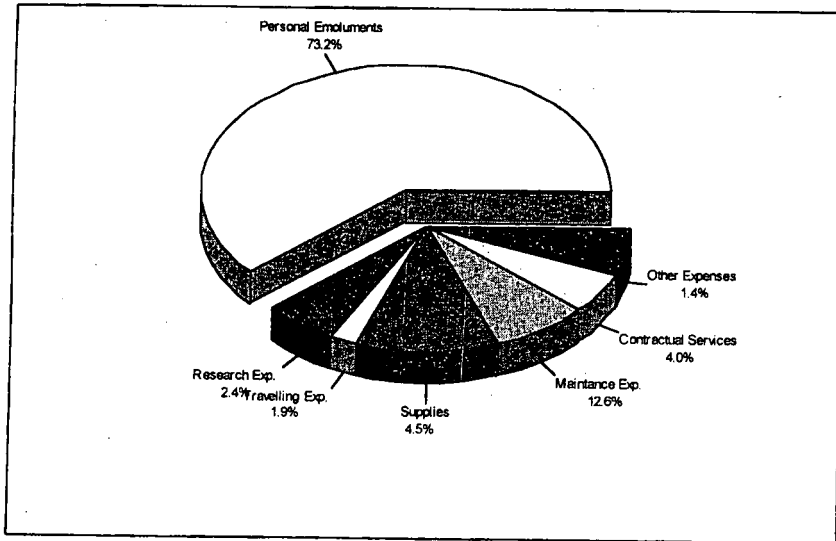
Name of the Garden	Nuts Production		Decrease %
	2001	2002	
Bandirippuwa	752,452	319,296	58.0%
Ratmalagara	760,846	405,307	47.0%
Pottukulama	777,906	430,877	45.0%
Walpita	160,124	129,473	19.0%
Makandura	636,889	286,187	55.0%
Maduruoya	346,507	344,623	0.5%
Ambakelle	1,475,761	622,856	55.0%
Pallama	681,390	354,060	48.0%
Dunkannawa	---	7,940	---
	<b>5,591,575</b>	<b>2,940,617</b>	<b>47%</b>

Total nut production decreased from 5,591,575 in year 2001 to 2,940,617 in year 2002 which was 47%. The yield decrease occurred due to prolonged drought prevailed during the year 2001 leading to poor nut setting and button nut fall. The difference in Maduruoya was very less (0.5 %). This was due to continuous irrigation of the Maduruoya Seed Garden.

**Table 2. Estate Sales and Profit**

Estates	1998		1999		2000		2001		2002	
	Sales Rs. Mln.	Profit (Loss) Rs. Mln.	Sales Rs. Mln.	Profit (Loss) Rs. Mln.	Sales Rs. Mln.	Profit (Loss) Rs. Mln.	Sales Rs. Mln.	Profit (Loss) Rs. Mln.	Sales Rs. Mln.	Profit (Loss) Rs. Mln.
Bandirippuwa Estate	3.38	-0.15	4.09	0.33	2.63	-2.24	5.17	0.30	2.26	-2.91
Rathmalagara Estate	3.79	1.25	3.85	0.88	3.07	-0.73	6.12	1.50	4.06	-0.43
Ambakele Seed Garden	12.49	7.60	14.26	8.74	7.73	1.36	13.66	6.74	7.94	1.65
Pottukulama Estate	5.09	2.75	6.56	3.96	4.62	2.09	3.50	0.65	5.80	2.85
Walpita Estate	1.21	0.33	1.11	0.03	1.07	-0.06	1.35	0.11	1.76	0.77
Makandura Estate	2.87	1.57	2.37	0.67	3.53	1.36	3.93	1.50	4.29	1.93
Maduru oya Seed Garden	1.73	0.41	2.20	0.35	1.57	-0.57	2.34	-0.25	4.29	1.69
Pallama Seed Garden			4.33	1.53	3.50	-1.01	5.89	1.24	4.60	0.11
Dunkannawa Estate									0.19	-0.33
<b>Total</b>	<b>30.56</b>	<b>13.77</b>	<b>38.77</b>	<b>16.49</b>	<b>27.71</b>	<b>0.20</b>	<b>41.95</b>	<b>11.78</b>	<b>35.17</b>	<b>5.10</b>

## Recurrent Expenditure of the Institute



**Figure 1** Utilization of consolidated funds and the profit from estate operations

The whole staff of the institute is consisted of 768 employees in the year 2002. Out of them 351 were permanent employees, 2 were on contract basis and 415 were daily paid workers. As indicated in figure 1 74.2% of the total recurrent expenditure was on personnel emoluments and the next highest expenditure was on maintenance such as building maintenance, vehicle maintenance, electricity, infrastructure development etc. Under supply expenditure stationary, book, periodicals, fuel and lubricant were included.

# COCONUT RESEARCH INSTITUTE

ESTABLISHED UNDER COCONUT DEVELOPMENT ACT NO. 46 OF 1971

## BALANCE SHEET AS AT 31<sup>st</sup> DECEMBER 2002

		COST VALUATION Rs.	ACCUMULATED DEPRECIATION Rs.	W.D. VALUE ON 31.12.2002 Rs.	VALUE ON 31.12.2001 Rs.
PROPERTY, PLANT & EQUIPMENT	NOTE-01	223,990,978.79	-88,818,346.26	135,172,632.53	145,599,595.93
RESEARCH & DEVELOPMENT	NOTE-1.1	2,254,292.84			0.00
<b><u>CURRENT ASSETS</u></b>					
STOCKS	NOTE-02	12,689,897.71			17,134,929.88
DEBTORS LESS PROVISION	NOTE-03	2,288,037.40			3,756,126.38
PURCHASE ADVANCES	NOTE-04	1,850,659.77			4,219,517.74
LOANS AND ADVANCES TO EMPLOYEES	NOTE-05	16,289,177.58			16,337,701.45
DEPOSITS RECEIVABLE		134,400.00			134,400.00
SAVING DIPOSIT	NOTE-06	576,308.13			539,122.01
PREPAYMENTS		1,095,808.58			2,725,442.84
I.A.E.A. PROJECT		5,513.29			5,513.29
CASH -IN -TRANSIT		0.00			3,600,000.00
CASH & BANK BALANCES	NOTE-07	14,391,227.49	51,575,322.79		10,325,255.92
					<b>58,778,009.51</b>
<b><u>LESS- CURRENT LIABILITIES &amp; PROVISIONS</u></b>					
SUNDRY CREDITORS	NOTE-08	138,067.85			377,523.74
ACCRUED EXPENSES		4,220,385.44			12,035,077.47
EXPENCE CREDITORS		1,294,584.75			1,916,320.64
DEPOSIT PAYABLE	NOTE-09	346,228.85			476,849.93
ON GOING PROJECTS	NOTE-10	8,149,849.44	14,149,116.33		5,872,653.69
					<b>20,678,425.47</b>
WORKING CAPITAL				<b>37,426,206.46</b>	<b>38,099,584.04</b>
<b><u>CAPITAL</u></b>				<b>172,598,838.99</b>	<b>183,699,179.97</b>
<b><u>AUTHORISED CAPITAL</u></b>				<b>18,000,000.00</b>	<b>18,000,000.00</b>
SURPLUS OF THE GRANT AFTER REURRENT EXPENDITURE	NOTE-11			223,402,973.86	220,010,959.10
FOREIGN AID				634,078.78	634,078.78
LOCAL AID				4,819,171.82	4,819,171.82
<b><u>RESERVES</u></b>					
CAPITAL RESERVE			20,025,001.95		11,218,173.46
REVENUE RESERVE	NOTE-12		(104,697,400.43)		(52,983,203.19)
				(84,672,398.48)	(41,765,029.73)
<b><u>NON CURRENT LIABILITIES</u></b>					
PROVISION FOR GRATUITY				28,415,013.01	
				<b>172,598,838.99</b>	<b>183,699,179.97</b>
.....		.....		.....	
DEPUTY DIRECTOR (A & F) COCONUT RESEARCH BOARD	MEMBER COCONUT RESEARCH BOARD	CHAIRMAN COCONUT RESEARCH BOARD			

**COCONUT RESEARCH INSTITUTE - LUNUWILA**  
**INCOME & EXPENDITURE FOR THE YEAR ENDED 31<sup>st</sup> DECEMBER 2002**

<u>Grants</u>	<u>YEAR 2002</u>	<u>YEAR 2001</u>
Government Grant	57,000,000.00	76,200,000.00
<b>Total Grant</b>	<b>57,000,000.00</b>	<b>76,200,000.00</b>
<b><u>Income</u></b>		
Sales of Coconut	39,487,494.33	31,578,284.96
Sales of Copra	1,044,486.67	739,583.96
Sales of Sundries	1,551,425.54	1,862,636.15
Sales of Animal & Animal Product	1,070,482.69	83,053.65
Interest income on loan & investments	683,863.67	642,805.44
Income from motor vehicles	408,132.18	416,321.16
Pess control	77,653.80	146,563.19
Sundry income	2,262,279.85	1,192,738.83
<b>Total Income</b>	<b>46,585,818.73</b>	<b>36,661,987.34</b>
	<b>103,585,818.73</b>	<b>112,861,987.34</b>
<b><u>Less :- Expenditure</u></b>		
Administration Division	76,924,492.02	72,091,729.90
Tissue Culture Division	662,717.18	968,877.97
Genetic & Plant Breeding Division	632,986.05	1,286,818.26
Soil & Plant Nutrition Division	1,046,772.48	1,495,083.27
Agronomy Division	1,443,648.17	2,092,256.22
Crop Protection Division	483,231.96	676,889.96
Biometry Division	289,943.81	379,772.29
Plant Physiology Division	810,631.48	1,026,927.90
Coconut Processing Research Division	624,571.29	685,789.38
Extension Services Division	875,078.62	835,860.28
Library Services Division	1,289,904.38	1,411,671.74
Estate Management Division	77,569.42	54,788.42
Estate working account	38,058,529.41	22,918,529.54
<b>Total Expenditure</b>	<b>123,220,076.27</b>	<b>105,924,995.13</b>
<b>Surplus/(Deficit)</b>	<b>(19,634,257.54)</b>	<b>6,936,992.21</b>
Balance B/F	(52,983,203.19)	(39,818,794.55)
Prior Period Items	(39,329,939.70)	(20,101,400.85)
<b>Balance C/F</b>	<b>(104,697,400.43)</b>	<b>(52,983,203.19)</b>

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