COCONUT RESEARCH BOARD

# COCONUT RESEARCH INSTITUTE OF SRI LANKA

## REPORT FOR 2005

COCONUT RESEARCH INSTITUTE - REPORT FOR 2005

# COCONUT RESEARCH BOARD


## REPORT OF THE
## COCONUT RESEARCH INSTITUTE
## FOR 2005

**Editorial Committee**

**C Jayasekara, Ph D (Qld)**
**J M D T Everard, M Sc (Jayawardenapura)**
**P A Henry Nimal Appuhamy, M Sc (Reading)**
**E M T Bandaranayake, M Sc (Peradeniya)**

# THE MEMBERS OF THE BOARD

The members of the Board as at 31st December 2005

| | | |
|---|---|---|
| **Dr D B T Wijeratne** | - | **Chairman** |
| **Mr S Wirasinghe** | - | **Member** |
| **Mr Abeygunasekera** | - | **Member (Treasury representative)** |
| **Mrs Chandrika V Ethugala** | - | **Member (Ministry representative)** |
| **Mr Indika Jayatilleke** | - | **Member** |
| **Mr K R M S S K Rajapakse** | - | **Member** |
| **Mr N Wijekoon** | - | **Member** |
| **Mr R M Gunawardena** | - | **Member** |
| **Dr (Mrs) C Jayaseakara** | - | **Director/CRI** |
| **Mr P Wadugedara** | - | **Chairman/CDA** |
| **Dr H A J Gunathilaka** | - | **Chairman/CCB** |

## COMMITTEES OF THE COCONUT RESEARCH BOARD
### As at 31st December 2005

### 1. Research Committee

| | |
|---|---|
| Dr D T B Wijeratne | Chairman/CRB |
| Dr (Mrs) Dr C Jayaseakara | Director/CRI |
| Mr J M D T Everard | DD (R)/CRI |
| Dr U Pethiyagoda | Member |
| Dr N C Kumarasinghe | Member |
| Dr D T Wettasinghe | Member |
| Mr Densil Aponso | Member |
| Mr K R M M S Kumara Rajapakse | Member |
| Vidya Jyothi Dr Ray Wijewardana | Member |
| Dr (Mrs) Janaki Gooneratne | Member |
| Dr Sunil Jayasekara | Member |
| Dr (Mrs) Jayanthi Edirisinghe | Member |
| Prof. Rohan Rajapakse | Member |
| Dr Chandra Jayasinghe | Member |
| Dr (Miss) Shantha Ramanayake | Member |
| Dr (Mrs) Manel Dassanayake | Member |
| Dr D S P Kuruppuarachchi | Member |
| Prof R B Mapa | Member |
| Dr Thilak Attanayake | Member |
| Dr Anil Jayasekara | Member |

### 2. Audit and Management Committee

| | |
|---|---|
| Mr A.Abeygunasekara | Member |
| Mrs Chandika V Ethugala | Member |
| Mr Indika Jayathilake | Member |
| Mr J G Weerasinghe | Superintendent of Audit<br>Auditor General's Dept |

### 3. Estates Committee

| | |
|---|---|
| Mr J M D T Everard | (Chairperson) |
| Dr N A Tennakoon | |
| Mr Indrajith Wickramananda | |
| Dr M T N Fernando | |
| Mr.N.P. Liyanage | (Manager Estates) |
| Mr. K.R.M.S.S.K. Rajapaksa | |
| Dr.C.K.Bandaranayake | |

# CONTENTS

# COCONUT RESEARCH INSTITUTE OF SRI LANKA

## THE STAFF

**(As at 31 December 2005)**

## DIRECTORATE

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

**Deputy Director (Research)** – J M D T Everard, B.Sc, M.Sc (New England), M.Sc. (Sri J'pura)

**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 Gunathilake, B.Sc. (Agric), Ph.D (Wales)

***Agronomists***

Mrs. E. Pathiraja, B.Sc. (Agric)
R P B S H Senaratne, B.Sc. (Agric), M.Sc. (Peradeniya)
N A K de Silva, B.Sc. (Agric)**
Miss. S C Somasiri, B.Sc. (Agric), M.Sc.

***Senior Agricultural Economists***

M T N Fernando, B.Sc.(Agric), Ph.D (Aberdeen)
Mrs. K V N N Jayalath, B.Sc. (Agric)

***Assistant Research Officer***

A W A D R Abeysekara, B.Sc. (Agric), Post G. Dip.( Econ )
B A S Manjula, B.Sc.(Agric)

***Technical Assistants***

H G Wasantha, B.Sc. (Agric)

***Senior Clerk/Typist***

A A D N Athauda

***Senior Lab/Field Assistants***

E M Gunarathne Banda
M D V Saparamadu
W S M A Fernando

***Lab/Field Assistants***

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

***Senior Technical Officers***

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

## Genetics and Plant Breeding Division

***Acting Head***

A A F L K Perera, B.Sc. (Agric), Ph.D. (Dundee)

***Senior Geneticists/Plant Breeders***

Mrs. C K Bandaranayake,B.Sc. (Agric),
Ph.D. (Birmingham)

**Geneticists/Plant Breeders**

Miss. S A C N Perera,
B.Sc. (Agric)**
M G M K Meegahakumbura,
M. Sc. (Bio), B.Sc.
Miss. H D M A C Dissanayake,
B. Sc. (Agric)

***Seed & Seedling Production & Certification Officer***

L M S R Jayathilake, B. Sc. (Agric)

***Seed Production & Certification Assistant***

P G R S Prematihilake, B. Sc. (Agric)
R I B C T Herath, B. Sc. (Agric)
M N Nadeeranga, B. Sc. (Agric)
R C M Wijayarathne, B. Sc. (Agric)
L J Saman, B. Sc. (Agric)
A S Jayasundara, B. Sc. (Agric)
D M A Leelananda Amarasiri, B.Sc. (Agric)
S A D W Priyankara, B. Sc. (Agric)

***Senior Technical Officers***

Mrs. W B S Fernando
M H L Padmasiri
L M S R Jayathilake, B.Sc. (Sci),
M. Sc. (Agric)
G K Ekanayake, B.Sc. (Sci)

***Technical Officers***

Miss. S M Mallawaarachchi,
B.Sc. (Sci)
H. M. N. B. Herath

***Technical Assistants***

R B Attanayake
A A Fernando

***Senior Clerk/Typist***

Mrs. I N Jayawardena

***Senior Lab/Field Assistants***

U V M Fernando
W T H C Fernando
M Victor
M. A. Hemachandra

***Lab/Field Assistants***

P A D M Appuhamy

## Soils and Plant Nutrition Division

***Acting Head***

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

***Senior Soil Scientisits***

Dr. (Mrs.) W C Fernando, B. Sc,
Ph.D. (Japan)

***Soil Scientists***

Mrs. D M D I Wijebandara B.Sc,
M Phil (Peradeniya), M I Biol**
Miss. E Pathiraja
Mrs. H M I K Herath,B.Sc.( Agric),
M.Sc.(Soil Management )
Miss. M K F Nadheesha,B.Sc.(Chemistry),
M. Sc.

***Senior Technical Officers***

Mrs. S Sabharatnem. N D S
Mrs. H H R M de Silva, B.Sc. (Sci)
U S S Perera
A H Norman
D P Panditharatne
E M A T Banda
Mrs. H L A Padmini, Dip (Agric)
Mrs. C P A Kurundukumbura, B.Sc.
(Agric)
Mrs. S D H Bandara, B.Sc.

***Assistant Research Officer***

Miss. D Paramasiwam, B.Sc. (Chemistry),
M.Sc. (Chemistry)
L R M C Liyanage, B.Sc. (Agri)

***Technical Officers***

K P A Pathirana, Dip. (Agric)
B S V J Perera, Dip. (Agric)

***Technical Assistants***

M R D Perera, B.Sc.

***Senior Stenographer***

Mrs. H M A Herath

***Senior lab / Field Assistant***

K. L. Ranasinghe

***Lab and Field Assistants***

K R E M Fernando
W Gunasena
K J S Perera
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 Arachchige, B.Sc. (Agric)**
K W L K Weerasinghe, B.Sc. (Agric)

***Assistant Research Officer***

A D N T Kumara, B.Sc. (Agric)
Mrs. N I Suwadaratne, 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***

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

***Senior Clerk***

Mrs. A A de Zoysa

***Senior Lab / Field Assistant***

W W F N Fernando
N G Premasiri

## Biometry Division

***Head***

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

***Biometrician***

Mrs. K P Waidyaratne, B.Sc. (Agric)

***Senior Technical Officer***

J D J S Kularatne, B. Sc.

***Technical Officer***

S S Rajapakse, Dip. (Agric)

***Technical Assistant***

W A S Wickramaarachchi

***Senior Clerk/Typist***

Mrs. U I Abeysinghe

***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)

***Principal Botanist***

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

***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)

***Senior Technical Officer***

E S Santha

***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)**

***Plant Physiologist***

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

***Senior Technical Officers***

Mrs. W P K K Fernando, B.Sc. (Sci)
R D N Premasiri
L R S Silva

***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 Technologist***

J M M N Marikkar, B.Sc.(Chemistry)**
Mrs. L L W C Yalegama, 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)
Mrs. S M Mallawarachchi

***Assistant Chemical Engineer***

J K Kelum Asanka, B.Sc. (Engineering)

***Assistant Mechanical Engineer***

Mrs. J A K M Fernando, B.Sc.
(Engineering)

***Senior 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)

***Assistant Extension Officers***

Mrs. H D N H Fonseka,
B.Sc. (Agric)
J K J P Jayawardena, B.Sc. (Agric) **
A R U Rathnasekara, B.Sc. (Agric)
E M T Bandaranayake, B.Sc. (Agric),
M.Sc. (Peradeniya)

***Senior Machine Operator***

W G L Rodrigo

***Senior Clerk/Typist***

R A L C Fernando
Mrs. K A P Chandani

***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

## Administration

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

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

### Establishment Unit

***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
A S Nanayakkara

***Supplies Officer***

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

***Secretary to the Chairman***

Mrs. S Z Suhair

***Assistant Manager (Information Sysetms)***

Miss. H M Nadeeja, B.Sc. (General)

***Chief Clerk***

B M D Bandara

***Senior Stenographer (English)***

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

***Stenographers (English)***

Mrs. M M S P Fernando

***Senior Supplies Assistant***

W F T Fernando

***Senior Clerk/Typists***

Mrs. A R S Hettiarachchi
Mrs. W S R Fernando
Mrs. K P S Jayathilake
Y H Wijesena
Mrs. M G Karunawathi

***Clerk/Typists***

N M H Wijewardena
M A D M F Appuhamy

## Internal Audit Unit

***Acting Internal Auditor***

Mr. E M Gunarathne

***Senior Internal Audit Clerk***

Mrs. M M J R Fernando

***Senior Book Keeper***

B M Jayathilaka Banda

***Senior Typist (English)***

Mrs. W J M D M A Fernando

## Accounts Unit

***Accountant***

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

***Senior Book Keeper***

N M R Sarathchandra
S M Sirisoma
R D Sumanasiri, H N D (Accountancy)

***Senior Shroff***

M C H N Fernando

***Senior Store Keeper***

M B Upali Wijetunga

***Senior Accounts Clerks***

W P C Fernando
Mrs. A S M S Abeywickrama

***Accounts Clerk***

S A D Richard
W A N K Wijesinghe

***Senior Clerk/Typist***

Mrs. C M B I Salwathura
Mrs. A A N P Kanthi

***Senior Audit Clerk***

M R U Attanayake

## 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 (Mechanical)***

R Vithanage

***Senior Draughtsperson***

Mrs. R M S Rathnayake

***Senior Clerk/Typist***

Mrs. N R Ayagama
K T J N W Perera

***Clerk / Typist***

M Somasiri

***Senior Motor Mechanic***

R M S G Ratnayake

***Senior Mason***

W M Dhanapala

***Senior Carpenter***

A A K Amarasinghe

***Linesman***

R S P Jayamanne

## Estate Management Division

***Manager (Estates)***

N P K Liyanage, B.Sc. (Agric)

***Senior Clerk/Typist***

Mrs. C Munasinghe
W P R R Fernando

***Experimental Officer***

G M R Karunasekara

***Assistant Livestock Officer***

H W A S Senarathne, B.Sc. (Agric),
M.Sc. (NRM)

***Clerk/Typist***

W A L R Feranando

## Bandirippuwa Estate

***Superintendent***

Mr. G B A Wijesekare

***Field Officer***

G P N Chandrasiri

***Senior Supervisor***

M P W Fernando
A G B G Silva

***Assistant Superintendent***

Mr. H B S Herath, B.Sc. (Agric)

***Supervisor***

S Alahakoon

## Ratmalagara Estate

***Superintendent***

A N Eknaligoda

***Assistant Superintendent***

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

***Senior Supervisor***

T M Keerthiratne

## Isolated Seed Garden

***Assistant Superintendent***

V H S Somasiri, B.Sc. (Agric)

***Senior Supervisor***

Piyal Ranjith Fernando

***Supervisor***

A Sugathadasa

***Clerk/Typist***

H M Podiratne

***Lab/Field Assistant***

H A P B Fernando

## Maduruoya Seed Garden

***Superintendent***

W M U Ratnayaka

***Supervisor***

M A S Fernando
W M D R Wijesinghe

***Lab/Field Assistant***

M G D Placidez

## Middeniya Estate

***Assistant Superintendent***

K Liyanarachchi, B.Sc. (Agric)

## 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

***Supervisor***

W M N G Wijethunga

***Clerk/Typist***

D M Jayawardena

## Makandura Seed Garden

***Superintendent***

I A N Hemasiri

***Assistant Superintendent***

H W N Nandakumara, B.Sc. (Agric)

***Supervisors***

A P C Pradeep, Dip. (Agric)

***Senior Lab/Field Assistant***

M Victor

## Pallama Seed Garden

***Assistant Superintendent***

T M P A K Tilakarathne, B.Sc. (Agric)

***Senior Clerk/Typist***

J A R Reginold

---

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

## THE COCONUT RESEARCH INSTITUTE
## LUNUWILA

### The Board and Institute

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

### Mission of the CRI

Our Mission is through Innovative Research and Development:

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

### Functions of the Institute

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

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

### The Coconut Research Board

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

The members of the Board up to October 2005 are given below:

| | |
|---|---|
| Dr D B T Wijeratne | Chairman |
| Mr S Wirasinghe | Member |
| Mr Abeygunasekera | Member (Treasury representative) |
| Mrs Chandrika V Ethugala | Member (Ministry representative) |
| Mr Indika Jayatilleke | Member |
| Mr K R M S S K Rajapakse | Member |
| Mrs N Wijekoon | Member |
| Mr R M Gunawardena | Member |
| Dr (Mrs) C Jayaseakara | Director/CRI |
| *Mr P Wadugedara | Chairman/CDA |
| *Dr H A J Gunathilake | Chairman/CCB |

* Chairman/CDA and Chairman/CCB were appointed as Observer Members to the Board with effect from March 2005.

**The Research Committee**

The members of the Research Committee are given below:

| | |
|---|---|
| Dr D B T Wijeratne | Chairman/CRB |
| Dr (Mrs) C Jayaseakara | Director/CRI |
| Mr J M D T Everard | DD (R)/CRI |
| Dr U Pethiyagoda | Member |
| Dr N C Kumarasinghe | Member |
| Dr D T Wettasinghe | Member |
| Mr Densil Aponso | Member |
| Mr K R M M S Kumara Rajapakse | Member |
| Vidya Jyothi Dr Ray Wijewardane | Member |
| Dr (Mrs) Janaki Gooneratne | Member |
| Dr Sunil Jayasekara | Member |
| Dr (Mrs) Jayanthi Edirisinghe | Member |
| Prof. Rohan Rajapakse | Member |
| Dr Chandra Jayasinghe | Member |
| Dr (Miss) Shantha Ramanayake | Member |
| Dr (Mrs) Manel Dassanayake | Member |
| Dr D S P Kuruppuarachchi | Member |
| Prof. R B Mapa | Member |
| Dr Tilak Attanayake | Member |
| Dr Anil Jayasekara | Member |

**The Audit and Management Committee**

The members of the Audit and Management Committee for the year 2005 are given below:

| | |
|---|---|
| Mr A Abeygunasekera | Member,Chairman |
| Mrs Chandrika V Ethugala | Member |
| Mr Indika Jayatilleke | Member |
| Mr J G Weerasinghe | Superintendent of Audit, Auditor General's Dept. |

**Audit and Management Committee Report**

The Committee comprises of three Board Members and chaired by the Treasury Representative as follows:

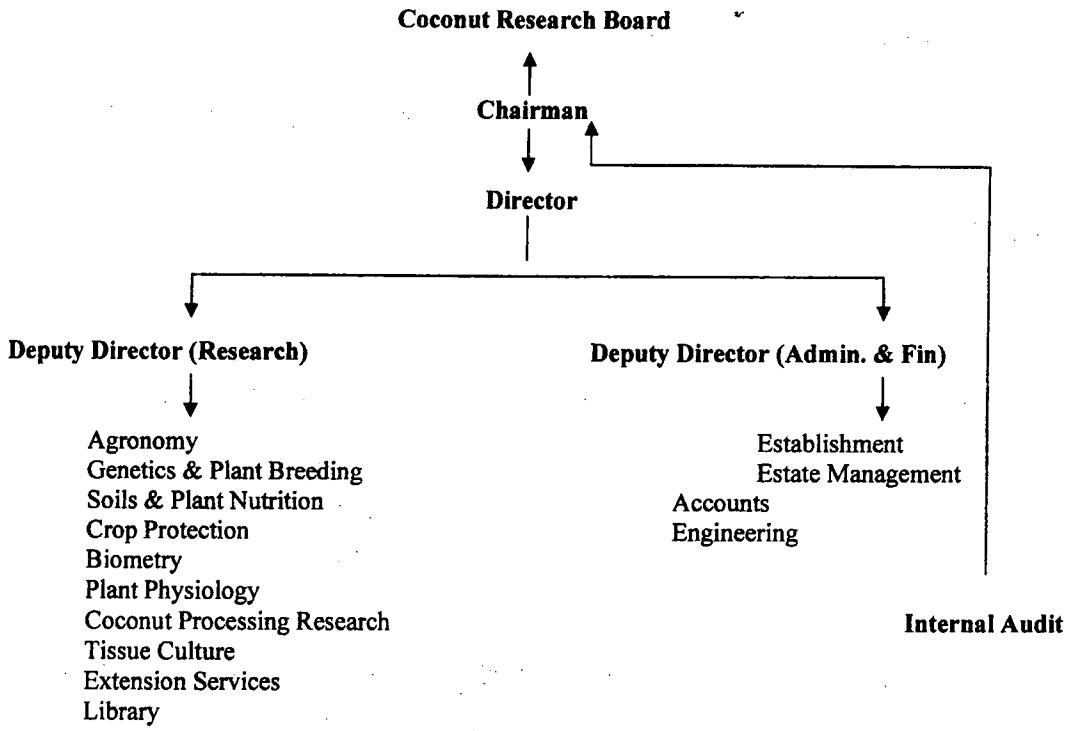
1) Mr A Abeygunasekara, Member of the Board/Treasury Representative and Chairman of the Committee
2) Mrs Chandrika V Ethugala, Member of the Board and Ministry Representative and Member of the Committee
3) Mr Indika Jayathilaka, Member of the Board and the Committee
4) Dr (Mrs) C Jayasekara, Director of CRI and observer attended the meetings
   Mr E P Gunapala, Deputy Director (Administration & Finance) - Convener

The Committee held 02 meetings in 28 March and 27 September during the year 2005.

**Management**

The Chairman is the Chief Executive Officer of the Institute. The Administrative Head of the Institute is the Director who is responsible for the direction and supervision of all research and administrative functions of the Institute, and the implementation of all policies and programs lay down by the Board.

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



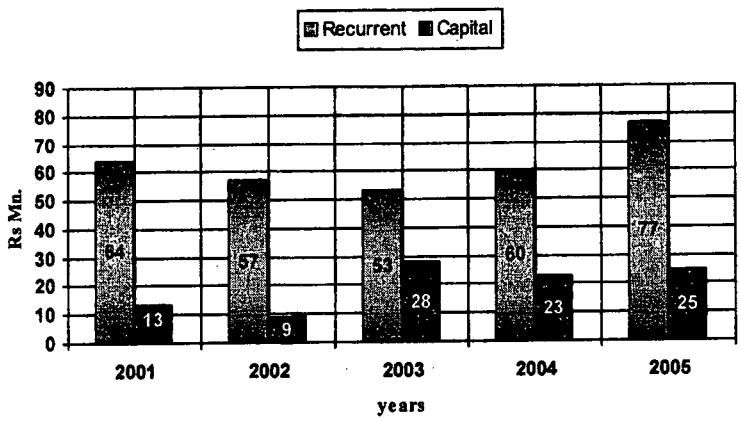

The Internal Auditor is directly responsible to the Chairman

**Funding**

As a public sector organization, CRI is primarily dependent on government funding (Consolidated Fund). Limited amount of research funding is received from outside funding sources and competitive research grants from Council for Agriculture Research Policy. However, reduced spending for research and extension due to severe budget cuts increasingly affect research and maintenance activities of the Institute.

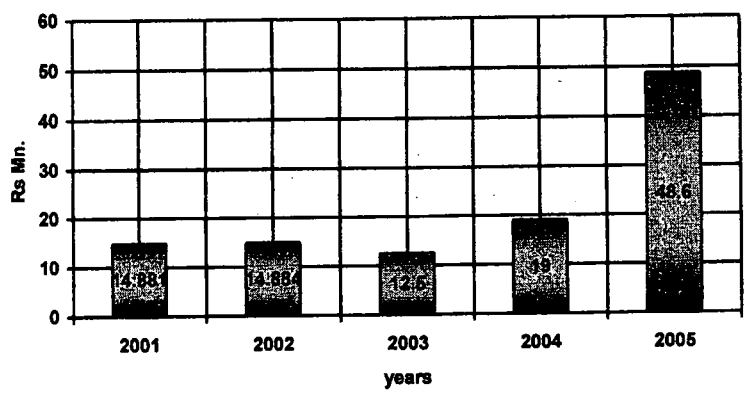
Government funding as capital and recurrent expenditure for the past five years is given below:

**Government funding as capital and recurrent expnditure for the last four years.**



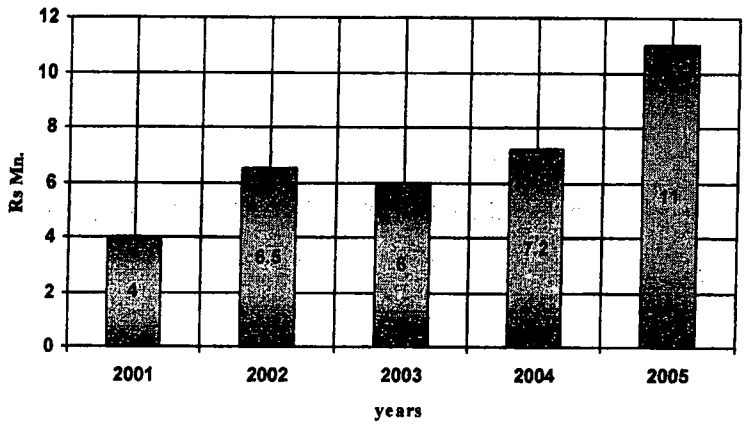

The Coconut CESS Fund also provides substantial contribution for special projects in situations where adequate funding is not available from the Government. The total investments from the CESS Fund and number of projects assisted for the past five years are given below:

**The total investment from the Cess Fund and number of projects assisted for the past four years**

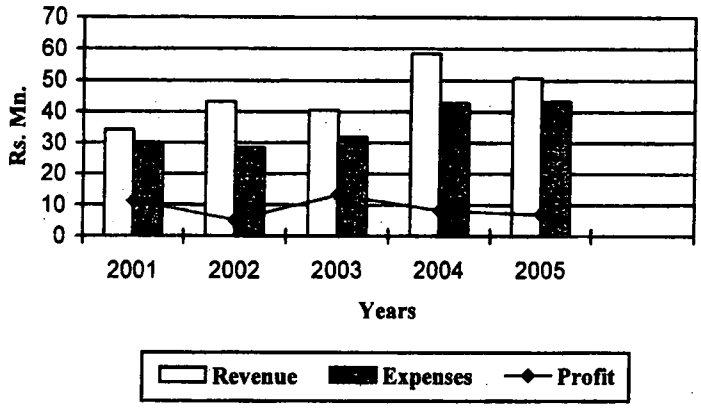


In addition to these funding, scientists at the CRI annually attract funding from various local and foreign funding sources as given below for the special projects:

**Local and foreign funding sources for special projects**




**Progress of Self-financing Units**



## REVIEW OF THE DIRECTOR
## COCONUT RESEARCH INSTITUTE
**C Jayasekara, Ph D (QLD)**

The effectiveness of the activities of the Institute lies with the performance of scientists and extension staff working as a team. During the period under review, Institute took important step to perceive the views of the stakeholders about technologies and services made available to them for the re-orientation of R & D activities of the institute to provide more benefits to the stakeholders effectively.

Multidisciplinary research approach, priority setting of research, and work effectiveness going to reap more benefits to growers in the future. Towards the latter part of the year, twenty-seven young graduates were absorbed to the Institute to fill the gaps and to strengthen essential activities of research divisions, which suffered several years lack of sufficient staff.

### Allocation of Funds

Coconut Research Institute receives funding from three main sources namely (i) Consolidated Fund (ii) Coconut CESS Fund, and (iii) Donor Assisted Funds.

Allocation from the consolidate fund for the year 2005 as Capital and Recurrent Funds was Rs.28.186 million and Rs.66 million respectively. This was 13 percent increase in the capital funds and 10 percent increase in the recurrent funds compared to the previous year. With the increase of CESS collection due to new introduction of vegetable oil import CESS, allocation from the CESS fund for development projects proposed by the CRI amounted to Rs.122 million and it was nearly 200 percent increase compared to the previous year. However, total receivable from the CESS fund for special development projects was Rs.60 M as disbursement of funds was irregular.

Direct Fund for International Development (DFID), Asia Pacific Coconut Community (APCC), and Council for Agriculture Research Policy (CARP) continued to fund for two coconut mite control projects. ADB funded Second perennial crop development project also continued to fund for farmer participatory coconut based intercropping adaptive trials up to September, until closure of the project activities. IPBGRI through COGENT agreed to fund for poverty alleviation project site at Dodanduwa as some of the families in the community group who participated in the previous project were severely affected by tsunami. This project will continue for another three years up to 2008. FAO funded project on "Causative agents for rapid decline syndrome in coconut" was terminated in June and CARP funded project on "Declining syndromes of coconut" was terminated towards the end of the year.

### ACHIEVEMENTS AND HIGHLIGHTS

### 1. Research

Major research achievements and highlights presented here in the summary under five thrust areas as given below:

### 1.1 Crop Improvement

One hundred and twenty six coconut plants raised from exotic germplasm brought as embryos from India (4 coconut varieties) and 59 coconut plants raised from embryos (4 coconut varieties) brought from Papua New Guinea (PNG). These exotic coconut plants raised from embryos were successfully field planted at Bandirippuwa Estate in September. Two multi-locational cultivar evaluation trials established to evaluate the performance of the crosses between dwarf brown x tall and its reciprocal and dwarf brown x San Ramon. A land suitability map for growing hybrid coconuts has been developed based on the results of the long-term multi-locational cultivar evaluation experiments. A

survey conducted to screen coconut varieties resistant/tolerant to Aceria mite has revealed that Sri Lanka dwarf yellow variety as a resistant variety for future breeding programs. In the field of molecular biology, development of a molecular marker system for hybrid identification and the development of DarT DNA markers for coconut are noteworthy achievements.

Another 27 coconut plants raised from the germplasm brought from PNG is ready for field planting. Germination of the embryos brought from the Marc Delome Research Station, Cote d' Ivoire, found to be very poor and a limited number of plants could be raised from the embryos of twelve coconut varieties brought.

A total of 138 Dikiri embryos were cultured in growth media during the period under review and 125 embryo-cultured Dikiri plants distributed among growers. More than 80 tissue-cultured plants established at Bandirippuwa, Lenawa, and Daisy Valley estate, Pallama seed garden are growing satisfactorily, and some are bearing fruits. Twenty-two tissue culture plants are ready for planting at Bandirippuwa estate

Evaluation of performance of dwarf brown form of coconut with two other dwarf forms namely dwarf green (DG) and Cameroon Red Dwarf (CRD) and one tall accession (Clovis) revealed that tall accession from Clovis estate has greater drought tolerant ability compared to other three cultivars. Out of the three dwarf forms tested, dwarf brown appeared to be more resistance to environment stress conditions than other dwarf forms. Therefore, dwarf brown will be a suitable cultivar for future breeding programs.

To ensure production and distribution of high quality coconut seedlings, Seeds & Seedling Certification Unit was established attached to the Genetics and Plant Breeding Division, with the objective of monitoring the entire coconut seedling production program of the Coconut Cultivation Board, registered private nurseries and certification of coconut seedlings. A Seeds and Seedling Certification Officer and eight assistants were recruited to this newly established unit. Several plus palm estates were identified to obtain seed nuts for nurseries. Identification of plus palms estates from North and East was a noteworthy progress made during the year, which made possible to supply the seed nut requirement of the region.

### 1.2 Crop Production

Rainfall distribution studies carried out by the institute revealed that rainfall distribution in the second quarter (April-June) of the year was even, compared to 2004, but overall distribution up to September was favourable for coconut production in 2006 and it is expected at least 10% increase in yield compared to 2005. The predicted yield for 2006 is 2866 million and its breakdown for period of Jan/Feb, March/April, May/June, July/Aug, Sep/Oct, and Nov/Dec in 2006 was 474, 624, 526, 364, 462 and 416 million nuts.

A study conducted to determine yield variation pattern at District level, revealed that Puttalam District having highest per palm yield, whereas Kurunegala District gave the lowest per palm yield. Based on that observed yield in 2005 were 2576 million nuts.

Consumer survey conducted for the first time by CRI identified variation of consumption rates by Districts and by months. Overall per capita consumption of coconut and coconut oil in 2005 was 97 nuts and 7.7 bottles respectively.

Research in the area of plant nutrition focused towards improving nutrient management in coconut lands particularly with inorganic fertilizer and locally available organic sources. An experiment conducted to formulate site-specific recommendation of fertilizers revealed that application of high doses of N P K, and Mg fertilizers than recommended level always gave significant increase in yield compared to recommended dosage of fertilizer and the control.

Nutrient removal studies conducted recently has also shown that nutrient removal from bearing coconut palms is higher than amount supplied as fertilizer. Thus eroded or leached soils need application of more nutrients to increase production of palms. Application of organic manures like cattle, poultry and goat manures, as well as green manure improved soil fertility as well as soil physical properties giving more benefits to the grower. Experiments conducted with different P sources have proven that application of Eppawala Rock Phosphate is sufficient to supplement phosphate requirement in the wet and intermediate zone coconut soils.

Drip irrigation at a rate of 40 l $palm^{-1}day^{-1}$and at six-day intervals with 12 split applications of fertilizer gave 49% increase in yield in Andigama series soil. In that same study, it was shown that irrigation changes the microclimate within the canopy by reducing canopy temperature as well as temperature in the manure circle during the dry period. Cooling effect in the canopy may reduce immature nut fall in the dry period.

Application of glyphosate at the rate of 4.0 l $ha^{-1}$ and Diuron 3.2kg ai/ha found to be very effective for coconut nurseries, where as application of glyphosate 4.0 l $ha^{-1}$ and subsequent establishment of cover crops such as Pueraria is an economically viable weed control method in mature coconut lands.

### 1.3 Crop Protection

Development of integrated management strategy for coconut mite received the highest priority in the institute research program. Therefore, more attention paid to develop biological and chemical control methods for coconut mite. Survey continued to determine the distribution pattern of aceria mite and predatory mites namely *Neoseiulus baraki* and *Neoseiulus phaspalivorous*, whereas both species found in intermediate and wet areas. Releases of laboratory bred *N. baraki* increased the population of predator up to three months with concomitant reduction in the aceria mite population.

Scientists working on the entomopathogenic fungus *Hirsutella thompsonii* have identified four local strains of this fungus, which has greater potential as a biological agent for the control of coconut mite. Field studies conducted with this fungus gave very encouraging results and a collaborative study is in progress with CABI Bioscience, UK to develop commercial myco-acaricide using *H. thompsonii.*

Macro and micronutrient spraying to the canopy of Leaf Scorch Decline (LSD) and Tapering disorder (TD) affected palms showed some improvement after application of nutrients. Using tritiated water it was found that upward movement of water to the canopy was delayed in LSD affected palms compared to healthy palms.

### 1.4 Coconut Processing

Coconut kernel is rich in dietary fiber and meager research studies have been carried out in the past to make use of coconut residue after extraction of coconut oil. Dietary fiber isolates obtained from the coconut residue after extraction of virgin coconut oil showed that it contains 81.36% neutral detergent fiber. Further fractionation of fiber into various dietary fiber components received 44.5% acid detergent fiber, 40 % hemi cellulose, 16% cellulose, and 1.23% ash. Finely ground dry residue (coco flour) can substitute in wheat flour up to 20% for noodles and various bakery products such as breads, buns, and cookies to improve nutritional value of wheat flour.

Nutritional studies conducted to compare total cholesterol level in rats fed with virgin coconut oil enriched meals and normal meals have shown that total cholesterol level does not increase by addition of virgin coconut oil.

Studies on coconut fiber and identification of suitable microorganism to develop consortium of microbes to enhance retting process was re-commenced.

### 1.5 Socio-Economic Studies

During the period under review institute placed more emphasis on four socio-economic studies namely (i) socio economic survey on fragmentation of coconut lands (b) analysis of price behavior of desiccated coconut, fresh nuts and coconut oil (c) situation analysis of organic coconut farming in Sri Lanka (d) socio economic survey on labour availability in the coconut triangle.

The findings of the fragmentation of coconut lands suggests that main causative factors for land fragmentation are high cost of fertilizer, non availability of labour on time, estate security problems, reduction of income due to mite infestation, availability of more attractive alternative investment opportunities by selling out the land and saving money in a bank as fixed deposits, migrate to other countries etc. One of the arguments of the land sellers is that they are helping to develop human settlements, which is one of the basic human needs. It is Pareto inefficient to meet the increasing land demand for human settlement through fragmentation of high potential coconut lands, because the coconut stakeholders are worse off, which ultimately affect the national economy.

The world demand for organic products has an annual growth rate of 20-30% and it exceeds the supply. Although organic coconut farming gaining popularity in Sri Lanka only 700 ha of certified organic coconut lands presently available.

According to the latest agricultural census carried out by the Department of Census and Statistics in Sri Lanka, the extent under coconut in 2002 was 394,836 ha. When compared with the total coconut extent in 1982, the percentage decline of coconut lands in 2002 was 5.4 %. Thus, the rate of decline was 1070 ha per year. Whereas on average 600 ha/year was added to the national coconut extent from the North Central Province.

## 2. TECHNOLOGY TRANSFER ACTIVITIES

Funding for Technology transfer activities was increased several fold this year with a view to develop more effective technology transfer program using modern technology.

### 2.1 Diagnostic Survey

With a view to determine awareness of technologies developed by the CRI and current status of coconut cultivation, a Diagnostic survey was conducted in all coconut growing Districts excluding North and East. The survey results revealed that strengthening of interaction among extension staff is needed to provide adequate knowledge on coconut cultivation. Whereas, awareness about CRI recommendations is high among large coconut holders.

### 2.2 Surveys on Declining Syndrome of Coconut

Survey on "Rapid decline," "Leaf Scorch Decline", and tapering "syndrome" of coconut palms was carried out within the coconut triangle to determine the intensity of the "diseases", distribution pattern and farmers perceptions about these "syndromes".

### 2.3 Research Extension Dialogues

Two Research- extension dialogues conducted at the CRI inviting Regional Managers and Coconut development officers of CCB of several Districts. These dialogues became very useful for the scientists to understand current problems in coconut growing regions and for them to focus on specific issues, which need immediate attention.

## 2.4 "Crop Clinics"

"Crop clinic" is a new initiative in which scientists participated with their instruments and products to provide advisory and extension services to the stakeholders. Two crop clinics were conducted during the year with a good response from the growers. Coconut growers in the area could walk into these crop clinics to clarify their problems through face-to-face discussions with the scientists.

## 2.5 "Farmer Field School Program"

With funding from Common Fund for Commodities (CFC) and Department for International Development (DFID) an innovative technology transfer program - "Farmer Field School" commenced at four locations in collaboration with Asia Pacific Coconut Community (APCC). The technical supervision of the project, carried out by the Food and Agriculture Organization (FAO). "Field School program" is being conducted at for smallholder coconut growers and this program offers the opportunity to learn by doing, by being involved in experimentation, discussions, and decision-making process, regular interactive sessions with extension staff. Instead of attending to seminars and workshops, farmers learned themselves by doing various activities on their own. Farmer field school program received overwhelming response from smallholder coconut growers.

## 2.6 Mass Media Programs

"Kapruka Pamula" weekly radio program conducted jointly with CCB and CDA on the commercial service, Rajarata sevaya, and Ruhunu Sevaya of Sri Lanka Broadcasting Corporation on every Sunday at 10.30 am for six months.

Three TV spots produced on the control of coconut mite telecasted on Rupavahini and ITN.

Three video documentaries on Coconut caterpillar control, intercropping under coconut and animal husbandry in Coconut Lands were produced for the benefit of the growers and these documentaries are available for coconut growers in the form of CDs.

## 2.7 One-Day Educational Program Series

As in the previous years, one-day training program series was conducted for the estate owners and estate staff from June and completed in December. One program per month was conducted and each program received heavy response, registering more than two hundred participants per each program. This program helped participants to gain theory as well as practical knowledge in various aspects of scientific cultivation of coconut.

# 3. PERFORMANCE OF THE GENETIC RESOURCE CENTERS AND RESEARCH CENTERS

## 3.1 General Performance

All Genetic Resource Centers and Research Centers showed 30-35 percent yield loss during the first half of the year, whereas in the last two picks 10-15 % yield increase recorded in all estates making overall annual yield reduction of 15-20%.

Seed nut issues from Ambakelle, Maduruoya, and Pallama GRC were 576,065, 287,930, and 20,280 nuts respectively. This was 20% reduction compared to the previous year.

Total income received fresh coconuts and copra from all centers was Rs.41, 449,168.34 Ambakelle and Maduruoya GRC as well as Ratmalagara, Walpita, and Dunkannawa Research Centers

maintained small nurseries. Total income incurred from the sale of seedlings was Rs.2, 270,790.00. Sundry income (fruits, vegetables, spices, milk and curd etc.) was Rs.5, 713,577.92. Therefore total income raised from centers was Rs.49, 433,536.26.

### 3.2 Development Activities Undertaken

Demonstration plots to demonstrate the field recommendations were established at Ambakelle, Pallama, and Maduru Oya Genetic Resource Centers (GRCC) as well as Ratmalagara, Walpita, and Pottukulama Research Centers (RC). All dud and "diseased" palms were eliminated at Makandura Research Center by uprooting them. A part of the land not suitable for coconut cultivation was diverted for pasture production to establish improved cattle production program.

Three water reservoirs were excavated to store rainwater during monsoon rain period and to utilize during dry spells for cattle as well as coconut plantations. Planting of high value timber such as Teak and Nadun were initiated in unsuitable and infertile blocks of lands in Bandirippuwa, Ratmalagara Research Centers and Pallama GRC.

Drip irrigation system established in 75 acres dwarf green and Typica tall mixed block at Ambakelle GRC to increase production of CRIC 65 seed nuts.

Cattle breeding and improved pasture production program initiated at Makandura RC to produce improved cattle by artificial insemination. It is expected to distribute animals among growers to promote cattle raring and milk production in coconut lands.

576,065 and 287,930 seed nuts of improved varieties (CRIC 60 and CRIC 65) were supplied to the nurseries from Ambakelle and Maduru Oya Genetic Resource Centers respectively for the National Program of Replanting of Coconut.

## 4. MAINTENANCE OF INSTITUTE PROPERTIES AND NEW CONSTRUCTIONS

Engineering Unit attended to all building, vehicle, roads, water, and electrical maintenance activities.

### 4.1 New Constructions

Construction work of the proposed two-story laboratory building for insect raring commenced. It is scheduled to complete in June 2006.

Construction of the office and training facility, boundary wall and the gate at Middeniya Research Center were completed.

Tenders for the constructions of OIC quarters and Circuit Bungalow, water tank at Middeniya RC, proposed extension for the Agriculture Economics Division,
In addition, the Sales outlet at Bandirippuwa RC was awarded towards the latter part of the year.

### 4.2 Renovations

Due to escalation of prices of building materials, allocations for renovation of office buildings and staff quarters became inadequate. With the approval of the Coconut Research Board, funds were reallocated providing sufficient provisions. Tenders for the renovation of BE/GR 111/34, BE/GR/1.22, BE/GR/1.16, BE/GR/111.23 staff quarters, renovation of insectary building, and Coconut Processing Division office were awarded in December.

## 5. NEW INITIATIVES

### 5.1 Middeniya Research Substation in the South

The "land suitability' survey for coconut cultivation in the South carried by the Coconut Research Institute, brought to the light the existence of high potential soils ideally suitable for coconut cultivation in area of about 28,000 joining Matara, Tangalle, and Middeniya. This area is now known as "Mini coconut triangle" and in addition to that another 77,000 ha in the Districts of Kalutara, Galle, Matara, Hambanthota, Ratnapura and Moneragala available for coconut cultivation. If coconut cultivation is promoted in this area it has a production potential of around 360 million coconuts per year.

Therefore, with the objective of development of coconut industry in the Southern province Middeniya Research Substation of the Institute was established in a 75-acre land acquired by the Ministry of Plantation Industries from the Middeniya farm belongs to the Department of Agriculture. Subsequently this land was handed over to the Coconut Research Institute. Land clearing, Fencing and construction of the office building completed in July 2005. Middeniya Research Sub Station was officially inaugurated on 09th July 2005 by the Minister of Plantation Industries.

### 5.2 Seeds and Seedlings Certification Unit

A Seeds and Seedling certification unit was established by recruiting nine graduates trainees from the graduate scheme for this purpose. They were given three months training on mother palm selection, seed nut selection, nursery management and seedling certification. Eight seeds and seedling certification assistants will be stationed in eight different regions. In the future selection of coconut estates for seed nut supply and seed nuts selection for the National Replanting Program (NRP) will be closely monitored by this team. Further seedling production, selection at nursery level will be carried out under their supervision. Authenticity and quality of seedlings will be certified before issuing to the growers.

### 5.3 Socio- Economics Division

As recommended in the strategic plan of the Institute Socio-Economics and Enterprise Development Division will be commenced from next year. As an initial step, research staff was recruited and the construction of an office building commenced.

### 5.4 Progress of CESS Assisted Projects

CRI has been allocated a total of Rs.111, 940.00 for continuation of nine ongoing projects and initiation of 17 new projects of which Rs.49, 836,829.00 were spent. The financial progress of ongoing projects was satisfactory but almost all the new projects that had constructions as major activities failed to meet the targets due to various administrative procedure and staff constraints.

Establishment of Middeniya Research Station (MRC) and upgrading ISG with drip irrigation facilities in 70 acres for increasing the production of CRIC65 have been highlights of the year. MRC was declared open by the Ministry of Plantation Industries in July. Construction of the office, establishing a fence around the 75-acre block, drilling a deep well, clearing approximately 20 acres of mango for coconut planting, awarding contracts for construction of circuit bungalow, OIC's quarters, ground water tank and pathaha were among infra structure developments made at MRC during the year. A course, training for trainers for the formal rural leadership in the Hambantota district was commenced from December 2005.

Further studies on molecular assaying of pathogens, constructing a segregating population of coconut for mapping, HR assistance to mite research, establishing the Pallama Seed Garden for mass production of CRISL98, purchase of multimedia aids and extension material and printing of proceedings II of the CRI 75th Anniversary have made considerable progress among ongoing projects. Scheduled germplasm importation from India did not take place because of the delays in obtaining clearance for germplasm exchange.

Successful completion of two surveys, diagnostic survey and palm decline survey are noteworthy achievements during the year as new projects. Studies on coconut diversity in the southern province and coconuts with potential use as natural beverage, analysis of the constituents of dikiri coconut, attempts towards value addition to virgin coconut oil were all initiated and continued successfully. In addition, constructions of mite laboratory and extension for Agriculture Extension Division were initiated. Plans, bill of quantities and estimates have been prepared for construction of a laboratory for testing soils, plant nutrients and various coconut based products but the commencement of the work was postponed for 2006 because of administrative delays. Proposed Technology Park and island wide mite control program were failed to meet the targets due to staff constraints. Construction of glass house to screen coconut seedlings of the mapping population was postponed due to delays in purchasing of roofing sheets.

### 5.5 Foreign Funded Projects

*Tsunami Rehabilitation Project at Dodanduwa*

IPBGR through COGENT agreed to fund Dodanduwa poverty alleviation project site from 2005 for another three years to restore livelihood of tsunami affected people.

## 6. OUTPUTS OF THE INSTITUTE

### 6.1 Awards

Mr K. D. P. P. Gunathilake, Miss J. M M A. Jayasundara, and Mrs L. L. W. C. Yalegama received a National Award for best technology developed and transferred for the year 2005 from the National Science Foundation for introducing coconut paste to reduce coconut wastage.

### 6.2 Innovation of New Machinery

Coconut Processing Research Division in collaboration with the private sector (i) designed and fabricated a low cost machine to extract virgin coconut oil at a cost of Rs.500,000.00.; (ii) developed a medium grade pin cutter to crush coconut kernel at a cost of Rs.200,000.00.

### 6.3 Technologies Provided to the Industry

CRI has given the technology for virgin coconut oil production to 4 entrepreneurs at a nominal cost of Rs.50, 000.00 per each project file. Similarly technology for coconut paste was given to 5 entrepreneurs.

## 7. Services Provided to the Industry

| | |
|---|---|
| No. of trials maintained in farmers fields | - 110 |
| No. of improved seed nuts produced and issued | |
| CRIC 60 | - 576,065 |
| CRIC 65 | - 287,930 |
| CRIC 98 (hand pollinated) | - 4695 |
| Kapruwana | - 2601 |

| | |
|---|---|
| No. of tissue cultured plants released for field establishment | - 6 |
| No of predator mite released | -4 pilot releases made |
| No of recommendations revised | -2 |
| No of DFR recommendations made | -204 |

## 8. ACKNOWLEDGMENTS

The co-operation extended by the Deputy Director (Research), Deputy Director (Administration & Finance), Heads of Divisions, and Staff of the Research and Service Divisions contributed to the successful implementation of the Annual Action Plan. Their contribution is gratefully acknowledged.

CRI is also thankful to Hon. Minister, Secretary, Additional Secretaries and other Staff of ministry of Coconut Development for their excellent cooperation provided to CRI for successful implementation of the year 2005 action plan.

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

Continued support given by the following organizations is also acknowledged:

- Ministry of Coconut Development
- General 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 (CARP)
- National Science Foundation
- National Institute of Plantation Management
- ADB funded Science and Technology Personnel Development Project
- Second Perennial Crop Development Project
- Water Resources Board
- Department of Botany, University of Peradeniya
- Postgraduate Institute of Agriculture (PGIA)
- Postgraduate Institute of Science (PGIS)
- Industrial Technology institute (ITI)
- National Science and Technology Commission (NASTEC)
- Kurunegala Plantations Ltd.
- Central Plantation Corp Research Institute, India
- Indian Council for Agricultural Research (ICAR)
- Plant Genetic Resource Center (PGRC)
- Asia and Pacific Coconut Community, Indonesia (APCC)
- International Service for National Agricultural Research (ISNAR)
- International Mycological Institute, UK
- Food and Agricultural Organization (FAO)

## REPORT OF THE AGRONOMY DIVISION

**Acting Head - S H S Senarathne, MSc**

### 1. GENERAL

The research program of the Agronomy Division was primarily aimed at i) increasing coconut yield, and ii) increasing land productivity through development of innovative agronomic practices. During the year, 16 field experiments were conducted under 10 major research projects. In addition, 6 socio-economic studies were conducted with the objective of analysing issues pertaining to social and economic aspects of the coconut industry. The total allocation of consolidated funds in terms of capital and recurrent budget for these studies was Rs 3.2 million.

Two out side funded projects, namely the Coconut Based Adaptive Research Project (ADB, Rs 3.0 million.) and Poverty Alleviation in Coconut Growing communities (IPGRI, Rs 0.24 million) were also in operation during the year.

Various field experiments were continued with a common goal of rehabilitating low yielding coconut plantations via improved cultivation practices. Under this category, planting of T x T coconut seedlings in 1.3 m x 1.3 m pits in Andigama shallow soils showed significantly higher leaf production over the year, showing the advantages of large size planting holes.

Results of the rehabilitation trial in the Andigama soil series using short rotation forestry continue to show the suitability of *Acacia* species and *Macaranga paltata* as fast growing trees.

The experiment which was established in year 2000 with the objective of improving the productivity of coconut through the management of leguminous ground covers revealed that *Pueraria* cover treated with N P K and Mg followed by harrowing could be an effective management practice that can increase the nut yield of coconut.

In a weed management experiment, application of Glyphosate at the rate of 4 litre/hectare twice a year effectively suppressed the weed growth in coconut lands. Cover cropping treatment with *Pueraria* was equally effective. Both treatments also showed higher nut yields over the control treatment. The experiment conducted to determine the effectiveness of different herbicides in controlling weeds in coconut nurseries revealed that application of Diuron (3.2 kg a.i./ha) or Glyphosate (1.4 kg a.i./ha) could successfully control weed growth thus enhancing seedling growth.

Intercropping cashew with coconut did not adversely affect coconut yield as observed in previous years indicating cashew as a potential intercrop under coconut.

The study conducted to assess the availability of agricultural labour in major coconut growing areas revealed that there is a severe shortage of skilled labour particularly in Marawila and Gampaha regions despite high wage rates. Inequalities were observed with respect to earnings of male and female labours where later always tend to have less earnings. The labour use efficiency seemed to increase with the land size class, particularly in Kuliyapitiya region.

Major causes for coconut land fragmentation were identified as high cost of fertilizer, unavailability of timely labour and high wage rates and the availability of alternative investment opportunities, among many others.

Economics of monthly harvesting of coconut revealed that it is not economical for landowners of less than 3 acres if the nut price is less that Rs 14.00. However, this seems economical for landowner with more than 3 acres even if the nut price drops below Rs. 7.00.

Price behaviour of desiccated coconut, fresh nuts and coconut oil seemed to follow weather induced seasonal variations in nut production and due to the regular pattern of this behaviour, the prices are predictable to a certain extent.

A cost benefit analysis was done in order to assess the economics of gravity flow drip irrigation system established at one of the CRI substations. The net present value and the benefit cost ratio of the system was Rs 74,989 per acre per year and 3.15 at 9% interest rate respectively whilst the payback period was 6-7 years.

## 2. RESEARCH PROJECTS

### PROJECT 2: REHABILITATION OF LOW YIELDING PLANTATIONS

**Experiment 2.3: Effect of root pruning and fertilizer application on yield of coconut palms with heavy root mat formation on Coastal Regosols ($DL_4/S_5$), Palavi - 1996**

The experimental design was a Randomised Complete Block Design (RCBD) with three replicates containing nine effective palms per plot. The soil was sandy Regosols characterized by a high water table that varies from 60 cm to 150 cm from the surface between the wet and dry seasons. In year 2004, root pruning by disk harrowing (15 cm depth) and application of 3.0 kg of APM + 1.0 kg of dolomite/palm were continued according to treatments given in Table 1.

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

| | Nuts/palm/year | | | |
|---|---|---|---|---|
| **Treatments** | **2002** | **2003** | **2004** | **2005** |
| Control (no fertilizer + no harrowing) | 27 | 46 | 55 | 39 |
| Harrowing + Fertilizer | 63 | 56 | 58 | 48 |
| Harrowing only | 42 | 40 | 49 | 29 |
| Fertilizer only | 47 | 49 | 58 | 44 |
| Significance | ** | n.s. | n.s. | n.s. |
| LSD (P=0.05) | 12 | | | |

In year 2005 also, treatments did not show significant effect on nut yield as in year 2003 and 2004. The treatment effects may have been masked by the variable climatic conditions prevailed during these years. (Table 1). Further, there was a reduction in nut yield in all treatments compared to year 2004.

The experiment is being continued.

*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 ($IL_1/S_5$) Madampe - 1997**

The objective of this experiment was to determine whether the growth performance of T x T coconut seedlings could be improved by increasing the size of the planting hole and and by changing physical and biological properties of soil with loamy soils. Treatments given in Table 2 have been arranged in a Randomized Complete Block Design (RCBD) with three replicates. There were nine effective palms per plot.

Unlike in year 2004, significant differences were observed in total number of fronds among treatments. Seedlings planted in standard size pits had the lowest number of leaves compared to other

treatments. The highest number of fronds was recorded in seedlings planted in 1.3 x 1.3 x 1.3 m pits. The results suggest that planting of coconut seedlings in large pits would be more beneficial to overcome the problems in shallow Andigama soils.

Table 2 shows the extent of reproductive attainment as a percentage of palms flowered in year 2005. However, the results appeared as same as in year 2004.

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

| Treatments | Total Number of fronds/palm | Number of leaves produced | % Flowering |
|---|---|---|---|
| $T_1$ 1 x 1 x 1 m pit (standard planting hole) | 10 | 6 | 5 |
| $T_2$ 1.3 x 1.3 x 1.3 m pit (filled with husk/same soil) | 14 | 8 | 17 |
| $T_3$ 1.3 x 1.3 x 1.3 m pit (filled with husk/soils brought from out side) | 13 | 8 | 33 |
| $T_4$ 1.3 m wide x 1.3 m deep trench (filled with husk/same soil) | 11 | 7 | 41 |
| $T_5$ $T_4$ + 20% increased standard density of palms (156/ha) | 12 | 8 | 58 |
| Significance | * | * | |
| LSD (P=0.05) | 3.8 | 0.8 | |

Eight years after planting in large pits and filling with good soil increased the flowering up to 33%. However, trench planting showed higher flowering percentage suggesting that there are other factors involved.

The experiment is being continued.

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**Experiment 2.4.5: Rehabilitation of degraded coconut soils through short-term forestry in Andigama Soil Series (shallow phase) at Ratmalagara Estate ($IL_1/S_5$), Madampe - 1999**

This experiment was initiated in October 1999 to investigate the possibility of improving soil quality of degraded coconut lands through short/medium term forestry for economical coconut production. The forest tree species used in this experiment have been planted in a Randomized Complete Block Design (RCBD) with three replicates (Table 3).

In year 2005, the three *Acacia* species followed by *Macaranga Paltata* (Kenda) showed higher growth rates as measured by stem girth at 30 cm and 130 cm above ground (Table 3). The growth rate of *Calophyllum eletum* (Domba) remained significantly low as in the previous years. Growth of *Gliricidia sepium* and *Grewia tilifolia* was also low during the year. To see whether the treatments had any effect on soil organic matter, amounts were quantified and presented in Table 3. However even after six years of planting trees, the soil organic matter has not been affected significantly by any of the treatments despite the heavy leaf litter accumulations in some plots.

**Table 3:** ***Growth of selected forest tree species***

| Treatments | Stem girth (cm) (at 30 cm above ground) | | Stem girth (cm) (at 130 cm above ground) | Soil OM (%) |
|---|---|---|---|---|
| | 2004 | 2005 | 2005 | 2005 |
| $T_1$ *A. auriculiformis* | 45 | 55 | 48 | 2.3 |
| $T_2$ *A. mangium-1* | 50 | 60 | 51 | 2.9 |
| $T_3$ *A. mangium-2* | 57 | 60 | 51 | 2.4 |
| $T_4$ *Calophyllum elatum* | 18 | 20 | 16 | 2.4 |
| $T_5$ *Grewia tilifolia* | 22 | 33 | 21 | 2.5 |
| $T_6$ *Macaranga paltata* | 52 | 53 | 47 | 2.3 |
| $T_7$ *Gliricidia sepium* | 26 | 27 | 24 | 3.4 |
| $T_8$ *Tectonia grandis* | 32 | 42 | 36 | 3.3 |
| $T_9$ *Swieteria macrophylla* | 26 | 34 | 27 | 2.8 |
| $T_{10}$ *Bridella mooni* | 37 | 46 | 37 | 3.0 |
| Significance | ** | *** | *** | n.s. |
| LSD (P=0.05) | 17 | 13 | 14 | |
| CV% | | | | |

The experiment is being continued.

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**Experiment 2.5: Use of different plant species to rehabilitate coconut soils**

**Experiment 2.5.1: Rathmalagara Estate ($IL_1/S_4$) - 2005**

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

Therefore, an experiment was established at Rathmalagara Estate using following treatments on a Randomized Complete Block Design with three replicates. There were 8 effective palms per plot.

Treatments: $T_1$- Planting *Gliricidia sepium*
$T_2$- Planting *Crotalaria juncea*
$T_3$- Planting *Panicum maximum*
$T_4$- Planting *Thitonia diversifolia*
$T_5$- Control (no plant species)

The experiment is in progress.

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**PROJECT 5:** **IMPROVEMENT 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 - $IL_1/S_4$ (Katukele Series) - 2000**

**Experiment 5.1.2:** **Melsiripura Farm, Melsiripura - $IL_1/S_3$ (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 plantations in the long run. Treatments shown in table 4 were laid on a two Factor Factorial Randomized Complete Block Design with three replicates with nine effective palms per plot.

Different treatments were applied according to the schedule. Plots were treated with two types of fertilizer mixtures with N and without N (N, P, K, Mg and P, K, Mg) for coconut palms and two types of ground cover management methods, harrowing and slashing, twice a year.

**Table 4:** ***Effect of ground cover management on coconut yield (nuts/palm/year) at Pallama Seed Garden and Melsiripura Estate***

| Treatment combination | Melsiripura | | | | | Pallama | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2001 | 2002 | 2003 | 2004 | 2005 | 2001 | 2002 | 2003 | 2004 | 2005 |
| $T_1$ - Pueraria cover + P,K,Mg + Slashing | 56 | 82 | 85 | 73 | 84 | 73 | 26 | 73 | 91 | 95 |
| $T_2$ - Pueraria cover + N,P,K,Mg + Slashing | 59 | 66 | 90 | 68 | 79 | 78 | 39 | 75 | 92 | 99 |
| $T_3$ - Pueraria cover + P,K,Mg + Harrowing | 55 | 68 | 73 | 70 | 86 | 74 | 33 | 67 | 90 | 108 |
| $T_4$ - Pueraria cover + N,P,K,Mg + Harrowing | 50 | 66 | 69 | 92 | 105 | 71 | 27 | 63 | 101 | 112 |
| Significance | n.s. | n.s. | * | * | * | n.s. | n.s. | n.s. | * | * |
| LSD (P=0.05) | | | 16 | 13 | 12 | | | | 8 | 9 |

During the year, there were significant differences in yield among the treatments (fertilizer mixtures and cover management methods) in both experiments and the highest nut yield was produced by $T_4$ - Pueraria cover + N, P, K, Mg + Harrowing treatment plots.

The experiments were terminated.

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**PROJECT 6:** **DEVELOPMENT OF BIOMASS ENERGY PRODUCTION SYSTEMS UNDER COCONUT**

**Experiment 6.1:** **Planting of Gliricidia to optimise the production of fuel wood and foliage biomass under coconut at Ratmalagara Estate ($IL_1/S_5$), Madampe - 2003**

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

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

Treatments had significant effects on the wood and foliage biomass yield of Gliricidia as early as two years after planting (Table 5). The quantities were nearly doubled in the current year as compared to the previous year. The highest wood and foliage biomass was recorded in plots with three rows of gliricidia while the lowest was in plots with a single gliricidia row. However, plots with higher plant densities had a low wood and foliage biomass yield per tree (data not shown). Although treatments 2 and 3 had equal plant densities, the wider spacing gave higher wood and foliage biomass yields.

The experiment is being continued.

**Table 5:** ***Wood and foliage biomass yield of gliricidia as affected by different planting densities***

| Treatment | Wood yield (kg/ha) | | Foliage biomass (kg/ha) | |
|---|---|---|---|---|
| | 2004 | 2005 | 2004 | 2005 |
| $T_1$ One row (1275 trees/ha) | 1494.9 | 3340.5 | 538.7 | 1354.7 |
| $T_2$ Two rows (2550 trees/ha) | 2524.5 | 5431.5 | 873.4 | 1510.9 |
| $T_3$ Two rows (2550 trees/ha) | 1887.0 | 4398.8 | 573.8 | 1020.0 |
| $T_4$ Three rows (3825 trees/ha) | 2916.6 | 7697.8 | 745.9 | 1558.7 |
| Significance | n.s. | * | * | * |
| LSD (P=0.05) | | 1923 | 301 | 281 |
| CV% | | 23 | 27 | 12 |

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**PROJECT 7: ORGANIC COCONUT FARMING**

**Experiment 7.1: Effect of different organic manure applications on the performance of mature coconut palms at Ratmalagara Estate ($IL_1/S_5$), Madampe - 2003**

An experiment was started in year 2003 with the objective of assessing the effect of organic fertilizer application on soil fertility and coconut yield. Following treatments were imposed on a Randomized Complete Block Design with a single replicate.

$T_1$ - Application of 30 kg of Gliricidia + 230 coconut husks + 600 g of ERP + 1 kg of Dolomite

$T_2$ - Application of 3 kg of APM

$T_3$ - Application of 25 kg of goat manure + 115 coconut husks + 600 g of ERP + 1 kg of Dolomite

$T_4$ - Application of 30 kg of Gliricidia + 230 coconut husks + 600 g of ERP + 1 kg of Dolomite + 150 ml of Humate Plus

**Table 6:** ***Effect of different organic manure applications on coconut yield***

| Treatments | Coconut Yield | |
|---|---|---|
| | 2004 | 2005 |
| $T_1$ | 63 | 74 |
| $T_2$ | 79 | 55 |
| $T_3$ | 51 | 75 |
| $T_4$ | 62 | 60 |

In year 2005, all palms receiving organic manure showed higher nut yields compared to the palms receiving chemical fertilizer. The highest nut yield was recorded in plots receiving goat manure as organic fertilizer. Application of Gliricidia together with other supplemental nutrients also seemed to have beneficial effects on nut yield.

The experiment is being continued.

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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**

**Experiment 15.1.1** **Pallama Seed Garden ($IL_1/S_4$) - 2000**

**Experiment 15.1.2** **Ussawa Division, Melsiripura Estate ($IL_1/S_3$) - 2000**

Treatments shown in Table 5 were laid on RCBD with three replicates and there are 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 growth in response to different cultural practices of weed management. Soil samples were taken to measure soil moisture content at two depths (0.5ft and 1.0ft). 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*).

$T_1$ - Control treatment (in which only the perennial shrubs were managed)
$T_2$ - Cover cropping with Pueraria
$T_3$ - Planting Gliricidia (in double rows in an avenue at 1m x 2m spacing)
$T_4$ - Slashing (two times per year)
$T_5$ - Application of Glyphosate (4 lit/ha, two applications per year)
$T_6$ - Grazing with cattle (6 rotations per year)

There were significant differences in weed biomass among treatments. The lowest weed biomass was recorded in Glyphosate applied plots. Pueraria cover was also equally effective to suppress weeds as in Glyphosate applied plots at Pallama and Melsiripura (Table 5 and 6). Nut yield of coconut as affected by the application of different cultural practices showed significant differences during the year at Pallama and Melsiripura experiments (Table 7). The highest nut yield was recorded in chemical weeding and cover crop planted plots. Soil moisture content was significantly higher in Glyphosate applied plots at 1.0 feet depth in both experiments (Table 8).

**Table 5:** ***Weed biomass ($g/m^2$) at different sampling times as affected by the application of different weed control practices at Pallama Seed Garden, Pallama***

| Treatments | Ave 01 | Ave 02 | Ave 03 | Ave 04 | Jan 05 | Mar 05 | May 05 | July 05 | Sep 05 | Nov 05 |
|---|---|---|---|---|---|---|---|---|---|---|
| $T_1$- Unweeded | 238 | 168 | 179 | 133 | 253 | 185 | 200 | 266 | 190 | 176 |
| $T_2$- Cover crop | 193 | 135 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $T_3$- Gliricidia | 216 | 129 | 150 | 88 | 142 | 155 | 172 | 194 | 99 | 99 |
| $T_4$- Slashing and mulching | 168 | 126 | 146 | 106 | 262 | 105 | 180 | 241 | 46 | 88 |
| $T_5$- Chemical weeding | 150 | 39 | 28 | 46 | 140 | 0 | 51 | 58 | 10 | 40 |
| $T_6$- Cattle grazing | 227 | 147 | 189 | 135 | 208 | 156 | 200 | 257 | 87 | 93 |
| Significance | | | | | ** | ** | ** | ** | ** | ** |
| LSD (P=0.05) | | | | | 75 | 63 | 48 | 66 | 39 | 44 |
| CV% | | | | | | | | | | |

Treatments were applied in June 01, December 01, June 02, December 02, June 03, December 03, June 04, December 04, June 05 and December 05.

**Table 6:** ***Weed biomass ($g/m^2$) at different sampling times as affected by the application of different weed control practices at Melsiripura Estate, Melsiripura***

| Treatments | Ave 02 | Ave 03 | Ave 04 | Feb 05 | Apr 05 | June 05 | Aug 05 | Oct 05 | Dec 05 |
|---|---|---|---|---|---|---|---|---|---|
| $T_1$- Unweeded | 168 | 177 | 179 | 248 | 267 | 186 | 156 | 178 | 268 |
| $T_2$- Cover crop | 135 | 16 | 13 | 12 | 18 | 19 | 0 | 22 | 40 |
| $T_3$- Gliricidia | 129 | 150 | 113 | 149 | 102 | 136 | 125 | 80 | 156 |
| $T_4$- Slashing and mulching | 126 | 146 | 157 | 89 | 218 | 280 | 58 | 110 | 142 |
| $T_5$- Chemical weeding | 32 | 28 | 67 | 15 | 34 | 85 | 12 | 42 | 66 |
| $T_6$- Cattle grazing | 147 | 189 | 160 | 145 | 128 | 240 | 112 | 135 | 189 |
| Significance | | | | ** | ** | ** | ** | ** | ** |
| LSD (P=0.05) | | | | 81 | 67 | 93 | 49 | 68 | 63 |
| CV% | | | | | | | | | |

Treatments were applied in June 01, December 01, June 02, December 02, June 03, December 03, June 04, December 04, June 05 and December 05.
The experiment (Melsiripura) was terminated

**Table 7:** ***Nut yield of coconut as affected by different cultural practices in controlling weeds at Pallama Seed Garden and Melsiripura Estate***

| Treatments | Nuts/palm/year | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pallama | | | | | Melsiripura | | | | |
| | 2001 | 2002 | 2003 | 2004 | 2005 | 2001 | 2002 | 2003 | 2004 | 2005 |
| $T_1$- Unweeded | 72 | 26 | 68 | 82 | 62 | 46 | 56 | 59 | 48 | 58 |
| $T_2$-Covercrop (Pueraria) | 88 | 38 | 87 | 101 | 94 | 45 | 52 | 61 | 51 | 71 |
| $T_3$- Gliricidia | 77 | 38 | 74 | 84 | 59 | 59 | 49 | 56 | 53 | 62 |
| $T_4$-Slashing and mulching | 78 | 27 | 81 | 87 | 75 | 54 | 50 | 51 | 50 | 62 |
| $T_5$-Chemical weeding | 81 | 44 | 97 | 102 | 99 | 44 | 61 | 78 | 69 | 85 |
| $T_6$- Cattle grazing | 83 | 36 | 75 | 81 | 66 | 58 | 46 | 53 | 47 | 62 |
| Significance | n.s. | n.s. | * | * | * | n.s. | n.s. | n.s. | * | * |
| LSD (P=0.05) | | | 15 | 13 | 17 | | | | 12 | 10 |
| CV% | | | | | | | | | | |

**Table 8:** ***Soil moisture content (%) as affected by different cultural practices in controlling weeds at Pallama Seed Garden and Melsiripura Estate***

| Treatment | Soil Moisture Content (%) | | | |
|---|---|---|---|---|
| | Pallama | | Melsiripura | |
| | 0.5 ft (depth) | 1.0 ft (depth) | 0.5 ft (depth) | 1.0 ft (depth) |
| $T_1$ - Unweeded | 2.73 | 4.25 | 2.72 | 3.51 |
| $T_2$ - Cover crop (Pueraria) | 4.72 | 4.31 | 3.72 | 4.52 |
| $T_3$ - Gliricidia | 3.48 | 4.81 | 2.88 | 4.78 |
| $T_4$ - Slashing and mulching | 3.25 | 4.37 | 2.92 | 4.38 |
| $T_5$ - Chemical weeding | 2.37 | 8.20 | 2.41 | 6.22 |
| $T_6$ - Cattle grazing | 4.68 | 4.50 | 3.45 | 4.19 |
| Significance | n.s. | * | n.s. | * |
| LSD (P=0.05) | - | 3.88 | - | 1.8 |

The experiment (Melsiripura) was terminated
The experiment (Pallama seed Garden) is being continued.

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**Experiment 5.2. Effectiveness of different herbicides in controlling weeds in coconut nurseries and their effect on seedling growth**

### 5.2.1. Coconut Cultivation Board Nursery - Ibbagamuwa ($IL_1$) - 2004

Treatments shown in Figure 1 were replicates. Forty seed nuts were established in each plot and 90% 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 Gandapana (*Hyptis suaveolens*). Treatments were applied according to the schedule. Glyphosate and Diuron treatment applied plots controlled weeds successfully and hence weed biomass of those plots was the lowest (Figure 1). There were no significant differences in weed biomass between $T_2$ and $T_3$ treatments.

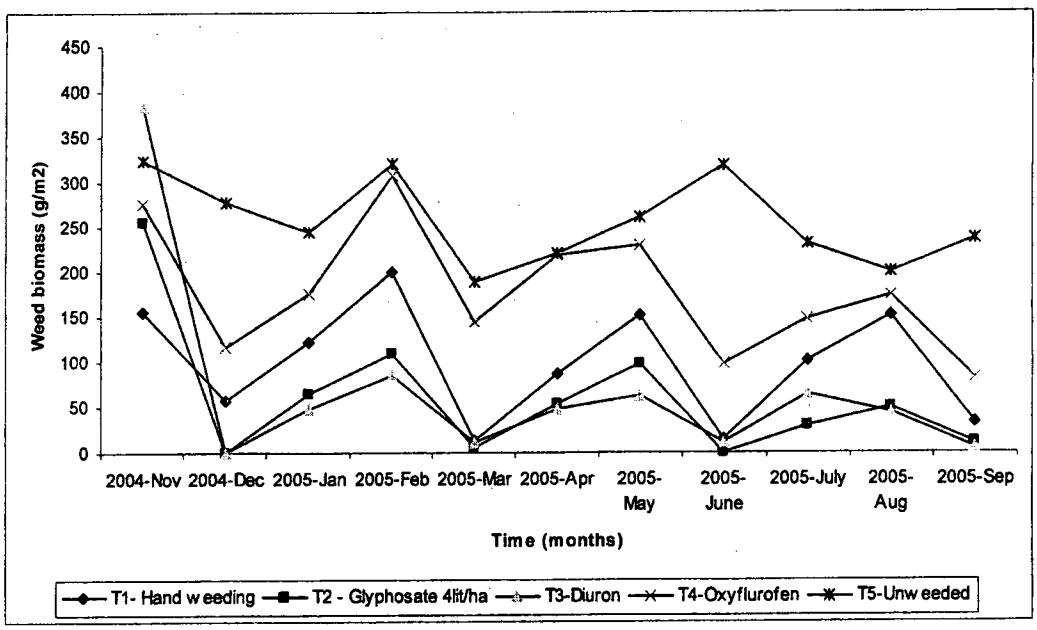


**Figure 1.** ***Weed biomass ($g/m^2$) in five different weed management methods from August 2003 to July 2004***

Treatments were applied in November 2004, February 2005, May 2005 and August 2005.

**Table 9:** ***Effect of different weed control treatments on the growth of coconut seedlings (expressed as the seedling girth (cm)) at Ibbagamuwa***

| Treatments | Feb 05 | Mar 05 | April 05 | May 05 | June 05 | July 05 | Aug 05 | Sep 05 | Oct 05 |
|---|---|---|---|---|---|---|---|---|---|
| $T_1$- Hand weeding | 8.04 | 9.00 | 9.84 | 10.70 | 11.57 | 12.00 | 12.10 | 13.14 | 14.14 |
| $T_2$- Glyphosate 1.40 kg/h | 8.34 | 9.14 | 10.27 | 11.20 | 12.30 | 12.74 | 12.94 | 14.16 | 14.97 |
| $T_3$- Diuron 3.2 kg ai/ha | 8.36 | 9.37 | 10.64 | 11.34 | 12.27 | 13.10 | 13.27 | 14.57 | 16.71 |
| $T_4$- Oxyflurofen 0.27 kg ai/ha | 7.80 | 8.84 | 9.94 | 11.00 | 11.80 | 12.40 | 12.64 | 13.14 | 14.30 |
| $T_5$ - Unweeded control | 7.70 | 8.67 | 9.96 | 10.50 | 11.26 | 11.56 | 11.74 | 12.57 | 13.27 |
| Significance | n.s | n.s | n.s. | n.s. | n.s | n.s. | n.s. | n.s. | * |
| LSD (P=0.05) | | | | | | | | | 1.30 |

**Table 10:** ***Effect of different weed control treatments on the growth of coconut seedlings expressed as the seedling height (cm) at Ibbagamuwa***

| Treatments | Feb 05 | Mar 05 | Apr 05 | May 05 | June 05 | July 05 | Aug 05 | Sep 05 |
|---|---|---|---|---|---|---|---|---|
| $T_1$- Hand weeding | 61.36 | 72.06 | 81.10 | 94.41 | 103.60 | 111.41 | 118.60 | 124.67 |
| $T_2$- Glyphosate 1.40 kg/h | 67.10 | 77.30 | 87.50 | 97.97 | 108.71 | 117.04 | 122.94 | 131.36 |
| $T_3$- Diuron 3.2 kg ai/ha | 69.03 | 79.28 | 91.27 | 107.40 | 123.54 | 125.30 | 147.13 | 148.27 |
| $T_4$-Oxyflurofen 0.27 kg ai/ha | 68.70 | 82.50 | 95.34 | 112.57 | 125.50 | 129.64 | 143.51 | 148.14 |
| $T_5$- Unweeded control | 74.24 | 76.37 | 98.24 | 111.50 | 123.90 | 128.14 | 142.34 | 156.8 |
| Significance | n.s. | n.s. | n.s. | n.s. | n.s. | n.s. | ** | ** |
| LSD (P=0.05) | | | | | | | 15.96 | 13.08 |
| CV% | | | | | | | | |

Growth of coconut seedlings as expressed by the seedling girth (cm) and seedling height (cm) was measured. Both growth parameters were significantly affected by the treatments at the end of the nursery period. Coconut seedlings in Diuron treated plots ($T_3$) showed higher seedling girth than in other treatments (Table 9). Unweeded plots showed higher growth rates (seedling height) than in other treatments (Table 10). Finally the high quality seedlings were produced in Diuron applied plots and total weeding cost per 1000 seedlings was Rs 310.00 (Table 11).

**Table 11:** ***Cost analysis of different weed control methods***

| Methods of weed control | Number of rounds | Cost per 1000 seedlings per round | Total cost per 1000 seedlings (Rs) |
|---|---|---|---|
| $T_1$- Hand weeding | 4 | 400.00 | 1600.00 |
| $T_2$- Glyphosate 1.4 kg/ha | 3 | 46.67 | 140.00 |
| $T_3$- Diuron 3.2 kg ai /ha | 2 | 156.80 | 313.60 |
| $T_4$- Oxyfluorfen 0.27 kg ai/ha | | | |

Include material and labour cost

Average price of commercial product of glyphosate SL Rs 400 / litre

Average price of commercial product of diuron SL Rs 560 / 400g

Average price of commercial product of oxyfluorfen SL Rs 1200 / 400ml

Average labour wage: SL Rs 200 / manday

US 1$ = Sri Lankan (SL) Rs 95

The experiment was terminated.

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**PROJECT 19: SMALLHOLDER 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 ($IL_1/S_4$) - 1995**

Treatments given in Table 12 were tested on a RCBD with three replicates. Each plot consisted of nine effective coconut palms.

Planting of cashew in coconut avenues did not affect coconut yield as in previous years suggesting cashew as a potential intercrop in coconut plantations (Table 12). Grafted cashew reached early flowering and yielded within two years of planting followed by air-layered cashew plants. At the age of seven, both vegetatively propagated cashew produced cashew yield of over 50 kg/tree/year. Cashew propagated with seeds took more than five years to flower, but from the 7th year onwards, produced the highest yield among other types. However, bud-grafted cashew produced the highest yield per unit area basis. In 2005, cashew yields could not be recorded due to pest (Helopeltis) attacks.

**Table 12:** ***The effect of the plant type of cashew on coconut yield***

| Treatments | Coconut yield (nuts/palm/year) | |
|---|---|---|
| | 2004 | 2005 |
| Coconut monoculture | 79 | 50 |
| Bud grafted cashew | 75 | 51 |
| Air-layered cashew | 70 | 40 |
| Seedling cashew | 67 | 51 |
| Significance (P=0.05) | n.s. | n.s. |

The experiment is being continued.

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

Intercropping cashew did not show any significant effect on coconut yield as was observed in the previous year (Table 13). At Pallama site also cashew yields were not taken because of severe pest damages.

**Table 13:** ***Coconut yield as affected by intercropping with three different types of planting materials of Cashew***

| Treatments | Coconut yield (nuts/palm/year) | | | |
|---|---|---|---|---|
| | 2000-2001 | 2002 | 2003 | 2005 |
| Coconut monoculture | 53 | 43 | 66 | 51 |
| Bud grafted cashew | 56 | 56 | 72 | 64 |
| Air-layered cashew | 53 | 52 | 68 | 61 |
| Seedling cashew | 50 | 49 | 69 | 58 |
| Significance (P=0.05) | | n.s | n.s. | n.s. |

The experiments are in progress.

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

**Study 25.1: An assessment of current labour availability in coconut cultivation sector**

This study focused on assessing the availability of labour in major coconut growing areas of coconut triangle. The objectives were to document the prevalence of labour shortage in various labour required activities in different regional management areas and different land size classes, to find out the demographic factors in labour availability and to explore the solutions suggested by the respondents during the survey. The survey was conducted during September 2005 to December 2005. The findings of the study were as follows.

A substantial percentage of respondents in Kuliyapitiya and Gampaha regions experienced an acute shortage of labour, 23% and 21% respectively. Generally, the observed shortage level in Kuliyapitiya region is 60% while it is 65% in Gampaha and 50% in Kurunegala. It is not severe in Marawila region and availability of refugees in some areas has an impact on its labour force.

An acute shortage of skilled labour necessary for harvesting of coconuts, both climbers and pole harvesters is observed in Marawila and Gampaha regions despite the fact that a higher wage is paid. This is partly due to the fact that young generation is unwilling to take up this job due to social stigma. In Kurunegala and Kuliyapitiya regions unskilled labour shortage is very high compared to other regions. Skilled labour is highly paid compared to unskilled labour and it is often contract type.

Activities involving skilled labour are male dominated while unskilled labour-involving activities are female dominated. This means that the employment opportunities in the coconut cultivation sector unequally empower the men and women in terms of earning possibilities favouring the men.

Irrespective of the region, there is a significant draw back in young generation's participation in the labour force. Highest drawback is in Kuliyapitiya region.

A statistically significant disparity exists between male and female wage rates (probability at 0.001).

Small holders have to pay higher wage rates compared to estate sector. Weeding is practiced as a routine activity irrespective of the region. Majority of the owners does not utilize their lands to the maximum potential. Intercropping is a poorly practiced activity except in Gampaha (climatic effects). Animal husbandry is practiced only by 25% of the respondents.
Low wage rates, high education level and poor social acceptance are causes for labour mobility from cultivation sector to other sectors. Husk pits, contour drains and weeding are the activities with a greater tendency to be mechanized.

Labour use efficiency changes with the land size class and it increases with the size of the land holding. This is statistically significant in Kuliyapitiya region.

Innovative technologies should be invented to reduce the labour requirement in cultivation related activities. Use of animal grazing can be promoted as an alternative measure for weeding. A deep attitudinal change should be made among younger generations. Incentive systems should be introduced to the plantation sector to minimize the labour turnover. A programme should be initiated to train a new generation of coconut harvesters and to provide an insurance scheme in view of its risky nature. A company can reintroduce coconut harvesting as a recognized commercial service.

**Study 25.2: Socio-economic survey on coconut land fragmentation**

After two decades of the last agriculture census in 1982, the Department of Census and Statistics in 2002 carried out the latest agriculture census. According to the latter survey the total land extent under

coconut in Sri Lanka has been reduced from 416 253 ha in 1982 to 394 836 ha in 2002, representing a 5% (21 417 ha) reduction. Therefore the equivalent annual rate of coconut land loss is 1 071 ha (2 645ac). In 1982, Gampaha district was the second largest coconut-growing district in terms of land area under coconut, but in 2002 this district has shifted to the third place because of rapid loosing of coconut lands due to fragmentation.

Among the 24 districts 11 districts, Gampaha, Kegalle, Colombo, Kalutara, Mannar, Puttalam, Kurunegala, Galle, Kandy, Jaffna and Batticoloa were net loosers of coconut lands while the remaining 13 districts were net gainers. The biggest looser of coconut lands was Kurunegala district (15 536 ha) followed by Gampaha (13 919 ha) and Puttalam (5 693 ha). The smallest looser was Mannar (271 ha). The biggest net gainer was Anuradhapura (8 407 ha). Land area under coconut both in smallholders and estate sectors has simultaneously increased in Anuradhapura, Polonnaruwa and Nuwara Eliya districts. Estate sector has significantly shrunk in Kurunegala, Gampaha, Puttalam and Matara districts.

The fragmentation of coconut lands is a continuous process as a result of the increase in demand for industries, housing and industrial development projects. A survey on land fragmentation was conducted in three major coconut-growing areas (i.e. Kurunegala, Puttalam and Gampaha) by the Coconut Research Institute. The findings of the study revealed that the major causes for coconut land fragmentation are high cost of fertilizer, unavailability of labour on time and high wage rates, security problems, reduction of income due to mite infestation, availability of more attractive alternative investments such as selling out land and save the money in a bank as a fixed deposit which generate him a risk free income, to earn funds to go abroad, illnesses of the landowner, family problems due to changing of attitudes in the open economy (e.g. selling out of coconut land to buy a car).

About 90% of the settlers are government employees. They are in the view that since they are very busy with their employment, they have no time to waste searching lands for buying to build a house. Therefore it is easy for them to buy a land from a land developer. On the other hand, the settlers have limited amount of money and with that they cannot afford to buy a 1 - 2 acre land. At the same time the land developers provide facilities to pay on the long-term credit basis, which is a great relief for the settlers even though they pay double the value of the land at the end. Most of the settlers do not like high-rise flats. They would rather like to have house even with a small home garden.

The new settlers have planted more coconut tree, in fragmented portions and maintaining the existing few palms with a great care. So productivity of them is higher. So the net effect of loosing lands due to fragmentation is nullified. Therefore a robust home garden programme such as providing hybrids small fertilizer packs etc. to raise the productivity of home garden coconut of new settlers is important.

Attractive name boards and posters displaying the importance and the value as galore in the survey area were abundant. Land sales are a very profitable avenue of income generation. During the survey, it was also revealed that land prices are higher in towns due to heavy demand for schooling, transport etc.

The ultimate objective of all the development projects is to improve the quality of livelihood. One argument of the land sellers is that they are helping to develop human settlement, which is one of the basic human needs. It is pareto inefficient to meet the increasing land demand for human settlement through the fragmentation of high potential coconut land because the coconut stakeholders are worse off, which ultimately affects national economy. Therefore fragmentation of high potential coconut lands should be minimized in order to achieve the pareto optimum level in developing human settlement schemes.

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**PROJECT 26: ECONOMIC STUDIES TO ENHANCE THE PRODUCTIVITY OF COCONUT LANDS**

**Study 26.1: Economics of monthly harvesting of coconut**

Coconuts are traditionally harvested in Sri Lanka at bimonthly intervals although harvesting in 45 days and in monthly intervals are also practiced to a lesser extent.

Mathes and Marikkar (2004) have established that monthly picking is the best practice due to several rewarding factors. Following table shows the yield increment of month picking.

**Table 14:** ***Average nut yield with respect to harvesting interval in different climatic zones***

| Location | Average Nut Yield/Palm/Year | | |
|---|---|---|---|
| | 30 days picking interval | 60 days picking interval | Incremental Yield |
| Walpita Estate (WZ) | 95.7 | 73.1 | 22.6 (30.92) |
| Rathmalagara Estate (IWZ) | 81.5 | 66.6 | 14.9 (22.7) |
| Poththukulama Estate (IDZ) | 94.1 | 86.2 | 7.9 (9.16) |

Source: Mathes and Marikkar, 2004
Note: Figures in parenthesis are the percentage increase of yield

However, growers are reluctant to adopt this practice due to various reasons. The scarcity of pickers, the extra cost incurred in additional 6 picks and difficulties in paying monthly visits to the estates are some of them. Among these reasons, non-availability of a rigorous economic analysis as to prove that the monthly picking is economically more attractive than bimonthly picking or otherwise is a notable deterrent factor precluding the adoption of the practice. Therefore, the objective of this research brief is to find out the economically best harvesting interval for coconut.

A cost benefit analysis was conducted to compare the net benefit of the two different harvesting intervals. The results revealed that monthly picking is not economical for a landowner of less than 3 acres when the picking activity consists of above-mentioned activities. When the nut price exceeds Rs.14.00 it is economical for them under the given wage rates and other costs. A landholder of above 3 acres is benefited from monthly picking even when the nut price is below Rs.7/-.

The study concluded that; a) economics of monthly picking depends on land holding size, nut price as well as the types of costs incurred b) the largest cost component in this activity is travelling cost and according to that benefit component may differ (for greater than 10 acres category) c) a landowner of less than 3 acres has to decide on monthly picking when the nut price goes down and breakeven remains around Rs.14/-. For others it is economical even at a rate of Rs.7/-.

**Remarks**

This analysis is done using the data of Poththukulama Research Station where the lowest nut increase is recorded compared to other two research stations. The benefit of other two would be higher as the average number of increased nuts was higher.

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## PROJECT 27: ECONOMIC STUDIES ON COCONUT MARKETING ISSUES

### Study 27.1: Analysis of price behaviour of fresh coconuts, desiccated coconut and coconut oil

Price behaviour of desiccated coconut (DC), fresh nuts (retail and farm gate prices) and coconut oil was analysed in terms of the variation in their prices due to seasonal, cyclical, trend and irregular components. Seasonal price behaviour is a regularly repeating price pattern that is completed once in every 12 months. Such a regular pattern might arise from seasonality in demand, seasonality in supply in marketing or a combination of the two. Coconut prices exhibited seasonal variations mainly due to the weather-induced variations in production. Seasonal price fluctuations are regular and predictable to a certain degree. Therefore, strategies based on seasonality such as conversion of fresh coconuts into CNO during crop glut, improved storage facilities of CNO, reducing the influence of DC industry in determining the fresh coconut price and use of efficient methods for coconut milk extraction at household level specially during lean crop periods will help to reduce the problems of acute price fluctuations. The seasonal price index for fresh coconut (farm gate price) price was lowest in June (90.25%) and highest during January (113.25%). The price usually remained above the average during November to March and below the average during April to October. The seasonal variation of DC, coconut oil and fresh coconuts (retail price) prices showed more or less similar pattern as the price of fresh coconut (farm-gate). It is interesting to see that the seasonality in prices is correlated with the seasonality in coconut production. May - August is the glut spells while November - February is the lean spells.

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### Study 27.2: Present status of organic coconut farming in Sri Lanka

World trade of organic and natural products will reach about US $ 100 billion in 2008. The world demand for organic products, which has an annual growth rate of 20-30%, will exceed the supply.
Organic coconut growing in Sri Lanka was started in 1986. Although, organic farming is gaining popularity in Sri Lanka, there are only eight organic coconut growers as in September 2005, collectively having an extent of 700 Ac of certified organic lands scattered in the Northwestern and Western provinces. These growers have obtained the International Organic Certificates (IMO-Switzerland) in 1995. Organic Coconut are processed to organic DC at Ganewatta DC mills, Kurunegala and shipped by Desicolanka Exports on behalf of Rapunzel Naturkost AG, Germany.

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## PROJECT 28: ECONOMIC STUDIES ON IRRIGATION OF COCONUT

### Study 28.1: Socio-economic analysis of gravity flow drip irrigation system in coconut plantations at Rathmalagara Estate

The moisture was found to be the significant factor in determining the coconut yield on aggregate level. This clearly indicates that the investments in irrigation, which facilitates soil moisture improvements during dry periods, would be extremely valuable to increase coconut production at national level. A gravity flow drip irrigation system was established at Rathmalagara Estate in 1996 by the Soils and Plant Nutrients Division of the CRI with the objective of determining the optimum method to overcome drought effect and optimum rate of irrigation for coconut palms. The treatments imposed were: a) $T_1$ - control (no irrigation), b) $T_2$ - husk buried around the palm (1/3 of the manure circle) c) $T_3$ - Irrigation 5 days intervals at 600 l per palm (5 hours wetting period) d) $T_4$ - Irrigation 10 days interval at 720 l per palm (6 hours wetting period), e) $T_5$ - Irrigation at 25 days interval at 1080 l per palm (9 hours wetting period), f) $T_6$ - Irrigation at 40 days intervals at 1200 l per palm (10 hours

wetting period). All the palms in each treatment were applied with 3 kg of APM and 1 kg of dolomite per palm annually and mulched around the base of the palms using coconut fronds. Based on the experimental evidences and over seven years experience of the research, technical and field staff involved in the experiment, $T_5$ was found to be the most appropriate for the coconut plantations. Therefore, $T_5$ was considered for the economic analysis.

The benefit incurred from the project is the increase of nut yield and the incremental cost of the project is the instalment and maintenance of cost of drip irrigation system. Actual data of nine years from 1996 to 2004 was collected and using these data it was projected for another five years ahead. Cost benefit analysis using discounted cash flow technique was employed for data analysis. The net present value and benefit cost ratio of the system was Rs 74 989 and 3.15 at 9% interest rate respectively. The pay back period was 6-7 years.

In addition to the above, a survey was conducted in the Puttalam district, which frequently experiences the uneven rainfall distribution and long dry spells than other major coconut growing areas to explore the farmer perception on drip irrigation systems. The data on farmer perceptions were collected using a structured questionnaire. The adopters were requested to indicate the major factors that influence for adoption of drip irrigation and scored based on highest marks for first choice and lower marks for last choice. Seventy seven percent of the drip irrigation adopters in Puttalam district are having coconut land extent more than 50 acres. Forty three percent of the sample have been irrigated the 80-100% of their total land extent under coconut. Although, it is accepted that drip irrigation is more profitable under intercropping system than monocropping, only few farmers were adopting the intercropping. Forty seven percent of the farmers have drip irrigated bearing palms. The recommended number of dripping points in sandy loam soil and sandy soil is 4 and 6 drippers per palm respectively. The study revealed that ninety-seven of the farmers were irrigating through 4 drippers in sandy soil, which is not sufficient. Tube well is the most common source of water for drip irrigation. Although, CRI has introduced gravity flow drip irrigation using an overhead tank none of the growers in the sample practice this method. Water shortage during droughts secured first rank among the factors associated with the adoption of drip irrigation as perceived by farmers. Economic motive, influence of extension personnel and influence of manufacturing firms were the second, third and forth ranks respectively. Clogging of drippers and pipe system is the major constraint faced by the growers. There is no significant satisfaction about improvement of their coconut yield. Majority of the farmers has adopted

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## 3. RESEARCH PROJECTS FUNDED BY OUTSIDE AGENCIES

### 3.1 Coconut-based adaptive research program (under the Second Perennial Crop Development Project, funded by the Asian Development Bank)

During the period, 96 sites established in 15 administrative districts were well maintained. Data on crop performance and socio-economic aspects of different farming systems were also collected.

Several extension activities were conducted during the period. Among them, the following were significant.

- Three programs for Coconut Development officers of Coconut Cultivation Board on perennial intercropping
- A program for B.Sc. Agricultural students of University of Sabaragamuwa

- A program for students of Agriculture School, Pelwehera
- Several other programs for local/foreign groups at Walpita Demonstration centre, Kotadeneyawa.

A field day was held from 3rd - 4th November 2005 and this was jointly organized by the Coconut Research Institute and Coconut Cultivation Board. Over 6000 participants were attended. Among them coconut growers and school students were the main participants. A permanent demonstration site has been established to demonstrate inter cultivation of perennial intercrops in coconut lands under the financial assistance of this project.

Based on the data collected, several development projects are being continued.

- Dole (Asia) Ltd, for research/development project on Banana and Pineapple
- A joint development project by Kurunegala Plantation Ltd, with Tropical Health Food (Private) Ltd of Germany for planting 1000 acres of pineapple in coconut lands

**Research Progress**

**Coconut**

A bumper crop of coconut is expected in 2006 due to well-distributed rainfall in year 2005. Yield increase of coconut in 2005 in several adaptive research trials were as follows.

**Table 15:** ***Nut yield increase in coconut with improved cultivation practices***

| Status | Nut Yield increase (%) |
|---|---|
| Dolomite application vs. no application | 21.0 |
| Soil moisture conservation vs. no conservation | 32.0 |
| Organic fertilizer vs. inorganic fertilizer application | 18.0 |
| Intercropping vs. no intercropping | 27.0 |

**Cashew**

This was a very adaptable intercrop particularly in Gampaha, Hambantota, Kurunegala and Puttalam districts. Cashew was able to produce 6.0 kg of nuts/tree/year under coconut. Soil analysis showed that there was no nutrient exporting pattern due to inter cultivation of cashew. Helopeltis was the major pest affected on cashew yield.

**Cinnamon**

This was an attractive intercrop among coconut growers mainly in the Southern region. Trials showed that cinnamon could be grown successfully in the Gampaha, Kurunegala and Kegalle districts too. Average yield of cinnamon under coconut was 350 kg/ha/year and minimum of Rs. 880,000 per ha could be obtained as profit. There were no constraints for cultivation (i.e. pest, diseases) except the scarcity of skilled labour for processing

**Rambutan**

The project was able to introduce this crop even in areas of Kegalle, Akuressa, and Passara, Change of fruiting season was observed and hence year around production could be planned based on planting Rambutan in different agro-climatic regions. Price of a fruit was remained at Rs. 6/- and this was able to generate a profit of Rs. 9000/- per tree/year.

**Cocoa**

Cocoa can create a favourable agro-climate in coconut lands by adding leaf litter, increasing microbial activity, increasing earthworm activity, etc. Current price is also attractive and is Rs. 160/- per kilo of beans.

**Pepper**

From the beginning of the project, pepper was the most popular intercrop but continued low price over two years discouraged farmers for expansion of pepper as an intercrop in coconut lands.

**Banana**

Dole (Asia) Ltd. expanded cultivation of banana over 1200 acres with the Kavendish variety. Technology of cultivation from planting to harvesting and marketing has been further upgraded (i.e. bunch management etc.).

At the end of 31 December 2005, project was scheduled to terminate officially. However, maintenance and data collection of the most promising sites (approximately 40) will be continued in the year 2006 under the program of the Coconut Research Institute.

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### 3.2 Development of sustainable coconut-based income generating technologies in poor rural communities - IPGRI Project

The project on "Livelihood and natural resources restoration for tsunami victims in Dodanduwa, Sri Lanka" was implemented at Dodanduwa, Sri Lanka with the objective of restoring income generating activities of CBO members in Dodanduwa and nearby communities to establish CBO managed community activities that would foster enhanced food security and nutrients; and to restore natural resources which includes crops, animals, soil and water; and mangroves.

Under this project, two training activities on home garden farming systems (vegetable nursery beds, compost production and vegetable cultivation) were completed. Sixty rope making machines, 20 doormat making equipments with toolkits and coconut fibre were distributed among CBO members to produce coconut fibre ropes and doormats immediately. They are now earning about US $ 1-3 per day.

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

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## 4. Self-financed projects

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

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

At present, fuel wood plantation covers 18 hectares with 30,000 and 5,000 gliricidia and acacia trees respectively. The production details are given in Table 15.

The total marketable wood yield has increased by only about 1% compared to the previous year. However, the increase in net profit is about 44% compared to the previous year mainly due to the reduction in total expenditure related to maintenance and operation of the plantation.

**Table 16:** ***Production details of the fuel wood plantation, Pallama Seed Garden***

| Description | |
|---|---|
| Number of harvests during the year | 2 |
| Wood yield per tree/yr | 13.6 kg |
| Total wood yield | 135, 165.0 kg |
| Total income | Rs. 267, 803.50 |
| Total expenditure | Rs. 205, 553.08 |
| Net profit | Rs. 62, 250.42 |

The project is being continued.

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## 5. Miscellaneous Studies

### 5.1 Demonstration farm, Thabbowa, Nattandiya

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

During the year, 18,295 coconut seedlings worth of Rs. 594,455.22 were issued. The farm had a net profit of Rs. 196,653.28 in year 2005 (Table 16).

**Table 17:** ***Annual income and expenditure of demonstration farm, Thabbowa***

| Income | | | Expenditure | |
|---|---|---|---|---|
| **Item** | **Quantity Nuts/Seedlings** | **Value Rs.** | **Item** | **Value Rs.** |
| a. Sale of coconut | 26,683 | 323,709.21 | a. Labour | 291,820.15 |
| b. Sale of coconut seedlings | | | b. Others | 94,100.89 |
| | | | c. Materials | 7,940.00 |
| Poly bagged T x T | 4,259 | 255,540.00 | d. Electricity | 370,758.29 |
| D x T | 1,078 | 64,680.00 | e. Seed nuts | |
| R.D | 21 | 1,260.00 | | |
| K.C | 68 | 4,080.00 | | |
| Bare rooted T x T | 7,965 | 238,950.00 | | |
| D x T | 395 | 11,850.00 | | |
| Other | 4509 | 18,094.75 | | |
| C. Sale of other crops | | 43,109.47 | | |
| **Total Income** | | 961,273.43 | | 764,620.15 |
| **Profit:** | | **196,653.43** | | |

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### 5.2 Animal breeding program

An animal-breeding programme each at Maduruoya and Pothukulama is being continued to provide improved breeds of buffalo and goats for coconut growers. The number of male and female heads remained at each site at the end of the year are given below.

**Table 18:** ***Animal breeding program***

| Place | Breed | Adults | | Calves | | Total | |
|---|---|---|---|---|---|---|---|
| | | F | M | F | M | F | M |
| Maduruoya | Moora | 27 | 09 | 06 | 05 | 33 | 14 |
| PRS | Sri Lankan Boer | 55 | 12 | 05 | 06 | 60 | 18 |

*H A J Gunathilake and S H S Senarathne*

## 6. Acknowledgements

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## REPORT OF THE GENETICS AND PLANT BREEDING DIVISION

**Head - Lalith Perera (PhD, UK)**

### GENERAL

Establishment of two multi-locational experiments to evaluate the performance of the crosses dwarf brown x tall and its reciprocal and dwarf brown x san ramon and establishment of tall x dwarf brown as adaptive trials in farmers' fields, initiation of the development of a land suitability map for hybrid coconut cultivation based on the results of long term multi-locational evaluation of cultivar experiments, screening of coconut varieties for resistance/tolerance to *Aceria* mite and identification of Sri Lanka dwarf yellow variety as a tolerant variety for future breeding, field planting of exotic coconut germplasm, identification of suitable varieties for beverage purpose, development of DArT DNA markers for coconut, development of a molecular marker system for hybrid identification are the research highlights of the Genetics and Plant Breeding Division in the year 2005. Establishment of coconut Seed and Seedling Certification Unit, establishment of a drip irrigation facility and establishment of a database at the Genetic Resources Centre at Ambakelle, selection of plus palm estates for supply of seeds for the national replanting programme from the North and East, development of research linkage between CIRAD, France and CRISL towards construction of coconut genome map are some of the other noteworthy achievements during the year. The on going long term experiments, genetic evaluation of existing cultivars, evaluation of progenies and evaluation of new cultivars in farmers' fields and maintenance of the gene banks were continued successfully during the year.

Analysis of long term yield data at the Bandirippuwa site confirmed the superiority of dwarf x tall hybrid coconuts over the tall cultivars even under average management conditions and further during moisture stress. However, as only about 5% of the annual seedling requirement of the country is met with hybrid seedlings at present, an initiative was taken to develop a land suitability map and land classification, for growing hybrids in collaboration with Soils and Plant Nutrition division, considering soil factors, drainage, water availability and rainfall, in order to direct hybrid seedlings to high potential areas to obtain the maximum yield of about 21,320 nuts/ha (200 palms/ha densit) under rainfed and average management conditions. About 100,000 ha in wet, dry and intermediate zones have been tentatively identified as suitable lands for growing hybrids in large scale under rainfed and average management conditions.

A new project in collaboration with Crop Protection Division was commenced to screen coconut varieties and improved cultivars for their resistance/tolerance to *Aceria* mite in order to develop/identify mite resistant/tolerant coconut cultivars. It was found that dwarf yellow variety is generally tolerant to *Aceria* mite. Many dwarf yellows showing very high degree of tolerance to *Aceria* mite at ISG were identified for future breeding. It was found that in tolerant dwarf yellows initiation of symptoms is similar to susceptible tall varieties but the population count of *Aceria* was significantly low. This envisages the usefulness of studying the biochemical differences between the nuts of susceptible cultivars and resistant dwarf yellows. Preliminary results indicated that variety Gon Thembili also had low incidence of symptoms initiation and expression.

During the year, two new hybrid evaluation trials, as multi-locational experiments to evaluate new crosses, dwarf brown x tall and its reciprocal and dwarf brown x san ramon were established at Rathmalagara estate, Madampe and in a private estate in Wanathawilluwa. Growth measurements and physiological data were collected from the previously established site at Raddegoda.

Three adaptive trials with tall x dwarf brown, two in farmers' fields, one in Ampara and the other in Yakalla and another at Dunkannawa estate owned by CRI were also established during the year in addition to 40 farmer fields established using tall x san ramon (34 sites) and dwarf green x san ramon (6

sites). For the first time adaptive trials were established in the districts of Hambantota (4 sites), Galle (4 sites) and Ampara (5 sites).

Under the germplasm collection and conservation programme of the division, one new germplasm was collected from Muthiyanganaya Raja Maha Viharaya from Badulla this year. Morphological characterization of stem, inflorescence, fruit and leaves were continued for 28 palms from 4 different phenotypes identified and collected from Unawatuna area last year. Comparable data were also collected from 6 other known coconut forms. A pollination programme was drawn to purify and multiply 13 of new coconut phenotypes during the year and 247 nuts were harvested and laid in the nursery. Hundred and ten coconut seedlings of Indian and PNG origin, imported as embryos were raised *in vitro* at the Tissue Culture Division last year, were also field established this year for the first time in the field no. 4 of the Bandirippuwa estate. Maintenance of all the other gene-banks and pollination programmes to multiply indigenous coconut varieties to establish a new site at Margaret estate for local germplasm collection was also successfully continued during the year.

A new project on assessment of the genetic variation in coconut varieties with the potential for use in the tender nut industry supported by CESS fund was commenced this year. As there is an increased awareness for natural beverages worldwide, an attempt was made to identify some less known coconut cultivars for beverage purpose with varying nut water quality, in addition to the known variety king coconut. Twelve coconut phenotypes were identified to be potential coconut types to be used for beverage purpose. A detailed study on the morphological variation of these coconuts in relation to the nut production and water quality is underway in collaboration with the Plant Physiology division.

The highlights of the molecular work of the division during the year were development of DArT markers, development of a DNA fingerprinting system for hybrid identification, and the progress made with regard to the genome mapping. The Diversity Arrays technology (DArT) is the most recent, high throughput molecular marker technology, which has been developed for a few crops already. For the first time, 347 such markers were developed for coconut by a researcher of the division as a part of DArT marker development project for orphan crops funded by IPGRI under the Generation Challenge Programme. This enrichment of the DNA marker pool for coconut will be immensely useful in research involving coconut genome mapping at CRISL and elsewhere. Two SSR primers for the PCR which are capable of discriminating hybrids from pure varieties and discriminating two hybrids dwarf green x tall and dwarf yellow x tall were identified as an accomplishment of Swedish funded project during the year. Pollination programme for the development of a mapping population for coconut between dwarf red and tall terminated this year and 640 nuts resulting from pollination were laid in the nursery. Germinated nuts were transplanted in polybags and they were transported to the green house for evaluation of variation for physiological parameters. During the year research linkage was developed between CIRAD, France and CRISL towards construction of coconut genome maps by both segregating mapping population approach and by association mapping approach. Genotyping a whole association mapping population from Vanuatu using 30 selected SSR markers, previously identified as closely located with QTLs for nut and fruit components using another map, was done at CIRAD, France by a researcher from the division this year. The same SSR markers are expected to be used to genotype mapping population at CRISL, then align the two maps and compare and confirm the locations of tentatively identified QTLs for nut number and fruit components.

The highlight of the development activities of the division this year was the establishment of a Seed & Seedling Certification Unit within the division with the objective of monitoring the entire coconut seedling production programme and certification of coconut seedlings. A Seed & Seedling Production and Certification Officer and eight Seed & Seedling Production and Certification Assistants were recruited this year. During the year, several plus palm estates were identified. Identification of plus palm estates from North and East was a noteworthy progress made during the year, which made it easy to supply the

seed nut requirement of the region. With assistance from CESS, upgrading of the ISG was continued. Establishment of drip irrigation facility at ISG with a view of boosting the hybrid seed production was a great achievement this year. Development of a computer database at the ISG was also initiated and some refinements to identification of palms for emasculation based on computer programme were introduced. In the year, completion of 50 years to ISG was celebrated and the founder and the past managers were felicitated.

**Detailed Report**

**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 (BE) | 1983 | Sandy Loam | Wet intermediate |
| 12.1.2 | Thammenna (TE) | 1983 | Latasol | Dry |
| 12.1.3 | Palugaswewa (PE) | 1985 | Sandy clay loam | Dry intermediate |
| 12.1.4 | Suriyapura (SE) | 1986 | Lateritic-gravel | Wet |

Yield recording (nuts/palm/pick) continued at sites BE and SE during the year. Compiling and computerizing of early growth measurements, flowering data, yield and fruit components data collected pick wise over several years at sites BE, TE and SE were in progress. Nut yield from 1994 to 2004 (Figure 1) and nut components data from 1994 to 2001 from all cultivars at BE site was critically analyzed during the year. Yield data (nut number) analyzed for BE site average over 11 years from 11 years after planting in 1994 to 22 years after planting in 2004 and nut yields in 1997 and 2002; the years that followed severe droughts in 1996 and 2001, nut yield average over 9 years excluding the drought affected years and nut yields in 1998 and 2003; the years that followed drought affected years showing recovery from drought are presented in Table1.

**Table 1:** *Comparative performance of five improved coconut cultivars at BE site under average management condition (nuts/palm) and their response to favorable and unfavorable weather conditions.*

| Cultivars | Mean nut yield (1994-2004) | Mean nut yield (1994 - 2004 excluding 1997 & 2002) | Mean nut yield (1997) | Mean nut yield (2002) | Mean nut yield (1998) | Mean nut yield (2003) |
|---|---|---|---|---|---|---|
| **DGT** | 68 a | 74 a | 44 a | 43 a | 53 ab | 56 b |
| **DYT** | 65 b | 71 b | 44 a | 36 b | 61 a | 72 a |
| **TT** | 49 c | 53 c | 32 b | 29 c | 45 bc | 44 c |
| **MT** | 42 d | 45 d | 31 b | 30 c | 39 c | 39 c |
| **PPT** | 48 c | 52 c | 34 b | 33 bc | 54 ab | 44 c |

(Means with same letters are not significantly different, $p<0.0001$)

(DGT – Dwarf green x tall, DYT- Dwarf yellow x tall, TT – Tall x Tall, MT- Moorock tall, PPT-Plus Palm tall)

At the BE site under average management conditions both DGT and DYT clearly outperformed all tall cultivars in terms of nut number average over 11 years including both favorable and unfavorable years (1994 & 2004). The mean yields of DGT and DYT were significantly different and the yields were 68 and 65 nuts/palm/year respectively when compared to 49, 48 and 42 nuts/palm/year in TT, PPT and MT respectively. The yield between TT and PPT were not significantly different. The % yield increase in hybrids average over DGT and DYT was as high as 44% over average yield of all tall cultivars. When only the favorable years were considered DGT and DYT produced 74 and 71 nuts /palm/year respectively with statistically significant difference compared to 53, 52 and 45 nuts/palm/year in TT, PPT and MT, yet again with no significant difference between TT and PPT. Among hybrids, DGT produced marginally but statistically highly significant yield (3 nuts/palm/year or 600 nuts/ha/year) than DYT and the % yield increase of DGT over DYT was 4.2%.

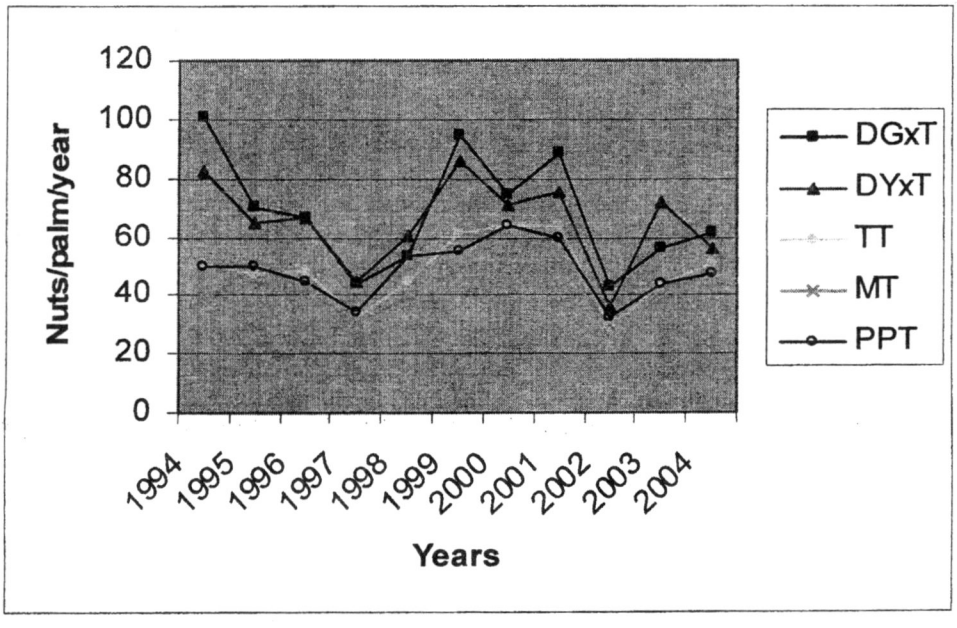


**Figure 1.** *Average yield (Nuts/palm/year) of different cultivars from 1994 to 2004*

Year 1996 and year 2001 were drought years at BE site and a high level of sensitivity to moisture stress was observed in all cultivars under evaluation as reflected by about 39% average yield reduction averaging over all cultivars compared to that of favorable years during the years that followed the drought years. The sensitivity of hybrids to moisture stress was observed to be higher compared to tall cultivars as reflected by the % mean yield reduction, which was 42% in hybrids and 36% in tall cultivars. Among the two hybrids the sensitivity to drought was observed to be higher in DYT compared to DGT and it was 9.4% more yield reduction than DGT. Although the sensitivity of hybrids to drought is higher in magnitude compared to tall cultivars, it is interesting to note that hybrids were capable of maintaining almost the same or a little higher yield than that of tall cultivars even during the years that follow drought years. The mean yield recorded by two hybrids and all tall cultivars during drought-affected years (1997 & 2002) were 44 and 40 nuts/palm/year respectively. This fact indicates that hybrid coconuts can be grown even in drought prone areas under average management conditions to obtain a higher yield than growing tall cultivars.

The recovery of coconut cultivars under evaluation from drought as reflected by their yield increase in the years that followed drought affected years in 1998 and 2003 (Table 1) indicated that DYT recovers from the drought much faster than all other cultivars though DYT is the most sensitive cultivar to moisture stress. However, DGT catches up fast and produces more nuts than DYT once the weather become favorable.

The mean nut yields of all cultivars over the years from 1994 to 2004 were examined to observe the highest achieved yield of each cultivar. DGT demonstrated the highest achieved yield of 20,200 nuts/ha/year in 1994, followed by DYT giving 18,975 nuts/ha in 1999. The highest achieved yield of TT, PPT and MT were 12,780, 12,600 and 11,000 nuts/ha/year respectively and these were achieved in year 2000.

The results of the analysis of fruit component data of the five cultivars under evaluation are given in Table 2. The data indicates that DGT and DYT produced 11.6% and 9.3% less kernel content per nut than TT cultivar. However this reduction in kernel content was more than compensated by the 40% and 34% nut yield increase in DGT and DYT respectively making hybrids still the better cultivar in terms of total kernel production per unit area in this particular site. DYT produced 2.33% more kernel than DGT, but this too is compensated by about 4% yield increase of DGT over DYT making DGT still the best cultivar as far as the total kernel production per unit area is concerned (Table 1).

The effect of drought in 1996 on fruit components was observed to be much less compared to its effects on nut number (Table 1) as demonstrated by only 5.67%, 3.45% and 4.4% kernel weight reduction in DGT, DYT and TT respectively. This indicates that even hybrids are capable of maintaining the fruit weight during dry period with the expense of its nut number.

**Table 2:** ***The results of the analysis of fruit component data from 1994 to 2001 excluding the data for 1997. The fruit component data during 1997 is given within brackets for comparison.***

| Fruit component / Cultivar | Fruit weight (g) | Husked nut weight (g) | Split nut weight (g) | Kernel weight (wet basis) g/nut | Kernel weight (wet basis) Mt/ha |
|---|---|---|---|---|---|
| **DGT** | 1250 d (*1225 c*) | 690 e (*654 d*) | 516 e (*470 d*) | 341 e (*322 c*) | 5.04 |
| **DYT** | 1362 c (*1295 c*) | 730 d (*708 c*) | 542 d (*508 c*) | 349 d (*337 c*) | 4.92 |
| **TT** | 1490 b (*1432 b*) | 805 b (*769 ab*) | 598 b (*574 b*) | 381 b (*364 b*) | 4.01 |
| **MT** | 1630 a (*1555 a*) | 847 a (*792 a*) | 631 a (*600 a*) | 408 a (*384 a*) | 3.67 |
| **PPT** | 1458 b (*1411 b*) | 757 c (*741 bc*) | 576 c (*558 b*) | 371 c (*360 b*) | 3.85 |

The results confirmed the superiority of two hybrids than all the other tall cultivars in BE site. Moreover results also confirmed the TT and PPT are not significantly different in terms of both nut number and kernel content per nut and are superior over MT among tall cultivars tested. The decrease in nut number in MT did not compensate for the increased kernel content of MT as the % reduction of nut number in MT was greater than that of its kernel content.

This particular site at BE is categorized as class 2 soil, having sandy loamy soils. However the site did not receive any special treatments such as husk pits or irrigation during drought. Therefore the results of BE site alone tend to suggest hybrid coconut as a suitable cultivar for growing in large extent of coconut growing areas. However as analysis of data from all the sites is in progress to study the cultivar x site interaction, a firm and specific recommendation on suitable cultivars for different locations will be made in early 2006.

Though hybrids could be grown in any soils and any climatic conditions based on the results of this experiment, obviously highest potential of hybrids can only be achieved when they grow in favorable environment with better agronomic follow up with high input agriculture. Therefore and as only about 5% of the annual seedling requirement of the country is met with hybrid seedlings at present, an initiative was made during the year to develop a land suitability map and land classification map for hybrids giving due considerations for soil factors, drainage, water availability and amount and distribution of rainfall, duration of solar radiation etc. to identify high potential areas for hybrids in order to obtain the maximum potential yield from hybrids to increase the national yield by increasing the productivity without going for area expansion. The work is in progress in collaboration with Soils and Plant Nutrition division.

Since sufficient data has been gathered from the site at BE, it was decided to discontinue this trial as a research experiment. However, this site will be continued as an observational trial as long as possible with maximum inputs (husk pits, irrigation during drought etc.) to harness the full potential of each cultivar at this site. Yield data would also be recorded as this site could still generate valuable information with respect to yield, climate and the age of palms.

Since sufficient data has not been taken from SE site, continuation of collection of yield data will be done at SE site.

*C K Bandaranayake, L Perera, W B S Fernando, M H L Padmasiri and R B Attanayake*

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

**Experiment 12.1.2:** **Evaluation of CRISL98 (tall x san ramon) and Kapruwana (dwarf green x san ramon) under farmer conditions**

Production of CRISL98 was continued by hand pollinating 100 tall palms at Isolated Seed Garden (ISG) with san ramon pollen from palms at Potthukulama Research Station. Seedling issue for planting was done after inspecting the field and the extent of the sites was restricted to a minimum of one acre and a maximum of two acres. A total of 5,639 seedlings were issued to 34 interested growers, 9 in Puttalam district, 4 in Kurunegala district, 2 each in Gampaha and Matale districts, 1 each in Kegalle, Kaluthara, Anuradhapura and Colombo districts and further for the first time to 4 farmers each in Hambantota and Galle districts and 5 farmers in Ampara district. Monitoring of these sites was in progress.

Production of Kapruwana was continued at ISG during the year by hand pollinating 50 dwarf green palms with san ramon pollen. The seeds were raised at ISG and issued to growers on the same conditions set out for issuing CRISL98. During the year, 1,177 Kapruwana seedlings were issued to 6 growers one each in Kurunegala, Matale, Puttalam and Kegalle districts and to 2 growers in Kandy districts.

*L Perera, CK Bandarnayake, N Herath and S A S 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) at Ambakelle and Maduru Oya Seed Garden (1995)**

The experiments at ISG and MOSG completed 14 and 12 years after planting respectively. These families are still maintained as observational trials until they reach the yield stabilizing at the age of about 15 years to commence yield recording and fruit components and assessment of physiological parameters. It is expected to identify a set of drought tolerant palms at ISG for future breeding, looking at the performance of the full-sib families during the drought and to estimate the heritability values for moisture stress related physiological traits. The response to drought will be studied via nut number produced, number of bunches produced and the size of the nut assessed by the weight of the husked nut as well as through water-use-related physiological parameters.

*L Perera and M H L Padmasiri*

**Experiment 12.7.3:** **Evaluation of dwarf green x Debarayaya tall (Raddegoda)**

This trial maintained satisfactorily and yield data recording from this trial continued.

*C K Bandaranayake, L Perera and G K Ekanayake*

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

This trial maintained satisfactorily as an observation trial.

*S A C N Perera and N Herath*

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

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

No of palms/variety/Block: 30 palms

*Locations and agro-climatic conditions*

| Location | Year of establishment | Soil type | Agro ecological zone |
|---|---|---|---|
| Bandirippuwa | 1986 | Loamy sand | Wet intermediate zone |
| Ratmalagara | 1986 | Lateritic | Dry intermediate zone |
| Andigama Mudalihamy | 1986 | Sandy Loam | Dry intermediate zone |
| Mangala Eliya | 1987 | Loamy sands | Dry zone |
| Daisy Valley | 1987 | Clay loam | Wet intermediate zone |

Crosses: tall x dwarf green (T x DG), tall x tall (T x T), tall x san ramon (T x SR), dwarf green x tall (DG x T) (only at Daisy Valley site), dwarf green x san ramon (DG x SR) (only at Daisy Valley site and observation trial at Puras block in Andigama), Open pollinated tall (OP) (only at Mangala Eliya site)

This multi-locational trial completed 19 years in the first three experiments established at Bandirippuwa, Ratmalagara and Andigama (Mudalihamy) sites in 1986. Based on the results of the evaluation of crosses in this experiment, two new cultivars; CRISL 98 (tall x san ramon) and Kapruwana (dwarf green x san ramon) were released to the industry in 1998 and 2004 respectively. However, recommendation of the Kapruwana was based only on the yield and fruit component data at a single site, Daisy Valley and as that particular site is located in a low laying area with adequate soil moisture through out the year, the response of Kapruwana to moisture stress could have not been evaluated. The only other site where this particular cross was replicated in a statistically designed trial was found in the Puras block at Andigama, Giriulla. This site represents lateritic soils categorized as class 4 soils for coconut cultivation and is in Dry intermediate zone. This site has been abandoned for several years due to poor performance of crosses due to bad maintenance but recently some improvement in the growth of palms was observed at this site. Hence during the year the site was rehabilitated by application of organic manure and establishment of good mulch. Yield and fruit component data from this site will be collected from 2006 for two consecutive years to make some fine recommendations to the existing recommendation for Kapruwana.

Collection of yield and fruit component data were continued at Daisy valley site as this site could still generate valuable information related to yield potential and age of palms.

The Yield recording of Andigama Mudalihamy site was terminated some years ago due to theft of nuts and hence that site had not been considered when recommending the CRISL98 cultivar. This site however, is the only site that represents sandy loam soil in dry intermediate zone and hence yield recording through button counting was proposed for two years commencing from 2006. This is to study the yield potential of the crosses in this particular environment to assess the cultivar x site interaction.

The analysis of previous results clearly indicated the dominance of the hybrids T x DG, DG x T and DG x SR in terms of nut production. The cultivar T x SR produced the highest per nut copra content. However, the major feature is the superiority of the hybrid DG x SR in terms of copra production per palm. Higher per nut copra content of San Ramon has been combined perfectly with the higher nut number of Dwarf green for this variety to surpass the per palm copra production of all the other cultivars tested so far.

*S A C N Perera L Perera, N Herath, R Jayathilake, and W B S Fernando*

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

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

*Locations and agro-climatic conditions*

| Exp. N0. | Location | Year established | Soil type | Agro-ecological zone |
|---|---|---|---|---|
| 4.1 | Raddegoda Estate | 2004 | Clay Loam | Dry intermediate |
| 4.2 | Ratmalagara Estate | 2005 | Lateritic gravel | Dry intermediate |
| 4.3 | Wanathawilluwa | 2005 | | Dry zone |
| | Bandirippuwa Estate | Proposed in 2006 | Lateritic | Wet intermediate |

During the year two more trials, one at Ratmalagara estate, Madampe and another at Wanathawilluwa were established. All trials were maintained satisfactorily.

As only a limited number of dwarf brown palms were used in the pollination programme for producing these new crosses, the palms showed some stress due to prolong pollinations. Therefore pollination program was terminated at the end of year, in order to give a rest to all palms.

During the year, growth measurements (girth, height and rate of leaf production) were recorded twice, at the age of 6 months after planting and a year after planting and physiological parameters once at the age of one year after planting at the Raddegoda site. However some initial variation for height and girth among varieties was anticipated in this trial, because seedlings of different varieties were produced at two different nurseries, Bandirippuwa estate and Ambakelle seed garden, girth and height measurements taken at 6 months after planting was considered as the covariate in analyzing the data collected from this trial to study the varietal differences one year after planting. However as the rate of leaf production is independent of initial growth differences, only rate of leaf production was analyzed at two stages of measurements. Tall x dwarf brown showed the highest mean height followed by tall x san ramon and

dwarf brown x tall. The same trend was observed in tall x dwarf brown for girth at collar also. However the rate of leaf production between hybrids/cultivars 6 months after planting was not significant between cultivars, but after one year the measurements were observed to be significantly different (Table 4). According to the results, dwarf brown x san ramon showed the highest rate of leaf production followed by tall x dwarf brown, dwarf brown x tall, dwarf green x san ramon, dwarf green x tall, tall x san ramon and tall x tall. However leaf production rate between tall x dwarf brown, dwarf brown x tall, dwarf green x san ramon, dwarf green x tall, tall x san ramon and tall x tall were not significant.

**Table 4:** ***Mean height, girth and rate of leaf production taken one year after planting at Raddegoda Estate***

| Variety | Mean rate of leaf production | Mean height | Mean girth |
|---|---|---|---|
| dwarf brown x san ramon | 0.75 a | 211.96 c | 29.39 de |
| Tall x dwarf brown | 0.61 b | 240.28 a | 37.86 a |
| dwarf brown x tall | 0.60 b | 223.53 abc | 31.19 cd |
| dwarf green x san ramon | 0.60 b | 216.62 bc | 33.05 bc |
| dwarf green x tall | 0.60 b | 213.25 bc | 31.36 cd |
| Tall x san ramon | 0.56 b | 236.24 ab | 36.29 ab |
| Tall x tall | 0.49 b | 190.45 d | 27.16 e |

(Means with same letters are not significantly different, $p<0.0001$)

Evaluation of these crosses under moisture stress based on physiological parameters showed significantly higher ($P < 0.0001$) stomatal conductance for both dwarf brown x tall and tall x tall compared to the other five cultivars tested. This higher conductance for gases and water vapour is reflected by the highest rate of transpiration observed in both dwarf brown x tall and tall x tall. Leaf temperature was significantly low in dwarf brown x tall probably because of the cooling effect due to higher transpirational flow. Dwarf brown x tall maintained the highest rate of photosynthesis also possibly due to facilitation for gaseous exchange due to the highest stomatal conductance. However, this difference was not statistically significant due to the large variation of the rate of photosynthesis observed between palms. No significant differences were observed between cultivars with respect to leaf chlorophyll content. Thus it appears that the differences in photosynthetic capacities between cultivars may be due to the differences in stomatal conductance.

The measurements under moisture stress would show the ability or inability of a particular cross or variety to retain its full potential for growth and productivity or a fraction of it with the progress of the moisture stress. Therefore the evaluation of crosses or varieties under no moisture stress, to identify the full potential of different hybrids/cultivars for growth and productivity, as indicated by the rate of photosynthesis is necessary for meaningful data interpretation. Thus taking physiological measurements from these crosses in multiple locations when seedlings are under no moisture stress followed by naturally under substantial moisture stress at predefined time intervals with the progress of moisture stress (drought) was foreseen as necessary. As it was also found that complementary data from pure dwarf brown at the same environmental condition is vital for the purpose of comparison of the performance of crosses, sufficient number of pure brown dwarf seedlings at comparable age will also established along side of the each trial at a later stage. Evaluation dwarf varieties in a separate experiment carried out by Plant Physiology division during the year found that out of the three dwarfs tested (dwarf green,

Cameroon red dwarf and brown dwarf), brown dwarf appeared more resistant to environmental stress condition with the ability to maintain higher rate of photosynthesis even under moisture stress.

Three adaptive trials about one acre in size in two farmers' fields; one in Ampara and the other in Yakalla; and another adaptive trial at Dunkkannawa estate of CRI using tall x dwarf brown, were also established during the year.

*L Perera and R Jayathilaka*

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

At present, coconut mite (*Aceria guerreronis*) is a serious problem in many countries including Sri Lanka. There is no proper control method identified so far for this problem anywhere in the world. Application of several chemicals, plant extracts and application of burnt engine oil treatment have been imposed to control coconut mite in Sri Lanka, but they have neither being effective nor practical. Biological control methods are being tested by the relevant division. In the mean time, it was felt that breeding for mite resistance/tolerance as important for a persistent solution for the problem. It has been observed that the different varieties and different genotypes of coconuts are showing different levels of resistance/susceptibility to coconut mite infestation. This has inspired an interest to commence a survey to screen different varieties and genotypes for mite resistance. Therefore, the objective of this study is to screen varieties having mite resistance/tolerance and initiates a breeding program to develop mite resistant coconut cultivars. A study to identify association of molecular markers to the mite resistance character will also be carried out in parallel.

This new project was commenced in 2005 in collaboration with Crop Protection division. The initial work of this experiment was screening of different coconut varieties for resistance/tolerance against coconut mite and identification of parents for development of coconut cultivar/hybrid for resistance/tolerance to mite.

For the screening, three parental coconut varieties at the Isolated Seed Garden Ambakelle, namely Sri Lanka dwarf yellow, Sri Lanka dwarf green and Ambakelle tall and three varieties at Bandirippuwa estate, namely gon thembili, san ramon and ordinary tall were considered. Isolated Seed Garden has been severely affected by mite when the measurements were taken and hence assessment of the damage caused by mite had been easy.

Population levels and damage initiation in the fourth and fifth bunch and crop loss at harvest were taken into consideration in assessing the level of mite tolerance. Harvests recorded in June 2005 showed that the crop loss due to mite damage is significantly low in dwarf yellow (7.32%) compared to dwarf green (22.3%) and Ambakelle tall (13.7) at the Isolated Seed Garden. As the green dwarf variety had been treated with used engine oil to control mite population, the population level and the symptoms initiation was recorded only for dwarf yellow and Ambakelle tall. Data showed that there was no significant difference between the two varieties with respect to the initiation of symptoms but the level of mite population and the damage caused was significantly high in Ambakelle tall compared to yellow dwarf. In the dwarf yellow population within the Isolated Seed Garden, the extent of damage observed varied among palms, many palms showing very low extent of damage due to mite while only a small number of

palms showing a significantly high damage. Palms with no or less symptoms were identified by a survey and marked for future breeding.

It was also noted during the survey that there is a substantial morphological diversity among dwarf yellow palms at Isolated Seed Garden, though a uniform population is expected in self-pollinating dwarfs such as dwarf green found in the same location. Hence it was decided to characterize the whole dwarf yellow population at the isolated seed garden morphologically as well as at molecular level using SSRs. This will provide an opportunity to see whether there is any strong association between morphological trait and mite symptom expression and also to evaluate whether morphological diversity is reflected at the molecular level.

The preliminary results of the evaluation of gon thembili, san ramon and ordinary tall, indicated that gon thembili has a lower incidence of symptoms initiation and subsequent damage expression in the fourth bunch, compared to others. The results are preliminary but are interesting and will be monitored during 2006. Further the morphological characters of the nuts will be examined to identify the mechanism behind this tolerance in gon thembili. Yield data will be recorded to assess the status of mite damage in the varieties at harvest.

Further the same study was extended to Thammanna Estate in Puttalam, where five improved coconut cultivars are being evaluated. Only the three cultivars dwarf yellow x tall, dwarf green x tall and tall x tall were under study for mite damage assessment exercise. Damage assessment in the fourth bunch and harvest records were obtained. Two characters that would lead to the tolerance were investigated. These characters were nut shape as measured by ratio of length to breadth and the tightness of perianth leaves to the nut surface. The same experiment was extended to the observational trial planted at Ratmalagara Estate where a new cross dwarf yellow x san ramon is being evaluated along with dwarf green x san ramon.

*L Perera, I R Wickramananda (CPD), H J M Kusumasena (Makandura University) S R Sarathchandra(University of Ruhuna), S Mayadunne (CPD) and W M Pushpakumara (CPD)*

**PROJECT: COCONUT GENOME MAPPING (CESS ASSISTED PROJECT)**

During the year 2005, all 33 dwarf red palms which were used as female parents for generating the segregating population last year were genotyped by 18 SSR primers and confirmed 26 out of 33 red dwarf palms as identical for all loci analyzed. Seeds arose from pollination of other non-identical 7 palms were discarded. The pollination programme was terminated this year after obtaining 640 nuts resulting from pollination of 26 red dwarf palms and they were laid in the nursery. Germination data were recorded and germinated nuts were transplanted in polybags and were transported to the green house for characterization for both morphological and physiological parameters of seedlings. Genotyping of the mapping population using SSR, DArTs and AFLP markers is expected to be carried out in years 2006 and 2007 to develop the framework map of coconut for these families.

During the year, a collaborative program was developed between CIRAD, France and CRISL towards construction of a coconut genome map by using segregating mapping population approach and association mapping approach. Genotyping the entire association mapping population from Vanuatu using 30 selected SSR markers, previously identified as closely located with QTLs for nut and fruit components using a another map developed at CIRAD, was done at CIRAD, France by Dr. C Bandaranayake, Senior Research Officer of the division at CIRAD this year. The same SSR markers are also expected to be used to genotype the mapping population at CRI described above and then align the two maps and compare and confirm the locations of tentatively identified QTLs for nut number and fruit components.

*C K Banadaranayake, W B S Fernando and A Fernando*

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

## ENRICHMENT OF COCONUT GERMPLASM

### Importation of Coconut Germplasm (CESS assisted project)

One hundred and twenty six coconut plants arising from embryos brought from India (4 coconut varieties) and 59 brought from Papua New Guinea were successfully field planted at Field 4, Bandirippuwa Estate in September 2005. Another 27 coconut plants raised from the germplasm brought from PNG are now ready for field planting. Germination of the embryos brought from the Marc Delorme Research Station, Ivory Coast was found to be poor and hence only a limited number of plants could be raised from the ten coconut varieties brought from the Ivory Coast.

*L Perera, C K Bandaranayake and R Jayathilake*

## EVALUATION OF CONSERVED COCONUT GERMPLASM

### Collection and conservation of coconut biodiversity within the country

All the field gene-banks were maintained successfully. A pollination program was in progress to multiply indigenous coconut varieties to establish a new field gene bank for conservation of indigenous germplasm at the Margaret estate.

### Collection, conservation and evaluation of coconut biodiversity in the Southern Province (CESS assisted Project)

Data such as morphology of stem, leaf, inflorescence, flower as well as fruit components were collected and compiled at bimonthly intervals this year from the identified new phenotypes in Unawatuna area. Preliminary data revealed a substantial variation between these types but the data were not yet analyzed to confirm the findings. A pollination programme was commenced to purify and multiply all the different phenotypes during the year in 22 palms to obtain 13 different phenotypes.

*C K Bandaranayake, G K Ekanayake and J M D T Everard [Deputy Director (Research)]*

### Collection of germplasm of the commercial tall variety

A new tall collection from Muthiyangana in Badulla was added to the pool of tall coconut germplasm conserved at CRI during the year, 2005. The total collection of tall accessions now exceeds 100. These tall coconut palms collections were mainly carried out to conserve coconuts existing in different agro-ecological regions and ecological niches, which may have been adapted to particular environments. However, as coconut is a highly heterozygous crop and with no long history of cultivation in the country except in the south for the crop to undergo a several generations of selection it is debatable whether further collection of tall coconut palms is worthwhile. Molecular evaluation of thirty accessions from the tall collection also showed that there is not much genetic variation between accessions conserved. Hence further collection of ecotypes was suspended and further collections were restricted only to phenotypically distinct genotypes.

*S A C N Perera and G K Ekanayake*

### *Ex-situ* Gene Banks

The 6 *ex-situ* field gene banks consisting of over 100 accessions of local tall and dwarf forms and exotic germplasm were maintained satisfactorily.

*L Perera, C K Bandaranayake, S A C N Perera, G K Ekanayake, M H L Padmasiri, N Herath and R B Attanayake*

## CHARACTERIZATION OF COCONUT GERMPLASM

### Characterization and evaluation of indigenous Thembili germplasm (1996)

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

*C K Bandaranayake and R B Attanayake*

### Molecular characterization of Thembili germplasm

Genetic diversity and genetic relationships of phenotypicaly distinguished forms of thembili (king coconut, Var. *aurantiaca*); common thembili, rathran thembili, nawasi thembili and recently identified bothal thembili from Southern province was studied during the year as an undergraduate research project (Makandura University) supervised by Dr. C. Bandaranayke. Along with them, ran thembili and gon thembili and recently identified two out breeding varieties, rath gon thembili and labu thembili were also studied along with Sri Lanka tall and Sri Lanka green dwarf green as reference varieties.

Common thembili, rathran thembili and bothal thembili showed the lowest genetic diversity (diversity index 0.136 to 0.139) with a tight grouping with green dwarf. Rath gon thembili and labu thembili, grouped with out breeding ran thembili and gon thembili, which were previously identified and classified as tall coconuts based on morphology. The study reveals that thembili forms, common thembili, rathran thembili and bothal thembili are more related to inbreeding dwarfs than tall coconuts, though they were previously classified as an intermediate variety based on morphological characteristics.

*C K Bandaranayake and K P Jayasingha (University of Wayamba)*

## OUTSIDE FUNDED PROJECTS

### (A) Molecular marker based characterization asm in national gene bank and selected Farmer's varieties in the IPGRI/COGENT poverty reduction project sites in Sri Lanka (IPGRI funded)

During the year a commissioned research activity offered by COGENT/IPGRI on molecular characterization of coconut was successfully completed. Using the microsatellite kit, comprising 14 microsatellite primers, developed and tested by CIRAD/France as another commissioned research activity of COGENT/IPGRI, four indigenous tall varieties, pora pol, dikiri pol, nawasi pol and thembili and one phenotypically exotic looking tall accession, Margaret tall and Sri Lanka green dwarf were molecular characterized in addition to the Farmers' varieties genotyped in 2004. Fifteen individuals were used for each group of pora pol, dikiri pol, nawasi pol, thembili and Margaret tall. Only five individuals were used for Sri Lanka green dwarf, the reference variety. The data were submitted to CIRAD/France for diversity analysis together with data from other countries to see theglobal scenario of the amount and distribution of genetic diversity of coconut and to assess the genetic relationships between coconut varieties world over.

This project was successfully completed this year and the data were submitted to CIRAD/France for diversity analysis together with data from other countries to see the global scenario of the amount and distribution of genetic diversity of coconut and to assess the genetic relationships between coconut varieties world over.

*L Perera, W B S Fernando and A Fernando*

**(B) Diagnosis of Pathogens using molecular tools (CESS funded)**

During the year Northern blotting technique was perfected with DIG labeled probes at the CRISL laboratory and Cadang-Cadang viroid (CCCVD) positive coconut palms detected by Dot-blot hybridization technique in 2004 were checked for confirmation of the results using DIG labeled Cadang-Cadang viroid specific probes. None of the samples became positive.
During the year rapid decline (CRD) syndrome affected coconut palms were PCR tested for the presence of Foliar Decay Virus (CFDV), which is the causative agent of the Vanuatu Wilt disease of coconut using PCR technique. None of the samples became positive. These results confirmed that CRD is caused neither by CCCVD nor CFVD.

Leaf samples were collected from Leaf rot affected coconut palms in South, which is another disease of coconut of which the cause is not yet known. The external symptoms of the disease-affected trees are said to be similar to Kerala wilt of coconut in India, which is suspected to be caused by phytoplasma. DNA were extracted from leaf samples and stored in a freezer. PCR analysis of samples collected for the presence of phytoplasma is expected to carry out during 2006.

*L Perera, N Herath and A Fernando*

**(C) Development of DArT Markers**

For the effective use of molecular markers and for higher precision in marker based genetic assessments there should be dense marker coverage over the entire nuclear genome. The most high throughput and abundant molecular marker system today is Single Nucleotide Polymorphism (SNP), which requires extensive sequence data. SSRs, which are relatively simple and also abundant in the genome, also require prior sequence information around the microsatellites. RAPD markers do not provide an adequate coverage of the genome and AFLPs although give a comparatively larger number of markers are cumbersome and sequential gel based.

Diversity Arrays (DArT) technology is the most recent, high throughput molecular marker technology, which has been developed for a few other crops. DArT is micro array based and uses high technology, yet provides hundreds to thousands of molecular markers in a short duration. As a collaborative project named 'Validation of Diversity Arrays (DArT) Technology as a Platform for Whole Genome Profiling in Orphan Crops' proposed to Generation Challenge Programme (GCP) of the IPGRI in May 2004, Dr. C. Perera visited Diversity Arrays Pty Ltd. in Australia in 2005 as a visiting scientist to develop DArT markers for coconuts. Five genomic libraries for coconut were constructed out of which two were expanded to include a total of 11,000 clones. Three hundred and forty seven polymorphic molecular markers were identified and 228 coconut accessions including 32 Sri Lankan accessions were genotyped using the newly identified DArT markers. This enrichment of the DNA marker pool for coconut will be immensely useful in research involving molecular marker technologies in coconut including genome mapping.

DArT is particularly useful in crops such as coconut which are important in the developing world. It is highly unlikely that much sequence data will be available for coconut over the next decade or so. Yet the genetic data developed by molecular markers will greatly help breeding programmes. Hence the

development of a high throughput and low cost molecular marker system such as DArT will be extremely useful in molecular breeding of coconut and like crops.

*S A C N Perera*

**(D) Increase of CRIC 65 seed nut production at the ISG (CESS funded)**

Organic manure application for palms at dwarf field was completed. Planting of field 11A of ISG with 430 dwarf green seedlings and a fence around was also completed. A drip irrigation system for all dwarf – tall mix fields and a fence around the fields were constructed.

*L Perera and S A S Chandrasiri*

**(E) Genetic variation and identification of varieties suitable for tender nut**

There is a growing demand locally as well as globally for consumption of natural food commodities. Tender coconut water has a great potential as a natural beverage due to its high palatability and nutrient content. It is rich in sugars, minerals (mainly $K^+$), vitamins (mainly B & C) and amino acids in addition to medicinal properties mentioned in indigenous medicine. King coconut is already a very popular natural beverage in the country with a high recognition for properties. In addition to this there are also various other forms of coconut, which have the potential for use as tender nuts. Some of these are profuse bearers and hence can even be better alternatives for mass scale use. Therefore, a project was commenced during 2005 with the objectives of identifying coconut phenotypes that has potential for use in the tender nut industry.

During the year twelve coconut varieties/phenotypes were identified to be potential coconut types to be used for beverage purpose. A survey was carried out to assess the extent and distribution of these coconut phenotypes within the areas where these particular types of coconuts are grown. A detailed study on the morphological variation of these coconut types in relation to the nut production is proposed for 2006.

*S A C N Perera and G K Ekanayake*

**ESTABLISHMENT OF THE PALLAMA SEED GARDEN**

Establishment of Pallama Seed Garden (PSG) for mass production of CRISL98 and the san ramon pollination at Pottukulama Research Station were continued. A pollination programme for production of more san ramon was initiated at Andigama farm, Giriulla involving 20 san ramon palms. Filling of vacancies using hand pollinated tall x tall seedlings were carried out.

*C K Bandaranayake and M H L Padmasiri*

## REPORT OF THE SOILS AND PLANT NUTRITION DIVISION

**Head – N.A. Tennakoon, Ph D**

### 1. GENERAL

The Research programme of the Division was aimed at refining technology on soil nutrient management giving emphasis on application of inorganic fertilizer and locally available organic sources such as animal and green manure, maintaining soil quality & evaluating nutrient levels of different types of coconut growing soils. Further particular interest is placed on developing irrigation techniques for coconut to overcome drought damage.

During the year, the Division maintained 17 on-going field experiments under 10 projects. Three new field experiments were commenced and one of them was CESS funded experiment. The Division has conducted 7 miscellaneous studies, which were supporting ongoing major experiments. The total research expenditure for research and maintenance was Rs. 2,767,000/- and Rs. 775,000/- respectively.

The experiment on site specific fertilizer recommendation at Mangala Eliya showed ($DL_3$, Borupan soil series $S_2$), 30% increase ($p \leq 0.01$) in nut yield from the palms receiving 1100 g Urea, 825 g Imported Rock Phosphate, 2200 g Muriate of Potash and 1375 g Dolomite (Treatment 3) over control (no fertilizer) and 22% nut yield increase in the recommended fertilizer mixture ($T_2$ - 800 g Urea, 600 g Imported Rock Phosphate, 1600 g Muriate of Potash and 1000 g Dolomite) treated palms over the control. Increase of Urea by 300 g, Imported Rock Phosphate by 225 g, Muriate of Potash by 600 g and Dolomite by 375 g ($T_3$) have shown the highest nut yield compared to the recommended dosage ($T_2$). The same experiment at Marapola ($WL_3$ Boralu soil series $S_4$) and Sirigampola ($IL_1$ Madampe soil series $S_2$), showed 85% and 59% significant increase in nut yield ($p \leq 0.01$) respectively from the palms receiving 1700 g Urea, 1905 g Eppawela Rock Phosphate, 3400 g Muriate of Potash and 2125 g Dolomite (Treatment 5) over control (no fertilizer) and 38% and 8% increase in nut yield were observed in the recommended fertilizer treated palms ($T_2$ 800 g Urea, The same experiment at Kobeigane ($IL_1$ Wariyapola soil series, $S_3$) 66% nut yield increase was observed (significant at $p \leq 0.01$) from the palms receiving 1400 g Urea, 1570 g Eppawela Rock Phosphate, 2800 g Muriate of Potash and 1750 g Dolomite (Treatment 4) over the control (no fertilizer) and 49% nut yield increase was observed in the recommended fertilizer treated palms ($T_2$) over the control. This year i.e. three years after fertilizer application, these nut yield increases have shown particularly in Boralu, Madampe and Wariyapola series soil in the Wet and Intermediate zones. 900 g Eppawela Rock Phosphate, 1600 g Muriate of Potash and 1000 g Dolomite) over the control.

The experiment to determine effect of different sources of phosphate i.e. Triple Super Phosphate, Imported Rock Phosphate and Eppawela Rock Phosphate on yield revealed that no significant difference in nut yield even 14 years after the establishment of the experiment at Ratmalagara Estate ($IL_1$). Therefore the recommendation of Eppawela Rock Phosphate as a P source especially for Wet and Intermediate zones can be continued and this will lead to a substantial savings of foreign exchange.

Drip irrigation experiment conducted at Ratmalagara Estate showed that 49% yield increase compared to control (no irrigation) in this year. This increase was observed in the treatment receiving 40 l/palm/day at 6 days interval with 250 g of APM plus 83 g of Dolomite at monthly intervals. This experiment further showed that 12 split application of fertilizer with irrigation (fertigation) was more beneficial than irrigation alone or annual application of fertilizer.

Experiment on comparison of the efficiency of organic and green manure against inorganic fertilizer (APM-W) showed 34% significant ($p \leq 0.001$) increase in the nut yield of the palms receiving poultry manure compared to the control (no fertilizer). The yield increase by inorganic fertilizer over the control (no fertilizer) was 8.5%. Nut yield of poultry manure treated palms increased by 23% over

inorganic fertilizer treated palms. The nut yield increase in other organic sources such as cattle manure, goat manure and green manure gliricidia was 18%, 28% and 17% over the control respectively. The initiation of female flowers was also significantly higher ($p \leq 0.001$) in poultry manure treated palms than that of control (no fertilizer) as well as inorganic fertilizer treated palms. The physical parameters of soil such as penetration (hardness) and bulk density in poultry manure treated soils were reduced by 13% and 10% over the control (no fertilizer) soils while the moisture was increased by 37% in poultry manure treated soils than that of control soil. Results indicated that the application of organic manures such as poultry manure, cattle manure, goat manure etc. were more economically beneficial than inorganic fertilizers as in the previous years.

The experiment on dissolution of dolomite in high pH soils revealed that the mean values of water soluble Mg were significantly ($p \leq 0.05$) low in dolomite and dolomite + urea applied high pH soil series i.e. Kalpitiya, Gambura, Mampuri and Elayapattu during 6 months after the establishment of the experiment. It further showed that available N and water soluble Mg were low in only urea applied soils compared to ammonium sulphate applied soils. In high pH soils, the application of neither dolomite nor urea showed much efficient release of nutrients.

The survey conducted by the Division on mite infestation of palms undergone different management practices such as i) organic manure vs inorganic fertilizer application, ii) irrigation vs non irrigation, iii) high levels of muriate of potash application showed that there was no significant effect on mite infestation from above different management practices. The study on the micro nutrient status in mite infected coconut palms showed that Cu and Zn were below the sufficiency ranges and B, Fe and Mn were above or within the sufficiency range.

As service functions, the Division provided Differential Fertilizer Recommendation (DFR) to 110 growers covering 1900 ha during the year. For quality testing 116 inorganic fertilizers, 58 organic manure and 1015 coir pith samples were analyzed. In addition, soil survey and land suitability tests were completed for 42 growers covering a total extent of 530 ha.

## 2. RESEARCH PROJECTS

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

Treatments are given in Table 1.

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

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

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

The leaf samples from 14th frond of each treated palm were taken in May 2005. Fertilizer application was carried out in July. Nut yield data from February 2005 to January 2006 did not show significant differences among the treatments (Table 2).

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

| Treatment levels | Nut yield (per palm per year) | | |
|---|---|---|---|
| | 2002 December to 2003 December | 2004 February to 2005 January | 2005 February to 2006 January |
| $T_1$ - TSP | 33 | 53 | 60 |
| $T_2$ - IRP | 35 | 50 | 56 |
| $T_3$ - ERP | 32 | 48 | 57 |
| $T_4$- Control (No P sources) | 27 | 40 | 51 |
| Level of significance | ns | ns | ns |

The leaf nutrient levels did not show significant differences ($p \leq 0.01$) among the treatments except P. Nitrogen, potassium and magnesium levels were above the critical levels (N > 1.9%, and K > 1.2 %). But the leaf magnesium levels of the treated palms were below the critical levels (Mg > 0.25 %). Please see the Table 3.

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

| Treatment levels | N% | P% | K% | Mg% |
|---|---|---|---|---|
| $T_1$ - TSP | 2.11 | 0.14 | 1.43 | 0.17 |
| $T_2$ - IRP | 2.08 | 0.12 | 1.48 | 0.18 |
| $T_3$ - ERP | 2.16 | 0.12 | 1.32 | 0.16 |
| $T_4$ - Control (No P source) | 2.12 | 0.11 | 1.36 | 0.16 |
| Level of significance | ns | ** | ns | ns |
| LSD ($p \leq 0.05$) | - | 0.006 | - | - |

Eventhough it has shown significant difference of P content of the leaf between TSP and other treatments. It was clearly proven that there was no significant difference of P content of the leaves among IRP and ERP treated palms as well as nut yield. Therefore application of ERP is sufficient to supplement phosphate requirement in the Wet and Intermediate zones coconut soils and this will lead to a substantial savings of foreign exchange.

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

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

The objectives of the experiment was

(i) to evaluate the Eppawela Rock Phosphate as a phosphate source for coconut in down south

(ii) to study the rate of release of available P in different types of P sources

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

| Treatment Levels | 6 m | 1 yr | 1 1/2 yrs | 2 yrs | 2 1/2 yrs | 3 yrs | 3 1/2 yrs | 4 yrs upto bearing | After bearing |
|---|---|---|---|---|---|---|---|---|---|
| $T_1$-Control | - | - | - | - | - | - | - | - | - |
| $T_2$ – ERP | 340 | 405 | 405 | 540 | 540 | 675 | 675 | 810 | 900 |
| $T_3$ – IRP | 225 | 270 | 270 | 360 | 360 | 450 | 450 | 540 | 600 |
| $T_4$ – HERP | 170 | 200 | 200 | 275 | 275 | 340 | 340 | 405 | 450 |
| $T_5$ - TSP | 145 | 175 | 175 | 235 | 235 | 290 | 290 | 350 | 390 |

Rates up to bearing - g/palm/6 months

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

**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 was established as a Randomized Block Design with 3 replicates and 6 palms per plot in 1996 at Wayagolla Estate, Attanagalla. The soil series of the site was Boralu series in $WL_3$. The site falls into land suitability class $S_4$. The age of the palms was about 42 years.

The treatments of this experiment are

$T_1$ - Control (no potassium, sodium or chloride treatment)
$T_2$ - Muriate of potash (1.6 kg/palm/y)
$T_3$ - Potassium sulphate (1.8 kg/palm/y)
$T_4$ - Sodium chloride (1.2 kg/palm/y)
$T_5$ - Sodium sulphate (1.45 kg/palm/y)

All plots were given a basal dose of ammonium sulphate (1.2 kg/palm/yr) and saphos phosphate (0.6 kg/palm/yr).

Evaluation of sodium chloride as a substitute for muriate of potash revealed that although the yield of potassium chloride treatment, it was higher than that of soidum chloride, the difference was not statistically significant. The nut yield difference was not significant among the treatments up to 2004. Therefore it has been decided to terminate this experiment at the Research Committee Meeting held in April, 2005.

*N A Tennakoon, U S S Perera and F H A J R Silva*

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

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

This experiment was established in 1991 with T x T seedlings planted on Andigama series soil at Ratmalagara Estate. The experiment was 3 x 3 x 3 N, K Mg factorial experiment. The treatment combinations and yield data are given in Table 4.

**Table 4 :** ***Treatment combinations and nut yield data of the experiment***

| Treatment levels | g/palm/y | Nuts Palm/yr | Female Flowers Palm/yr |
|---|---|---|---|
| | | 2004 Dec - 2005 Oct | 2004 Dec - 2005 Oct |
| N (Urea 46% N) | | | |
| $N_1$ | 0 | 33 ± 3 | 101 ± 13 |
| $N_2$ | 600 | 40 ± 4 | 115 ± 16 |
| $N_3$ | 1200 | 34 ± 3 | 122 ± 13 |
| K (Muriate of potash 60% $K_2O$) | | | |
| $K_1$ | 0 | 30 ± 4 | 103 ± 12 |
| $K_2$ | 1200 | 36 ± 4 | 112 ± 15 |
| $K_3$ | 2400 | 40 ± 5 | 122 ± 16 |
| Mg (Kieserite 24% MgO) | | | |
| $Mg_1$ | 0 | 34 ± 4 | 111 ± 15 |
| $Mg_2$ | 750 | 34 ± 5 | 114 ± 17 |
| $Mg_3$ | 1500 | 38 ± 4 | 113 ± 12 |
| | Level of Significance | LSD $P \leq 0.05$ | Level of Significance LSD($p \leq 0.05$) |
| N | * | 5.644 | ns - |
| K | ** | 5.644 | ns - |
| Mg | ns | - | ns - |

Basal phosphate application - Imported Rock Phosphate 600 g/palm/yr

Yield data revealed that only N & K were significant ($p \leq 0.05$) among the main treatments. The interaction of the above main treatments was not significant in this year. The highest K levels applied palms have shown highest nut yield. The significant yield increases were obtained from the highest K and Mg levels ($K_3$ and $Mg_3$) and higher N ($N_2$) or ($N_3$) applied palms.

Leaf sampling of the 14$^{th}$ leaf was done in March. Those nutrients such as P, K and Mg have shown significant differences among the treatments (Table 5). Eventhough N levels of the treated palms were not significant among the treatments; the N levels were higher than the critical level (N > 1.9%). The highest Mg level was observed in the lowest K level applied palms and which was significant at p $\leq 0.05$ level. The fertilizer application was done in April 2005.

**Table 5 :** ***Leaf nutrient levels in the 14th frond***

| Treatments | N | P | K | Mg |
|---|---|---|---|---|
| N (Urea 46% N) | | | | |
| $N_1$ | 1.90 | 0.15 | 1.14 | 0.25 |
| $N_2$ | 1.92 | 0.16 | 1.31 | 0.27 |
| $N_3$ | 1.97 | 0.16 | 1.25 | 0.25 |
| K (Muriate of potash 60% $K_2O$) | | | | |
| $K_1$ | 1.96 | 0.16 | 1.16 | 0.29 |
| $K_2$ | 1.92 | 0.16 | 1.31 | 0.25 |
| $K_3$ | 1.92 | 0.16 | 1.51 | 0.22 |
| Mg (Kieserite 24% MgO) | | | | |
| $Mg_1$ | 1.95 | 0.16 | 1.35 | 0.24 |
| $Mg_2$ | 1.94 | 0.16 | 1.31 | 0.27 |
| $Mg_3$ | 1.91 | 0.16 | 1.32 | 0.26 |
| Level of Significance | ns | ** | *** | *** |
| LSD ($p \leq 0.05$) | - | 0.005 | 0.108 | 0.028 |

*N A Tennakoon, H M I K Herath, N H R M de Silva, K J S Perera and W Gunasena*

**Experiment 7.0.2: Dissolution of dolomite in high pH soils (2004)**

**A POT EXPERIMENT**

The objective of this experiment was to study the dissolution of dolomite in high pH soils and to study the soil pH variation in high pH soils due to ammonium sulphate/urea/dolomite application. Four soil series of the Dry zone were used for this experiment. A pot was filled with 5 kg of soil and fertilizer treatments were given as following treatments. Pots were watered according to the rainfall pattern existing in the location where the soil been sampled.

$T_1$ - Control (no dolomite, urea and $(NH_4)_2SO_4$)
$T_2$ - Dolomite only (2.5 g dolomite/5 kg soil)
$T_3$ - Ammonium sulphate only (4.38 $(NH_4)_2SO_4$/5 kg soil)
$T_4$ - Urea only (2.0 g urea/5 kg soil)
$T_5$ - Dolomite + urea (2.5 g dolomite + 2 g urea/5 kg soil)
$T_6$ - Dolomite + Ammonium sulphate (2.5 g dolomite + 4.38 $(NH_4)_2SO_4$/5 kg soil)

The details of the soil series are given in Table 6.

**Table 6 :** ***Details of the used soil series for the experiment***

| Soil series | Great soil group | pH (1:5 w/w) | Water soluble Mg level before establishment of the experiment (mg/kg) |
|---|---|---|---|
| Kalpitiya | Sandy Regosols | 7.02 | 0.46 |
| Gambura | Red Yellow Latosols | 7.17 | 0.63 |
| Mampuri | Sandy Regosols | 6.39 | 0.74 |
| Elayapattu | Reddish Brown Earth | 6.52 | 1.63 |

The experiment (90 pots) was established as a Randomized Complete Block Design with 3 replicates for each soil at the green house in Bandirippuwa Estate in December 2004. Soil sampling has to be done in 14 days, 1 month, 2 months and 1 year.

The results clearly showed that the mean values of water soluble Mg were significantly ($p \leq 0.05$) low in dolomite ($T_2$) and dolomite + urea ($T_5$) applied high pH soils series i.e. Kalpitiya, Gambura,

Mampuri and Elayapattu during 1 year after the establishment of the experiment (Tables 7, 8, 9 and 10). It further showed that available N ($NH_4N$ and $NO_3N$) and water soluble Mg were low in only urea applied soils compared to ammonium sulphate applied soils. The available N amounts are given in Tables 11, 12, 13 and 14. This clearly showed that, in high pH soils, the application of neither dolomite nor urea showed much efficient release of nutrients.

**Table 7 :** ***Water soluble Mg (mg/kg) in Kalpitiya soil series (Sandy Regosols)***

| Treatment | Time after establishment of the experiment | | | |
|---|---|---|---|---|
| | 14 days | 1 month | 2 month | 1 year |
| $T_1$ - Control | 15.00 | 6.85 | 13.80 | 12.50 |
| $T_2$ - Dolomite only | 18.40 | 6.40 | 10.35 | 11.65 |
| $T_3$ - Ammonium sulphate only | 34.80 | 30.50 | 36.10 | 40.70 |
| $T_4$ - Urea only | 19.20 | 9.90 | 14.00 | 19.25 |
| $T_5$ - Dolomite + Urea | 16.80 | 9.50 | 19.70 | 22.60 |
| $T_6$ - Dolomite + Ammonium Sulphate | 53.00 | 29.30 | 60.00 | 63.60 |
| Level of Significance | *** | *** | *** | *** |
| LSD ($p \leq 0.05$) | 9.043 | 4.258 | 9.823 | 19.182 |

**Table 8 :** ***Water soluble Mg (mg/kg) in Gambura soil series (Red Yellow Latosols)***

| Treatment | Time after establishment of the experiment | | | |
|---|---|---|---|---|
| | 14 days | 1 month | 2 month | 1 year |
| $T_1$ - Control | 3.80 | 9.00 | 10.60 | 9.60 |
| $T_2$ - Dolomite only | 2.85 | 7.30 | 13.80 | 11.60 |
| $T_3$ - Ammonium sulphate only | 29.70 | 30.60 | 69.90 | 49.00 |
| $T_4$ - Urea only | 4.75 | 9.95 | 83.00 | 16.10 |
| $T_5$ - Dolomite + Urea | 4.00 | 7.80 | 33.80 | 20.30 |
| $T_6$ - Dolomite + Ammonium Sulphate | 39.50 | 38.25 | 83.90 | 85.30 |
| Level of Significance | *** | ** | *** | *** |
| LSD ($p \leq 0.05$) | 12.087 | 14.231 | 22.651 | 8.769 |

**Table 9 :** ***Water soluble Mg (mg/kg) in Mampuri soil series (Sandy Regosols)***

| Treatment | Time after establishment of the experiment | | | |
|---|---|---|---|---|
| | 14 days | 1 month | 2 month | 1 year |
| $T_1$ - Control | 9.60 | 4.25 | 8.40 | 4.90 |
| $T_2$ - Dolomite only | 15.60 | 5.55 | 13.70 | 10.15 |
| $T_3$ - Ammonium sulphate only | 25.70 | 11.30 | 11.00 | 19.40 |
| $T_4$ - Urea only | 11.00 | 2.20 | 8.35 | 4.45 |
| $T_5$ - Dolomite + Urea | 8.10 | 4.25 | 9.45 | 12.25 |
| $T_6$ - Dolomite + Ammonium Sulphate | 43.10 | 31.45 | 25.25 | 45.70 |
| Level of Significance | ** | ** | ** | *** |
| LSD ($p \leq 0.05$) | 17.602 | 12.08 | 8.013 | 14.354 |

**Table 10:** ***Water soluble Mg (mg/kg) in Elayapattu soil series (Reddish Brown Earth)***

| Treatment | Time after establishment of the experiment | | | |
|---|---|---|---|---|
| | 14 days | 1 month | 2 month | 1 year |
| $T_1$ - Control | 17.40 | 9.40 | 23.20 | 15.70 |
| $T_2$ - Dolomite only | 25.10 | 13.45 | 15.40 | 23.90 |
| $T_3$ - Ammonium sulphate only | 54.35 | 91.70 | 133.35 | 36.50 |
| $T_4$ - Urea only | 25.30 | 26.70 | 42.50 | 22.10 |
| $T_5$ - Dolomite + Urea | 13.00 | 25.00 | 42.50 | 33.40 |
| $T_6$ - Dolomite + Ammonium Sulphate | 53.45 | 101.70 | 191.70 | 56.50 |
| Level of Significance | *** | *** | *** | *** |
| LSD ($p \leq 0.05$) | 11.401 | 11.322 | 29.243 | 10.276 |

**Table 11 :** ***Available Nitrogen (mg/kg) in Kalpitiya soil series***

| Treatment | Time after establishment of the treatment | | |
|---|---|---|---|
| | 1 month | 2 months | 1 year |
| $T_1$ | 11.00 | 149.70 | 10.50 |
| $T_2$ | 18.10 | 150.50 | 7.50 |
| $T_3$ | 287.80 | 639.10 | 89.80 |
| $T_4$ | 39.35 | 150.90 | 19.10 |
| $T_5$ | 46.40 | 185.50 | 19.60 |
| $T_6$ | 143.80 | 470.90 | 75.10 |
| Level of Significance | < 0.0001 | 0.0002 | < 0.0001 |
| LSD ($p \leq 0.05$) | 80.98 | 198.18 | 8.96 |

**Table 12 :** ***Available Nitrogen (mg/kg) in Gambura series***

| Treatment | Time after establishment of the treatment | | |
|---|---|---|---|
| | 1 month | 2 months | 1 year |
| $T_1$ | 52.10 | 198.75 | 31.15 |
| $T_2$ | 24.40 | 174.55 | 25.90 |
| $T_3$ | 254.50 | 192.00 | 100.15 |
| $T_4$ | 103.00 | 293.00 | 28.45 |
| $T_5$ | 92.30 | 246.70 | 22.35 |
| $T_6$ | 270.10 | 234.60 | 74.25 |
| Level of Significance | < 0.0001 | ns | < 0.0001 |
| LSD ($p \leq 0.05$) | 91.83 | - | 16.45 |

**Table 13 :** ***Available Nitrogen (mg/kg) in Mampuri series***

| Treatment | Time after establishment of the treatment | | |
|---|---|---|---|
| | 1 month | 2 months | 1 year |
| $T_1$ | 62.90 | 275.25 | 51.00 |
| $T_2$ | 108.20 | 237.00 | 30.45 |
| $T_3$ | 233.95 | 270.80 | 394.25 |
| $T_4$ | 198.65 | 187.75 | 134.25 |
| $T_5$ | 87.00 | 159.90 | 102.15 |
| $T_6$ | 255.35 | 272.15 | 281.90 |
| Level of Significance | ns | 0.033 | < 0.001 |
| LSD ($p \leq 0.05$) | - | 80.57 | 45.65 |

**Table 14 :** *Available Nitrogen (mg/kg) in Elayapattu series*

| Treatment | Time after establishment of the treatment | | |
|---|---|---|---|
| | 1 month | 2 months | 1 year |
| $T_1$ | 30.90 | 124.60 | 18.15 |
| $T_2$ | 33.80 | 113.20 | 25.50 |
| $T_3$ | 309.75 | 370.00 | 324.50 |
| $T_4$ | 310.65 | 146.10 | 95.00 |
| $T_5$ | 278.75 | 160.00 | 75.15 |
| $T_6$ | 293.55 | 380.00 | 271.70 |
| Level of Significance | < 0.0001 | 0.0001 | < 0.0001 |
| LSD ($p \leq 0.05$) | 109.96 | 51.69 | 46.48 |

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

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

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

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

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

The treatments for the all sites are given in Table 15.

**Table 15 :** *Treatment combinations in the experiment (g/palm/yr)*

| Treatments | Urea | IRP/ERP | MOP | Dolomite |
|---|---|---|---|---|
| $T_1$ | 0 | 0 | 0 | 0 |
| $T_2$ | 800 | 600 / 900 | 1600 | 1000 |
| $T_3$ | 1100 | 825/1235 | 2200 | 1375 |
| $T_4$ | 1400 | 1050/1570 | 2800 | 1750 |
| $T_5$ | 1700 | 1225/1905 | 3400 | 2125 |

**7.1.2.1: Mangala-eliya site**

The nut yield of the experiments is given in Table 16.

**Table 16 :** ***The nut yield of Mangala-eliya site***

| Treatment | Cumulative nut yield 2001 January to 2004 Dec. | Nut yield (palm/year) 2004 Jan. to 2005 Dec. |
|---|---|---|
| $T_1$ | 285 | 87 |
| $T_2$ | 353 | 107 |
| $T_3$ | 341 | 114 |
| $T_4$ | 355 | 110 |
| $T_5$ | 338 | 107 |
| Level of Significance | $P \leq 0.05$ in (2003 & 2004) | $P \leq 0.01$ |
| LSD ($P \leq 0.050$) | 13 | 15 |

A significant increase ($p \leq 0.01$) in nut yield (30%) was observed from those palms receiving 1100 g urea, 825 g Imported Rock Phosphate, 2200 g Muriate of Potash and 1375 g Dolomite ($T_3$) over control (no fertilizer) and 22% nut yield increase was observed in the recommended fertilizer treated palms ($T_2$) - 800 g Urea, 600 g Imported Rock Phosphate, 1600 g Muriate of Potash and 1000 g Dolomite over control.

Increase of urea by 300 g, Imported Rock Phosphate by 225 g, Muriate of Potash by 600 g and Dolomite by 357 g have shown the highest nut yield by 7% compared to the recommended dosage ($T_2$). This year i.e. 5 year after fertilizer application, this nut yield increase was shown particularly by Borupan soil series in the Dry zone where the site is located.

All the leaf nutrients were in the sufficiency range ($N \geq 1.9\%$, $P \geq 0.11\%$, $Mg \geq 0.25\%$) except K levels ($K \geq 1.2\%$). Among them leaf N levels were significantly ($p \leq 0.05$) increased in the treated palms compared to control palms (Table 17).

**Table 17 :** ***Leaf nutrient levels of the 14$^{th}$ leaf at Mangala eliya site***

| Treatments | N% | P% | K% | Mg% |
|---|---|---|---|---|
| $T_1$ | 1.95 | 0.14 | 1.10 | 0.35 |
| $T_2$ | 2.15 | 0.14 | 1.06 | 0.31 |
| $T_3$ | 2.13 | 0.14 | 1.04 | 0.31 |
| $T_4$ | 2.23 | 0.14 | 1.04 | 0.30 |
| $T_5$ | 2.17 | 0.14 | 1.10 | 0.29 |
| Level of Significance | * | ns | ns | ns |
| LSD ($p \leq 0.05$) | 0.17 | - | - | - |

The soil nutrient values of the treatment-applied soils were given in Table 18.

Only K and P levels have shown significant difference ($p \leq 0.05$) at both depths (i.e. 0-20 cm and 20-40 cm) among the treatments. The pH was also significantly different ($p \leq 0.05$) among the treatments at both depths.

**Table 18 :** ***Soil nutrient levels at Mangala-eliya site***

| Treatment | pH (1:5) | | EC(µs/cm) | | N (mg/kg) | | P (mg/kg) | | K(meq/100g) | | Mg(meq/100g) | | Ca(meq/100g) | | Na(meq/100g) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (I) | (II) | (I) | (II) | (I) | (II) | (I) | (II) | (I) | (II) | (I) | (II) | (I) | (II) | (I) | (II) |
| $T_1$ | 6.35 | 6.16 | 53.42 | 45.75 | 139.97 | 127.69 | 364.86 | 123.02 | 0.09 | 0.07 | 0.55 | 0.33 | 0.83 | 0.46 | 0.04 | 0.06 |
| $T_2$ | 6.74 | 6.16 | 67.72 | 54.42 | 127.69 | 104.35 | 731.62 | 147.87 | 0.17 | 0.16 | 0.46 | 0.27 | 0.86 | 0.30 | 0.05 | 0.07 |
| $T_3$ | 6.95 | 6.54 | 63.80 | 61.40 | 116.63 | 115.41 | 789.46 | 136.37 | 0.19 | 0.19 | 0.58 | 0.40 | 1.00 | 0.61 | 0.04 | 0.07 |
| $T_4$ | 7.00 | 6.37 | 64.10 | 60.47 | 178.03 | 154.69 | 1033.85 | 239.55 | 0.19 | 0.20 | 0.48 | 0.37 | 1.20 | 0.64 | 0.06 | 0.06 |
| $T_5$ | 7.06 | 6.55 | 60.82 | 59.28 | 205.03 | 128.91 | 821.52 | 139.04 | 0.20 | 0.24 | 0.49 | 0.29 | 1.01 | 0.29 | 0.04 | 0.07 |
| Level of Significance | ** | * | ns | ns | ns | ns | * | * | * | *** | ns | ns | ns | ns | ns | ns |
| LSD ($p \leq 0.05$) | 0.292 | 0.298 | - | - | - | - | 282.20 | 97.94 | 0.067 | 0.050 | - | - | - | - | - | - |

(I) Soil depth at 0 - 20 cm

(II) Soil depth at 20 - 40 cm

- **Experiment 7.1.2.2: - Naiwala**

A significant increase ($p \leq 0.01$) in nut yield (85%) was observed from the palm receiving 1700 g Urea, 1905 g Eppawela Rock Phosphate, 3400 g Muriate of Potash and 2125 g Dolomite (Treatment 5) over control (no fertilizer) and 38% increase in nut yield was observed over recommended fertilizer applied palms ($T_2$ - Urea 800 g, Eppawela Rock Phosphate 900 g, Muriate of Potash 1600 g and Dolomite 1000 g) 3 years after imposement of K fertilizer treatment (Table 19).

**Table 19 :** ***Nut yield and female flowers of the Naiwala site***

| Treatment | Nut yield palm/year | | Female flowers palm/year | |
|---|---|---|---|---|
| | 2003 Nov.to 2004 Oct. | 2004 Nov. to 2005 Oct. | 2003 Nov. to 2004 Oct. | 2004 Nov. to 2005 Oct. |
| $T_1$ | 4 | 27 | 129 | 75 |
| $T_2$ | 7 | 49 | 122 | 69 |
| $T_3$ | 5 | 37 | 118 | 63 |
| $T_4$ | 6 | 48 | 119 | 65 |
| $T_5$ | 5 | 50 | 106 | 59 |
| Level of significant | ns | ** | ns | ns |
| LSD ($p \leq 0.05$) | - | 8 | - | - |

The leaf samples collected in August were analyzed to determine the nutrient status of the treated palms. Only potassium and magnesium levels have shown significant differences in this year (Table 20). The N and P values were above the critical levels (N > 1.9% and P > 0.11%). But Mg and K in $T_1$, $T_2$ and $T_3$ were below the critical levels (K > 1.2% and Mg > 0.25). Third application of treatment combinations was carried out in September. It was clearly showed that K levels were increased and magnesium levels were decreased when K source of Muriate of Potash has increased as treatments ($T_1$ to $T_5$). This may be due to antogonism effect of K & Mg.

**Table 20 :** ***Leaf nutrient of the 14th frond at Naiwala site***

| Treatment | N % | P % | K % | Mg % |
|---|---|---|---|---|
| $T_1$ | 1.94 | 0.14 | 0.39 | 0.22 |
| $T_2$ | 1.99 | 0.13 | 0.95 | 0.14 |
| $T_3$ | 2.11 | 0.12 | 0.99 | 0.13 |
| $T_4$ | 2.10 | 0.14 | 1.25 | 0.12 |
| $T_5$ | 2.05 | 0.14 | 1.38 | 0.13 |
| Level of significant | ns | ns | *** | * |
| LSD ($p \leq 0.05$) | - | - | 0.198 | 0.051 |

Soil sampling was done in August. Analysis of nutrients such as total N and exchangeable K revealed significant difference ( $p \leq 0.05$ respectively) among the treatments at both soil depths (i.e. 0-20 cm and 20-40 cm). The exchangeable Na values have shown significant difference ($p \leq 0.05$) at 20-40 cm soil depth (Table 21).

**Table 21:** ***Soil nutrient levels at Naiwala Site***

| Treatment | pH (1:5) | | EC(µs/cm) | | Total N (mg/kg) | | Available P Bray & Kurtz (mg/kg) | | Available P Olsen (mg/kg) | | Exch. K <---------- | | Exch. Na me eq/100 of soil ---------- | | Exch. Ca | | Exch. Mg ----------> | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (I) | (II) | (I) | (II) | (I) | (II) | (I) | (II) | (I) | (II) | (I) | (II) | (I) | (II) | (I) | (II) | (I) | (II) |
| $T_1$ | 4.80 | 4.47 | 67.06 | 41.60 | 71.27 | 145.00 | 15.50 | 11.43 | 20.24 | 16.30 | 0.10 | 0.07 | 0.07 | 0.07 | 1.11 | 0.47 | 0.63 | 0.35 |
| $T_2$ | 5.08 | 4.40 | 56.16 | 40.30 | 85.42 | 112.50 | 16.27 | 15.50 | 17.39 | 14.33 | 0.08 | 0.06 | 0.06 | 0.05 | 1.32 | 0.20 | 0.84 | 0.17 |
| $T_3$ | 4.87 | 4.31 | 57.72 | 41.86 | 37.67 | 103.50 | 12.98 | 12.20 | 18.63 | 17.71 | 0.08 | 0.06 | 0.06 | 0.06 | 0.95 | 0.13 | 0.62 | 0.11 |
| $T_4$ | 5.15 | 4.74 | 74.10 | 39.78 | 119.83 | 64.17 | 22.86 | 21.31 | 17.02 | 15.94 | 0.10 | 0.07 | 0.07 | 0.06 | 1.45 | 0.19 | 0.92 | 0.17 |
| $T_5$ | 5.20 | 4.64 | 75.67 | 45.76 | 176.33 | 83.93 | 19.18 | 14.33 | 17.86 | 15.94 | 0.13 | 0.09 | 0.08 | 0.08 | 1.60 | 0.19 | 0.98 | 0.17 |
| Level of Significance | ns | ns | ns | ns | *** | *** | ns | ns | ns | ns | * | * | ns | * | ns | ns | ns | ns |
| LSD ($p \leq 0.05$) | - | - | - | - | 17.188 | 25.326 | - | - | - | - | 0.031 | 0.016 | - | 0.014 | - | - | - | - |

(I) Soil depth at 0 - 20 cm

(II) Soil depth at 20 - 40 cm

**Experiment 7.1.2.3: - Kobeigane**

The site at Kobeigane has shown 66% increase in nut yield ($p \leq 0.01$) from the palms receiving 1400 g Urea, 1570 g Eppawela Rock Phosphate, 2800 g Muriate of Potash and 1750 g Dolomite (Treatment 4) over the control (no fertilizer) and 49% nut yield increase in the treatment receiving recommended dosage of fertilizer ($T_2$) over the control. This year i.e. three years after fertilizer application, nut yield increase has shown particularly in Wariyapola series soil in the Intermediate zone (Table 22).

**Table 22 :** ***Nut yield of the Kobeigane experimental site***

| Treatment | Nut yield palm/year | |
|---|---|---|
| | 2003 November - 2004 October | 2004 November - 2005 October |
| $T_1$ | 70 | 46 |
| $T_2$ | 72 | 51 |
| $T_3$ | 76 | 70 |
| $T_4$ | 82 | 76 |
| $T_5$ | 78 | 65 |
| Level of significant | ns | ** |
| LSD ($p \leq 0.05$) | - | 15.91 |

The leaf sampling after the 2nd application of fertilizer was done in September and different treatment combinations were applied for the 3rd time in October 2005. Analytical data showed no significant difference in leaf nutrient levels during the year (Table 23).

**Table 23 :** ***Leaf macro nutrient levels of the 14th frond at Kobeigane site***

| Treatment | N % | P % | K % | Mg % |
|---|---|---|---|---|
| $T_1$ | 1.95 | 0.126 | 0.79 | 0.30 |
| $T_2$ | 1.96 | 0.136 | 0.92 | 0.31 |
| $T_3$ | 1.99 | 0.141 | 0.90 | 031 |
| $T_4$ | 2.15 | 0.143 | 0.94 | 0.33 |
| $T_5$ | 2.06 | 0.147 | 0.94 | 0.33 |
| Level of significant | ns | ns | ns | ns |
| LSD ($p \leq 0.05$) | - | - | - | - |

**Experiment 7.1.2.4: - Sirigampola**

The site at Sirigampola has shown 59% significant increase ($p \leq 0.01$) in nut yield from the palms receiving 1700 g Urea, 1905 g Eppawela Rock Phosphate, 3400 g Muriate of Potash and 2125 g Dolomite (Treatment 5) over control (no fertilizer) and 8% nut yield increase in the treatment received recommended fertilizer (Treatment 2) over the control (Table 24).

**Table 24 :** ***Nut yield of the experiment at Sirigampola Site***

| Treatment | Nut yield palm/year | |
|---|---|---|
| | 2003 November - 2004 October | 2004 November - 2005 October |
| $T_1$ | 72 | 41 |
| $T_2$ | 75 | 45 |
| $T_3$ | 74 | 54 |
| $T_4$ | 74 | 55 |
| $T_5$ | 81 | 65 |
| Level of significance | ns | ** |
| LSD ($p \leq 0.05$) | - | 14.42 |

The leaf samples collected in September. Leaf nutrient analysis showed the leaf nitrogen has been increased with the N increased treatments (significant at $p \leq 0.05$) in this year (Table 25). Fertilizer application was done in December 2005.

**Table 25 :** ***Nutrient level of the 14th frond at Sirigampola site***

| Treatment | N % | P % | K % | Mg % |
|---|---|---|---|---|
| $T_1$ | 2.19 | 0.17 | 0.86 | 0.30 |
| $T_2$ | 2.12 | 0.17 | 1.36 | 0.24 |
| $T_3$ | 2.33 | 0.17 | 1.14 | 0.24 |
| $T_4$ | 2.20 | 0.17 | 1.55 | 0.22 |
| $T_5$ | 2.37 | 0.17 | 1.29 | 0.23 |
| Level of significant | * | ns | ns | ns |
| LSD ($p \leq 0.05$) | 0.1568 | - | - | - |

**Experiment 7.1.2.5: - Wellawa**

The 2nd fertilizer application was carried out in December. The nut yield has not shown significant difference among the treatment in this year (Table 26).

**Table 26 :** ***Nut yield of the experiment at Wellawa Site***

| Treatment | Nut yield palm/year | |
|---|---|---|
| | 2003 November - 2004 October | 2004 November - 2005 October |
| $T_1$ | 72 | 46 |
| $T_2$ | 75 | 47 |
| $T_3$ | 74 | 45 |
| $T_4$ | 74 | 42 |
| $T_5$ | 81 | 43 |
| Level of significant | ns | ns |
| LSD ($p \leq 0.05$) | - | - |

Leaf nutrient levels and soil nutrient levels (0-20 and 20-40 cm depth) were not statistically significant among the treatments in this year (Tables 27 and 28).

**Table 27 :** ***Nutrient levels of the 14th frond at Wellawa site***

| Treatment | P (mkg) | K (me.eq) | Mg (me.eq) | Ca (me.eq) |
|---|---|---|---|---|
| $T_1$ | 0.11 | 0.67 | 0.28 | 0.35 |
| $T_2$ | 0.11 | 1.08 | 0.29 | 0.32 |
| $T_3$ | 0.1 | 0.99 | 0.29 | 0.37 |
| $T_4$ | 0.12 | 1.09 | 0.30 | 0.35 |
| $T_5$ | 0.12 | 1.11 | 0.30 | 0.35 |
| Level of Significance | ns | ns | ns | ns |
| LSD ($p \leq 0.050$) | - | - | - | - |

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**Table 28 :** ***Soil nutrient levels of Wellawa site***

| Treatment | N (mg/kg) | | P (mg/kg) | | K (me.eq) | | Mg(me.eq) | | Na(me.eq) | | Ca(me.eq) | | Zn(mg/kg) | | Cu(mg/kg) | | Fe(mg/kg) | | Mn(mg/kg) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (I) | (II) | (I) | (II) | (I) | (II) | (I) | (II) | (I) | (II) | (I) | (II) | (I) | (II) | (I) | (II) | (I) | (II) | (I) | (II) |
| $T_1$ | 380.63 | 295.20 | 17.18 | 24.59 | 0.16 | 0.14 | 0.98 | 0.62 | 0.04 | 0.07 | 2.26 | 1.42 | 3.41 | 3.17 | 2.88 | 3.73 | 35.36 | 37.53 | 57.58 | 48.92 |
| $T_2$ | 615.00 | 418.20 | 21.77 | 18.59 | 0.18 | 0.39 | 0.62 | 0.75 | 0.02 | 0.17 | 3.04 | 2.08 | 2.94 | 3.25 | 3.17 | 3.14 | 21.66 | 23.06 | 44.13 | 38.68 |
| $T_3$ | 369.00 | 578.10 | 33.33 | 14.33 | 0.33 | 0.20 | 0.70 | 0.88 | 0.08 | 0.10 | 2.96 | 2.20 | 3.81 | 3.18 | 3.44 | 4.41 | 35.23 | 50.14 | 33.43 | 60.68 |
| $T_4$ | 455.03 | 437.63 | 19.84 | 11.25 | 0.14 | 0.26 | 0.87 | 0.66 | 0.08 | 0.02 | 0.0.27 | 2.76 | 3.41 | 2.83 | 3.59 | 4.08 | 39.27 | 55.07 | 41.15 | 48.38 |
| $T_5$ | 430.50 | 319.80 | 8.88 | 7.40 | 0.14 | 0.38 | 0.71 | 1.53 | 0.11 | 0.03 | 5.14 | 2.82 | 3.62 | 3.31 | 4.33 | 4.04 | 45.82 | 41.72 | 65.39 | 63.91 |
| Level of Significance | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| LSD ($p \leq 0.05$) | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

(I) Soil depth at 0 - 20 cm

(II) Soil depth at 20 - 40 cm

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

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

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

The experiment on land suitability class $S_4$ was commenced in 2004 in a field containing Boralu series soil at Bandirippuwa Estate. Ten T x T palms, which were 20 years old, were randomly selected as replicates for further experiments. The number and the weight of each component harvested and removed from the palm was determined at monthly intervals. The palm vegetative and plant components were collected from September 2005 in each month. The available data are given in Tables 29, 30 and 31.

**Table 29 :** ***Different components removed by the palms in each month***

| Component of the palm | September | October | November | December | Total |
|---|---|---|---|---|---|
| Number of nuts | 6 | 4 | 5 | 7 | 22 |
| Number of fronds | 1 | 2 | 1 | 0 | 4 |

**Table 30 :** ***Dry matter production per palm from September to December (values are means of 10 palms)***

| Component of the palm | Dry matter production (g/palm) | | | | |
|---|---|---|---|---|---|
| | September | October | November | December | Total |
| Nut - Husk | 6681.8 | 2216.0 | 2722.8 | 2451.8 | 14072.4 |
| Shell | 3817.1 | 1108.0 | 749.8 | 1176.2 | 6851.1 |
| Kernel | 3127.9 | 1260.7 | 619.8 | 1575.1 | 6583.5 |
| Total | 13626.8 | 4584.0 | 4091.6 | 5203.1 | 27507.0 |
| Frond- | | | | | |
| Leaflets | 2373.5 | 1721.3 | 753.8 | - | 4848.6 |
| Ekel | 1015.8 | 703.6 | 396.3 | - | 2112.7 |
| Rachis | 4170.5 | 340.4 | 675.4 | - | 5186.3 |
| Total | 7559.8 | 2765.3 | 1825.5 | - | 12150.6 |
| Inflorescence | | | | | |
| 'Matulu' | 164.3 | 77.0 | 74.7 | 39.3 | 355.3 |
| Spath | 95.8 | 8.7 | 59.7 | 52.4 | 216.6 |
| Dried spath | 425.6 | 159.6 | 206.6 | 181.1 | 972.9 |
| Spiklet | 782.7 | 149.7 | 164.3 | 152.2 | 1248.9 |
| Spadix | 643.4 | 112.8 | 166.9 | 121.9 | 647.8 |
| Bract | 77.4 | 29.5 | 31.5 | 44.5 | 182.9 |
| Total | 1212.5 | 537.3 | 703.7 | 591.4 | 3044.9 |

**Table 31:** *Nutrient values of the component (mean of 4 months)*

| Component of the palm | Nutrients (g) | | | | | |
|---|---|---|---|---|---|---|
| | N | P | K | Mg | Ca | Na |
| Nut - Husk | 33.35 | 8.30 | 339.99 | 15.48 | 18.72 | 10.70 |
| Shell | 5.96 | 1.85 | 21.79 | 0.69 | 0.27 | 3.63 |
| Kernel | 76.83 | 15.14 | 45.43 | 6.12 | 0.59 | 4.69 |
| Total | 116.14 | 25.29 | 407.21 | 22.29 | 19.58 | 19.02 |
| Frond- | | | | | | |
| Leaflets | 35.64 | 3.54 | 27.25 | 11.54 | 32.19 | 60.37 |
| Ekel | 6.24 | 2.41 | 9.82 | 7.38 | 6.03 | 2.56 |
| Rachis | 11.57 | 3.84 | 54.66 | 11.72 | 33.45 | 23.81 |
| Total | 53.45 | 9.79 | 91.73 | 30.64 | 71.67 | 86.74 |
| Inflorescence | | | | | | |
| 'Matulu' | 1.60 | 0.19 | 0.07 | 0.31 | 0.59 | 0.31 |
| Spath | 0.96 | 0.13 | 1.06 | 0.48 | 0.69 | 0.21 |
| Dried spath | 3.76 | 0.54 | 3.48 | 1.46 | 2.67 | 0.37 |
| Spiklet | 9.42 | 1.54 | 34.28 | 5.37 | 4.45 | 2.98 |
| Spadix | 1.96 | 0.70 | 17.80 | 1.61 | 0.67 | 2.28 |
| Bract | 0.84 | 0.16 | 4.09 | 0.26 | 0.23 | 0.24 |
| Total | 18.54 | 3.26 | 60.78 | 9.49 | 9.30 | 6.39 |

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

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

Treatment combinations are given in Table 32.

**Table 32 :** *Treatment combinations of the experiment*

| | Application rate (palm/year) |
|---|---|
| $T_1$ | 3 kg APM (MOP 1600 g + Urea 800 g + ERP 600 g) |
| $T_2$ | 3 kg APM + 1 kg Kieserite |
| $T_3$ | 3 kg APM + 1 kg Kieserite (6 months later) |
| $T_4$ | Urea 800 g + ERP 600 g + MOP 1600 g + Kieserite 1 kg — ½ circle |

Nut yield of this experiment during the period of January to October 2005 has not shown significant difference among the treatments. But female flowers have shown significant difference among the treatments (Table 33).

**Table 33 :** ***Female flowers and nut production of the treatment palm***

| Treatment | Nut yield (palm/yr) (January to October 2005) | Female Flowers (palm/yr) (January to October 2005) |
|---|---|---|
| $T_1$ | 27 | 75 |
| $T_2$ | 33 | 118 |
| $T_3$ | 29 | 72 |
| $T_4$ | 28 | 78 |
| Level of Significance | ns | ** |
| LSD ($p \leq 0.05$) | - | 1.472 |

Leaf nutrient levels of 14th leaf are given Table 34. The nutrients such as P and K have shown significant differences among the treatments.

**Table 34 :** ***Leaf nutrient levels of the experiment***

| Treatment | N % | P % | K % | Mg % |
|---|---|---|---|---|
| $T_1$ | 2.16 | 0.14 | 1.33 | 0.27 |
| $T_2$ | 2.09 | 0.14 | 1.39 | 0.26 |
| $T_3$ | 2.21 | 0.14 | 1.53 | 0.28 |
| $T_4$ | 2.20 | 0.14 | 1.39 | 0.25 |
| Level of Significance | ns | * | * | ns |
| LSD ($p \leq 0.05$) | - | 0.005 | 0.143 | - |

Soil sampling was done in June 2005 and the soil nutrient values are given in Table 35. The nutrients such as Mg and Ca of the top soil (0-20 cm) have only shown significant differences among the treatments.

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**Table 35 :** ***Soil nutrient levels of the experiment***

| Treatment | pH (1:5) | | EC(µs/cm) | | N (mg/kg) | | P (mg/kg) | | K(meq/100g) | | Mg(meq/100g) | | Ca(meq/100g) | | Na(meq/100g) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (I) | (II) | (I) | (II) | (I) | (II) | (I) | (II) | (I) | (II) | (I) | (II) | (I) | (II) | (I) | (II) |
| $T_1$ | 6.59 | 6.13 | 155.83 | 114.13 | 1549.50 | 959.00 | 367.83 | 175.60 | 0.54 | 0.52 | 1.35 | 1.07 | 3.27 | 2.41 | 0.12 | 0.13 |
| $T_2$ | 6.64 | 6.03 | 152.67 | 108.60 | 1710.50 | 992.17 | 392.00 | 128.80 | 0.60 | 0.53 | 2.30 | 1.13 | 4.29 | 2.14 | 0.10 | 0.13 |
| $T_3$ | 6.68 | 6.07 | 138.83 | 113.78 | 1286.00 | 888.83 | 375.67 | 148.40 | 0.49 | 0.48 | 2.15 | 1.18 | 3.71 | 1.93 | 0.09 | 0.11 |
| $T_4$ | 6.83 | 6.25 | 132.30 | 102.03 | 1503.25 | 973.58 | 392.33 | 115.65 | 0.56 | 0.51 | 2.21 | 1.06 | 4.65 | 2.13 | 0.09 | 0.10 |
| Level of Significance | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | *** | ns | *** | ns | ns | ns |
| LSD | - | - | - | - | - | - | - | - | - | - | 0.331 | - | 0.531 | - | - | - |

(I) Soil depth at 0 - 20 cm

(II) Soil depth at 20 - 40 cm

**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)**

The experiment design was a Randomized Block Design with 3 replicates and 6 palms (15 years old) per plot and was established in 1996 at Ratmalagara Estate ($IL_1$). It was located on a shallow sandy clay loam soil (Andigama series) falling to land suitability class $S_5$. A sub-terrain reticulater system and screw drippers were installed to provide different quantities of water to coconut palms at different irrigation intervals.

The treatments were given in Table 36.

**Table 36 :** ***Treatments effect from November 2002***

| Treatment | Irrigation intervals in days | Application of water per day/palm in liters | Application of water per day/palm in hours | Rate of application of fertilizer | No. of time of fertilizer application per year |
|---|---|---|---|---|---|
| $T_1$ | - | - | - | 3 kg | 1 |
| $T_2$ | 6 | 40 | 2 | 3 kg | 1 |
| $T_3$ | 3 | 80 | 2 | 3 kg | 1 |
| $T_4$ | 6 | 40 | 2 | 250 g | 12 |
| $T_5$ | 3 | 80 | 2 | 250 g | 12 |

Nut yield did not show significant difference among the treatment receiving in this year (Table 37). However this irrigation experiment showed 49% yield increase compared to control (no irrigation). This increase was observed in $T_4$ treatment 40 l/palm/day at 6 days interval with 250 g of APM-W plus 83 g of dolomite at monthly intervals per year. The yield of this treatment ($T_4$) was 39% higher than application of 40 l/palm/day at the same interval but with application of 3 kg of APM-W and 1 kg of dolomite annually ($T_2$). The results further showed that 12 split application of APM-W and dolomite with irrigation (fertigation) is more beneficial than irrigation alone.

**Table 37 :** ***Nut yield of the treatment palms***

| Treatment | Nut yield per palm per year | | |
|---|---|---|---|
| | November 2002 to October 2003 | November 2003 to October 2004 | November 2004 to October 2005 |
| $T_1$ | 48 | 74 | 62 |
| $T_2$ | 64 | 78 | 66 |
| $T_3$ | 53 | 85 | 69 |
| $T_4$ | 82 | 98 | 92 |
| $T_5$ | 65 | 84 | 84 |
| Level of Significance | ns | ns | ns |

The leaf sampling carried out in August was analyzed and only N levels have shown significant difference among the treatments (Table 38).

**Table 38 :** ***Nutrient levels of 14th frond***

| Treatment | N % | P % | K % | Mg % |
|---|---|---|---|---|
| $T_1$ | 2.18 | 0.15 | 1.61 | 0.23 |
| $T_2$ | 2.20 | 0.16 | 1.50 | 0.25 |
| $T_3$ | 2.43 | 0.15 | 1.60 | 0.23 |
| $T_4$ | 2.39 | 0.16 | 1.46 | 0.24 |
| $T_5$ | 2.48 | 0.15 | 1.41 | 0.26 |
| Level of significant | * | ns | ns | ns |
| LSD ($p \leq 0.05$) | 0.1860 | - | - | - |

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**Experiment 10.0.2: Evaluating the effect of fertigation on coconut**

This experiment was established in 2004 at Ratmalagara Estate ($IL_1$). It was located on a shallow sandy clay loam soil (Andigama series) falling into land suitability class $S_5$. This experiment was Randomized Complete Block Design with 3 replicates and 6 palms (15 years also) per plot. Treatment combinations were given in Table 39.

**Table 39 :** ***Treatment combinations of the experiment***

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

Preliminary records were undertaken for one-year period and treatment were imposed in October 2005 (Table 40).

**Table 40 :** ***Preliminary nut yield data of the experiment***

| Treatment | Nut yield (palm/y) (November 2004 to October 2005) |
|---|---|
| $T_1$ | 52 |
| $T_2$ | 41 |
| $T_3$ | 48 |
| $T_4$ | 46 |
| $T_5$ | 57 |
| $T_6$ | 55 |
| Level of Significance | ns |

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

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

The objective of this experiment was to determine available nutrients in all major soils in the coconut growing areas and to attempt to establish threshold levels for each nutrient in the coconut growing soils. Soil samples were collected to represent the top layer (0-25 cm depth) and the sub layer (25-50 cm) of soil series. Samples were obtained at the frequency of one sampling location per every 100 ha. Soil samples were taken from each location to represent the manure circle of the coconut palm as well as the centre of the square. Leaf samples (14$^{th}$ frond) from coconut palms were also taken from the same location.

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

Soil and leaf sampling for another major soil series of Kurunegala 1 inch sheet namely Wariyapola (50,053 ha) and Maho (16,533 ha) were commenced from January 2005. It was planned to complete sampling of 250 sites from Wariyapola series and 50 sites from Maho series. At the end of the year, sampling was completed in 116 sites and 26 sites of Wariyapola and Maho series respectively.

At each site soil samples were collected from 4 locations to prepare composite samples separately from top soil (0-25 cm) and sub soil (25-50 cm).

In leaf sampling, leaflets from 14$^{th}$ frond of four coconut palms were collected to prepare a composite sample from each site.

Soil and leaf samples were analyzed chemically for nutrients and available analytical data are given in Tables 41 and 42.

**Table 41 :** ***Soil analytical data***

| Soil series | Position in the coconut land | Soil depth (cm) | Fertilizer practice | N (mg/kg) | K (meq/100g) | Mg (meq/100g) | Na (meq/100g) | Ca (meq/100g) |
|---|---|---|---|---|---|---|---|---|
| Maho series | Center of square | Top soil (0-25) | With manure application | 108.06 ± 49.95 | 0.28 ± 0.10 | 1.90 ± 0.88 | 0.06 ± 0.02 | 2.19 0.80 |
| | | | Without manure application | 507.76 ± 63.25 | 0.19 ± 0.06 | 0.90 ± 0.22 | 0.09 ± 0.03 | 1.97 ± 0.48 |
| | | Sub soil (25-50) | With manure application | 175.89 ± 96.61 | 0.39 ± 0.24 | 2.21 ± 1.05 | 0.07 ± 0.01 | 2.84 ± 0.75 |
| | | | Without manure application | 422.95 ± 121.54 | 0.10 ± 0.01 | 0.78 ± 0.11 | 0.06 ± 0.01 | 2.33 ± 0.69 |
| Maho series | Manure circle | Top soil (0-25) | With manure application | 347.51 ± 164.76 | 0.48 ± 0.11 | 1.51 ± 0.30 | 0.09 ± 0.02 | 4.01 ± 1.06 |
| | | | Without manure application | 651.30 ± 111.69 | 0.22 ± 0.05 | 0.88 ± 0.09 | 0.09 ± 0.02 | 1.94 ± 0.45 |
| | | Sub soil (25-50) | With manure application | 208.00 ± 115.16 | 0.43 ± 0.11 | 1.28 ± 0.28 | 0.01 ± 0.03 | 3.30 ± 1.01 |
| | | | Without manure application | 474.62 ± 106.71 | 0.26 ± 0.08 | 0.87 ± 0.11 | 0.11 ± 0.03 | 2.28 ± 0.48 |
| Wariyapola series | Center of square | Top soil (0-25) | With manure application | 18.45 ± 67.19 | 0.18 ± 0.03 | 0.88 ± 0.15 | 0.14 ± 0.03 | 2.62 ± 0.68 |
| | | | Without manure application | 251.13 ± 47.81 | 0.17 ± 0.02 | 0.96 ± 0.09 | 0.13 ± 0.02 | 2.72 ± 0.28 |
| | | Sub soil (25-50) | With manure application | 135.96 ± 52.08 | 0.15 ± 0.03 | 1.03 ± 0.15 | 0.11 ± 0.02 | 2.67 ± 0.65 |
| | | | Without manure application | 232.11 ± 42.52 | 0.15 ± 0.03 | 1.01 ± 0.10 | 0.14 ± 0.02 | 3.21 ± 0.49 |
| Wariyapola series | Center of square | Top soil (0-25) | With manure application | 193.51 ± 75.21 | 0.34 ± 0.07 | 1.12 ± 0.16 | 0.14 ± 0.03 | 2.54 ± 0.46 |
| | | | Without manure application | 272.29 ± 47.65 | 0.21 ± 0.02 | 1.01 ± 0.09 | 0.14 ± 0.01 | 2.91 ± 0.29 |
| | | Sub soil (25-50) | With manure application | 172.28 ± 61.54 | 0.32 ± 0.06 | 1.02 ± 0.18 | 0.18 ± 0.03 | 2.34 ± 0.46 |
| | | | Without manure application | 254.05 46.14 | 0.20 ± 0.03 | 1.03 ± 0.11 | 0.17 ± 0.02 | 2.59 ± 0.29 |

| Soil series | Position in the coconut land | Soil depth (cm) | Fertilizer practice | Zn (mg/kg) | Cu (mg/kg) | Fe (mg/kg) | Mn (mg/kg) | Cl (mg/kg) |
|---|---|---|---|---|---|---|---|---|
| Maho series | Center of square | Top soil (0-25) | With manure application | 3.06 ± 0.89 | 2.38 ± 0.39 | 32.86 ± 7.57 | 53.87 ± 8.48 | 21.58 ± 4.27 |
| | | | Without manure application | 2.17 ± 0.46 | 1.47 ± 0.17 | 39.92 ± 3.78 | 49.76 ± 9.01 | 18.38 ± 1.53 |
| | | Sub soil (25-50) | With manure application | 2.12 ± 0.45 | 2.11 ± 6.33 | 31.14 ± 8.49 | 49.24 ± 7.27 | 38.35 ± 9.79 |
| | | | Without manure application | 2.69 ± 0.92 | 1.86 ± 0.22 | 30.86 ± 5.10 | 51.01 ± 9.55 | 20.91 ± 2.85 |
| Maho series | Manure circle | Top soil (0-25) | With manure application | 4.05 ± 1.00 | 1.76 ± 0.34 | 27.26 ± 4.32 | 41.56 ± 5.26 | 44.52± 10.02 |
| | | | Without manure application | 2.39 ± 0.41 | 1.25 ± 0.13 | 45.05 ± 7.13 | 43.40 ± 3.73 | 45.02 ± 6.08 |
| | | Sub soil (25-50) | With manure application | 2.20 ± 0.42 | 2.47 ± 0.56 | 31.15 ± 6.00 | 42.12 ± 8.95 | 23.51 ± 5.31 |
| | | | Without manure application | 2.50 ± 0.51 | 1.61 ± 0.17 | 41.69 ± 6.64 | 53.26 ± 6.00 | 37.94 ± 7.23 |
| Wariyapola series | Center of square | Top soil (0-25) | With manure application | 1.65 ± 0.18 | 1.45 ± 0.14 | 36.09 ± 3.77 | 42.01 ± 3.54 | 26.98 ± 3.99 |
| | | | Without manure application | 2.37 ± 0.23 | 1.52 ± 0.10 | 39.61± 2.96 | 41.94 ± 2.93 | 32.87 ± 3.52 |
| | | Sub soil (25-50) | With manure application | 2.04 ± 0.35 | 1.63 ± 0.16 | 29.25 ± 1.83 | 45.03 ± 4.90 | 26.60 ± 3.16 |
| | | | Without manure application | 2.21 ± 0.26 | 1.53 ± 0.10 | 31.06 ± 2.50 | 36.49 ± 2.85 | 34.02 ± 2.88 |
| Wariyapola series | Center of square | Top soil (0-25) | With manure application | 2.48 ± 0.20 | 1.33 ± 0.14 | 47.88 ± 4.09 | 34.87 ± 3.80 | 35.45 ± 3.05 |
| | | | Without manure application | 2.58 ± 0.27 | 1.43 ± 0.11 | 43.67 ± 3.65 | 39.20 ± 3.43 | 40.65 ± 3.55 |
| | | Sub soil (25-50) | With manure application | 1.60 ± 0.18 | 1.59 ± 0.18 | 36.83 ± 2.81 | 39.48 ± 3.37 | 48.34 ± 4.56 |
| | | | Without manure application | 2.39 ± 0.31 | 1.53 ± 0.14 | 38.59 ± 4.79 | 39.65 ± 3.90 | 44.35 ± 3.48 |

**Table 42 :** ***Leaf analytical data of 14th frond***

| Soil series | Fertilizer practice | N % | P % | K % | Ca % | Mg % | Na % | Cl % |
|---|---|---|---|---|---|---|---|---|
| Maho | With manure application | 2.08 ± 0.05 | 0.13 ± 0.00 | 1.16 ± 0.18 | 0.45 ± 0.05 | 0.32 ± 0.04 | 0.21 ± 0.04 | 1.47 ± 0.25 |
| | Without manure application | 1.97 ± 0.02 | 0.14 ± 0.00 | 0.95 ± 0.12 | 0.40 ± 0.02 | 0.32 ± 0.03 | 0.31 ± 0.08 | 0.99 ± 0.08 |
| Wariyapola | With manure application | 2.04 ± 0.04 | 0.14 ± 0.00 | 1.04 ± 0.09 | 0.44 ± 0.02 | 0.29 ± 0.02 | 0.25 ± 0.02 | 1.28 ± 0.13 |
| | Without manure application | 1.97 ± 0.02 | 0.14 ± 0.00 | 0.84 ± 0.04 | 0.46 ± 0.01 | 0.35 ± 0.01 | 0.32 ± 0.01 | 1.33 ± 0.09 |

| Soil series | Fertilizer practice | Fe(mg/kg) | Mn(mg/kg) | Cu(mg/kg) | Zn(mg/kg) | S(mg/kg) |
|---|---|---|---|---|---|---|
| Maho | With manure application | 106.26 ± 18.19 | 210.66 ± 39.31 | 3.96 ± 0.68 | 29.89 ± 2.68 | 0.11 ± 0.03 |
| | Without manure application | 115.73 ± 6.89 | 188.58 ± 28.90 | 3.03 ± 0.13 | 28.79 ± 1.76 | 0.10 ± 0.01 |
| Wariyapola | With manure application | 139.26 ± 8.68 | 179.00 ± 19.32 | 3.61 ± 0.32 | 29.13 ± 1.56 | 0.12 ± 0.01 |
| | Without manure application | 121.83 ± 4.30 | 134.21 ± 8.56 | 3.87 ± 0.34 | 29.85 ± 0.72 | 0.12 ± 0.01 |

Among the major nutrients N, P and Mg have shown above the critical levels at the leaf samples collected in manure application soils as well as without manure application soils (N > 1.9%, P > 0.11% and Mg 0.25%) in both soil series. But, K levels were below the critical levels (K > 1.2%) of sampling sites at both soil series.

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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)

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

A new site was selected at Bandirippuwa Estate in the year 2003. The experiment was established as demonstration block having 9 palms (25 years old) in each treatment. Treatments were applied in May.

The annual treatment application was as follows.

$T_1$ - Control (no fertilizer)
$T_2$ - 3 kg APM (Adult Palm Mixture) + 1 kg dolomite per palm
$T_3$ - 35 kg cattle manure + 1200 g MOP per palm
$T_4$ - 25 kg goat dung + 800 g MOP per palm
$T_5$ - 30 kg poultry manure + 250 kg MOP per palm
$T_6$ - 30 kg Gliricidia + 750 g SP + 1500 g MOP + 1000 g dolomite per palm

Gliricidia was not applied at BE site.

Leaf samples collected at Ratmalagara Estate site on May 2005 were analyzed and results are given in Table 43. Leaf Mg has shown significant difference ($p \leq 0.05$) among the treatments. This difference was clearly shown between fertilized palms and no fertilized palms. Essential nutrients such as N, P and Mg were in the above critical level except K (N < 1.9 %, P < 0.11 %, K < 1.2 %, Mg < 0.25%).

**Table 43 :** ***Leaf nutrient levels in 14$^{th}$ frond***

| Treatment | N % | P % | K % | Mg % |
|---|---|---|---|---|
| $T_1$ | 2.39 | 0.14 | 0.81 | 0.25 |
| $T_2$ | 2.30 | 0.14 | 1.08 | 0.26 |
| $T_3$ | 2.28 | 0.14 | 1.07 | 0.29 |
| $T_4$ | 2.34 | 0.14 | 1.12 | 0.29 |
| $T_5$ | 2.28 | 0.15 | 1.14 | 0.30 |
| $T_6$ | 2.37 | 0.14 | 1.17 | 0.27 |
| Level of significant | ns | ns | ns | * |
| LSD ($p \leq 0.05$) | - | - | | 0.068 |

**Table 44 :** ***Nut yield data in the Ratmalagara Experimental Site***

| Treatment | June 1997 to August 2004 Nuts/palm | June 2004 to August 2005 Nuts/palm/yr |
|---|---|---|
| $T_1$ | 370 | 54. |
| $T_2$ | 443 | 59 |
| $T_3$ | 478 | 63 |
| $T_4$ | 472 | 69 |
| $T_5$ | 513 | 72 |
| $T_6$ | 441 | 63 |
| Level of Significance | * Only in year 2002/2003 | ns |
| LSD ( $p \leq 0.05$) | 20 | - |

Nut yield of the palms receiving poultry manure was significantly increased ($p \leq 0.01$) by 34% compared to that of the control (no fertilizer) while the yield increase by inorganic fertilizer over the control (no fertilizer) was 8.5% (Table 44). Among other organic sources such as cattle manure, goat manure and gliricidia, the yield increase was 18%, 28% and 17% over the control (no fertilizer) respectively. Twenty two percent yield increase was observed in palms receiving poultry manure over inorganic fertilizer (APM-W). Results indicated that the application of organic manure such as poultry manure, cattle manure, goat manure etc were more economical and beneficial than that of inorganic fertilizer.

Table 45 shows some important physical parameters of the soil. Even though the data have not shown any significant differences, penetration (hardness) and bulk density of soil in poultry manure treated soils were reduced by 13% and 10% over the control soils while the moisture was increased by 37% in poultry manure treated soil than control soil.

**Table 45 :** ***Soil physical parameters***

| Treatment | Penetration/$Nm^{-3}$ | | Moisture % | | Bulk density/$gcm^{-3}$ | |
|---|---|---|---|---|---|---|
| | MC | CS | MC | CS | MC | CS |
| $T_1$ | 306.50 | 298.30 | 2.54 | 4.19 | 1.39 | 1.59 |
| $T_2$ | 312.50 | 283.33 | 2.59 | 4.56 | 1.48 | 1.60 |
| $T_3$ | 283.33 | 288.33 | 3.27 | 3.76 | 1.34 | 1.58 |
| $T_4$ | 297.50 | 295.00 | 3.04 | 4.49 | 1.33 | 1.53 |
| $T_5$ | 271.67 | 245.00 | 3.47 | 3.84 | 1.26 | 1.67 |
| $T_6$ | 260.00 | 261.67 | 2.72 | 4.10 | 1.44 | 1.52 |
| Level of significance | ns | ns | ns | ns | ns | ns |
| LSD($p \leq 0.05$) | - | - | - | - | - | - |

**II) BE site**

Treatment combinations are given in Table 46.

**Table 46 :** ***Treatment combination of the BE site***

| | |
|---|---|
| $T_1$ | 35 kg cow dung + 1250 g MOP |
| $T_2$ | 25 kg goat dung + 800 g MOP |
| $T_3$ | 4 kg APM + 1600 g MOP |
| $T_4$ | 30 kg layer poultry manure + 750 g MOP |
| $T_5$ | 30 kg broiler poultry manure + 750 g MOP |
| $T_6$ | Control |

**Table 47 :** ***Nut yield of the experiment at BE site***

| Treatment | Nut yield per palm/year | |
|---|---|---|
| | 2003 May to 2004 May | 2004 May to 2005 May |
| $T_1$ - cow dung | 97 | 50 |
| $T_2$ - goat dung | 101 | 61 |
| $T_3$ - APM | 93 | 69 |
| $T_4$ - layer poultry manure | 85 | 95 |
| $T_5$ - broiler poultry manure | 116 | 84 |
| $T_6$ - control | 81 | 34 |
| Level of Significance | ns | * |
| LSD ($p \leq 0.05$) | - | 25 |

Nut yield of the experiment have shown significant differences ($p \leq 0.05$) among the treatments (Table 47). Highest nut yield was recorded from the palms receiving layer and broiler litter poultry manure.

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

The objective of the experiment was to study the rate of increase in soil organic matter with application of different levels.

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

Treatments are given as follows.

| | |
|---|---|
| $T_1$ | Control |
| $T_2$ | Cattle manure 35 kg per palm/yr |
| $T_3$ | Cattle manure 50 kg per palm/yr |
| $T_4$ | Cattle manure 75 kg per palm/yr |
| $T_5$ | Cattle manure 100 kg per palm/yr |

| | | |
|---|---|---|
| Basal dosage - | Eppawela Rock Phosphate | 900 g |
| | Muriate of Potash | 1600 g |
| | Dolomite | 1000 g/palm/yr |

Plots demarcating was completed and preliminary nut yields recording is in progress.. The site for Sudu soil series will be selected in 2006.

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## MISCELLANEOUS STUDIES

### I) The effect of different management practices on mite infestation

A survey was conducted by the division on mite infestation of palms undergone different management practices such as (i) organic manure vs. inorganic fertilizer, (ii) irrigation vs. non irrigation, (iii) high levels of muriate of potash application etc.

The results reveled that there is no significant relationship between mite infestation and the above management practices (Table 48).

**Table 48 :** ***Effect of different management practices***

| Experiment | No. of nuts% Mite infestation | Mite infested normal nuts | | | |
|---|---|---|---|---|---|
| | | Husk nut weight/nut | Dehusk nut weight/nut | Split nut/nut | Significance $p \leq 0.05$ |
| ***1. Irrigation*** | | | | | |
| No irrigation | 56 | 1.46 | 0.63 | 0.48 | ns |
| Irrigation + APM once a year | 59 | 1.37 | 0.65 | 0.50 | ns |
| Irrigation + APM split application | 69 | 1.41 | 0.66 | 0.51 | ns |
| ***2. Different K levels (As Muriate of Potash)*** | | | | | |
| No K (MOP)/palm/yr | 76 | 1.75 | 0.68 | 0.54 | ns |
| 1600 g MOP/palm/yr | 81 | 1.63 | 0.66 | 0.53 | ns |
| 2200 g MOP/palm/yr | 68 | 1.65 | 0.69 | 0.55 | ns |
| 2800 g MOP/palm/yr | 71 | 1.69 | 0.66 | 0.51 | ns |
| 3400 g MOP/palm/yr | 73 | 1.85 | 0.71 | 0.55 | ns |
| ***3. Poultry manure*** | | | | | |
| No manure applied | 73 | 1.47 | 0.69 | 0.54 | ns |
| Three months seasoned layer litter | 74 | 1.57 | 0.70 | 0.56 | ns |
| ***4. Different organic manure*** | | | | | |
| No fertilizer | 52 | 1.61 | 0.67 | 0.53 | ns |
| APM only | 52 | 2.25 | 1.05 | 0.84 | ns |
| Cattle manure | 55 | 1.63 | 0.74 | 0.59 | ns |
| Goat manure | 52 | 1.51 | 0.66 | 0.54 | ns |
| Poultry manure | 47 | 1.64 | 0.73 | 0.58 | ns |
| Gliricidia | 55 | 1.73 | 0.76 | 0.57 | ns |

## II) The nutrient status of the mite infestation coconut palms

The 14th leaf were collected from the highly (100%) mite infested coconut palms in the different locations of Dry zone (Table 49). The leaf nutrient levels reveled that Cu and Zn were below the critical levels of the mite-infested palms and other nutrients determined were in the sufficiency ranges (Table 49).

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**Table 49 :** ***Leaf nutrient levels of the mite infested palms***

| Sample details | 1st bunch % affected | 2nd bunch % affected | Age of palm | Soil type |
|---|---|---|---|---|
| Battuluoya (Thomaskanda) Pudukudirippuwa | 100 | 100 | 50 yrs | Sandy |
| Mundel (Puttalam Main Road) | 100 | 100 | 45 yrs | Sandy loam |
| Mundel - Hotel Watta (Main Road) | 100 | 100 | 50 yrs | Sandy loam |
| Mangala Eliya (Sirivasa Estate) | 100 | 100 | 40 yrs | Sandy loam |
| Marachchikatti (Nelumwatta) | 100 | 100 | 40 yrs | Sandy loam |
| Kadayamottai (Madurankuliya Road) | 100 | 100 | 15 yrs | Sandy |
| Sembatta (Madurankuliya Main Road) | 100 | 100 | 15 yrs | Sandy |
| Karambe (Molawatta) (Kalpitiya Road) | 100 | 100 | 15 yrs | Sandy loam |
| Mampuri (Kalpitiya Road) | 100 | 100 | 20 yrs | Sandy |
| Mampuri (Sevathiya Estate) | 100 | 100 | 15 yrs | Sandy |
| Sirambiadiya (Anuradhapura Road) | 100 | 100 | 35 yrs | Sandy loam |
| Sirambiadiya (2nd Mile Post) | 100 | 100 | 15 yrs | Sandy loam |
| Arachchivilluwa (Kurunegala Road) | 100 | 100 | 40 yrs | Sandy loam |
| Kurunegala Road (3rd Mile Post) | 100 | 100 | 12 yrs | Sandy clay |
| Wepumaduwa (Vanathavillu Road) | 100 | 100 | 15 yrs | Sandy clay |
| Karandipuwal (Vanathavillu Road) | 100 | 100 | 15 yrs | Sandy clay |

| Sample details | N% | P% | K% | Mg% | Ca% | Na% | Fe mg/kg | Mn mg/kg | Cu mg/kg | Zn mg/kg | B mg/kg |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Battuluoya (Thomaskanda) | | | | | | | | | | | |
| Pudukudirippuwa | 2.25 | 0.142 | 1.29 | 0.19 | 0.46 | 0.12 | 145 | 144 | 6.7 | 31.1 | 8.95 |
| Mundel (Puttalam Main Road) | 1.93 | 0.139 | 1.00 | 0.32 | 0.46 | 0.22 | 137 | 171 | 5.2 | 37.8 | 10.0 |
| Mundel - Hotel Watta (Main Road) | 2.20 | 0.142 | 1.40 | 0.31 | 0.49 | 0.27 | 198 | 157 | 4.5 | 20.1 | 13.3 |
| Mangala Eliya (Sirivasa Estate) | 2.03 | 0.118 | 1.21 | 0.41 | 0.37 | 0.20 | 117 | 221 | 4.4 | 42.5 | 8.43 |
| Marachchikatti (Nelumwatta) | 2.13 | 0.136 | 1.75 | 0.23 | 0.37 | 0.16 | 173 | 57.8 | 5.5 | 21.5 | 8.60 |
| Kadayamottai (Madurankuliya Road) | 2.15 | 0.142 | 2.47 | 0.12 | 0.36 | 0.11 | 271 | 44.1 | 4.7 | 20.8 | 7.55 |
| Sembatta (Madurankuliya Main Road) | 2.00 | 0.125 | 0.63 | 0.45 | 0.58 | 0.37 | 144 | 62.7 | 3.8 | 21.6 | 11.2 |
| Karambe (Molawatta) (Kalpitiya Road) | 2.23 | 0.162 | 0.78 | 0.37 | 0.53 | 0.24 | 203 | 97.6 | 4.9 | 33.4 | 8.16 |
| Mampuri (Kalpitiya Road) | 2.25 | 0.162 | 1.28 | 0.43 | 0.44 | 0.27 | 189 | 128 | 4.7 | 26.2 | 12.3 |
| Mampuri (Sevathiya Estate) | 2.30 | 0.162 | 1.86 | 0.25 | 0.43 | 0.22 | 117 | 54.9 | 3.9 | 18.0 | 9.57 |
| Sirambiadiya (Anuradhapura Road) | 2.20 | 0.130 | 1.50 | 0.28 | 0.50 | 0.17 | 171 | 81.1 | 4.9 | 20.1 | 16.8 |
| Sirambiadiya (2nd Mile Post) | 2.30 | 0.162 | 2.70 | 0.28 | 0.48 | 0.48 | 131 | 86.8 | 5.9 | 52.6 | 14.1 |
| Arachchivilluwa (Kurunegala Road) | 2.30 | 0.142 | 1.37 | 0.26 | 0.57 | 0.20 | 117 | 126 | 4.2 | 25.9 | 10.2 |
| Kurunegala Road (3rd Mile Post) | 2.53 | 0.139 | 2.71 | 0.25 | 0.29 | 0.22 | 116 | 89.6 | 4.7 | 26.9 | 12.8 |
| Wepumaduwa (Vanathavillu Road) | 2.40 | 0.162 | 1.68 | 0.36 | 0.59 | 0.53 | 180 | 194 | 4.1 | 24.4 | 9.57 |
| Karandipuwal (Vanathavillu Road) | 1.80 | 0.122 | 1.39 | 0.25 | 0.60 | 0.19 | 121 | 174 | 4.3 | 32.9 | 9.04 |
| Mean | 2.19 | 0.143 | 1.56 | 0.30 | 0.47 | 0.25 | 158 | 118 | 4.78 | 28.5 | 10.7 |
| Sufficiency Range | 1.9-2.1 | 0.11-0.13 | 1.2-1.5 | 0.25-0.35 | 0.35-0.5 | 0.4-0.5 | 40 | 60 | 5 | 30< | 8-10 |

### III) Physico-chemical and nutritional status and the occurrence of arbuscular mycorrhiza in coconut palms affected with leaf scorch decline and rapid decline, compared with healthy palms in Makandura Research Station

The experiment was conducted in Block No. 4 of Makandura Research Station in a Randomized Block Design. Three soil types ($S_2$, $S_3$ and $S_4$) were considered as blocks, and Leaf Scorch Decline (LSD). Coconut Rapid Decline (CRD), and apparently healthy (H) palms were considered as treatments. Three replicate palms were selected for each treatment from each block (soil type).

The objectives of the experiment were to understand the difference in nutritional status and soil condition of LSD, CRD and healthy palms, to investigate whether there is a toxicity of Al in LSD palms, and to study the presence of arbuscular mycorrhizal fungi (AMF) in palms subjected to this study, hypothesizing the healthy palms are benefited by AMF.

Soil samples were collected from the manure circle of each palm from top (0-20) and sub (20-30) soil and analyzed for the following parameters.

$pH_{(H2O)}$, $pH_{(KCl)}$, electrical conductivity, cation exchange capacity, organic carbon, total nitrogen, available phosphorus, exchangeable K, Ca, Mg and the micronutrients, Zn, Cu, B, Mn, Fe, Na and Al. Leaf samples were analyzed for N, P, K, Ca, Mg, Zn, Cu, B , Mn and Fe.

Root samples were collected and stained to observe mycorrhizal fungi to determine infection ratio. Soil samples collected from the rhizosphere soil were used to extract AMF spores to determine AMF spore density.

The results reveled that the total N and available P in soil were significantly high in LSD palms compared with CRD and H.

This is supposed to be due to the inability of the roots of LSD to absorb N and P or any other disability related to soil condition.

This observation was in consistence with the low level of N in the leaves of LSD palms. But leaf P was not significantly different from CRD and H.

No Al toxicity was observed in LSD affected palms. But all the micronutrients except Fe were significantly lower in the leaves of LSD and CRD palms compared with H. But in soil no significant difference in micronutrients were observed between LSD, CRD and H.

The spores of AMF were observed in the rhizosphere soil of LSD, CRD and H palms. There were several types.

No fungal colonization was observed in the roots. Therefore, the spores obtained could not be confirmed as AMF spores. Much sophisticated study is needed in this regard.

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## 3. SERVICE FUNCTIONS

| | | |
|---|---|---|
| Differential Fertilizer Recommendation | - | 110 growers (1900 ac) |
| Land suitability tests for coconut cultivation/surveys | - | 42 growers |
| Inorganic fertilizer analysis | - | 116 samples |
| Organic fertilizer analysis | - | 58 samples |
| Analysis of coir pith samples | - | 1015 samples |
| Soil analysis | - | 29 samples |

| | | |
|---|---|---|
| Leaf analysis | - | 78 samples |
| Water analysis | - | 30 samples |
| Participation in training programmes | - | 07 |

## 4. ACKNOWLEDGEMENT

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

# REPORT OF THE CROP PROTECTION DIVISION

**Head – L.C.P. Fernando, PhD**

## 1. GENERAL

The research on the development of an integrated management programme for coconut mite continued to receive the highest priority of the Division. The research was mainly focused on biological and chemical control methods. The predatory mite, *Neoseiulus baraki* population increased steadily with a mean of 9.3 mites per nut in the field. In contrast to the decreasing trend of the coconut mite population over the last few years the coconut mite population showed a considerable increase in 2005. Laboratory breeding of *N. baraki* was continued and field releases of 50,000 mites in each of two infested sites were made. The study indicated that *N. baraki* numbers in the released blocks were higher than the unreleased blocks throughout the experimental period. The coconut mite numbers were lower in the released blocks than in the control blocks at many occasions after release. Survey to determine the composition of *N. baraki* and *N. paspalivorus* in different agro-ecological regions of infested areas indicated that *N. baraki* was mainly confined to dry areas whereas both species were found in intermediate and wet areas.

Studies on the life cycle, fecundity and interaction with *N. baraki* and the ability to enter underneath bracts of infested coconuts of the exotic predatory mite, *Proctolalaeps bickleyii* were made. Egg to adult stages of *P. bickleyii* took 8-10 days and a female laid a mean of 36.2 eggs during the lifetime. In the field (bagged) only 1.2% of *P. bickleyii* released on to coconut mite infested nuts entered underneath the bracts. They feed on *N. baraki* even in the presence of abundance of coconut mites indicating that *P. bickleyii* is not a promising candidate for the biological control of coconut mite in Sri Lanka.

The collaborative project with CABI Bioscience, U.K. funded by the Department for International Development, U.K. to develop an integrated management programme for coconut mite with emphasis on the use of entomopathogenic fungus *Hirsutella thompsonii* was continued. Field studies indicated that the isolate IMI 391722 has the greatest potential as a biological control agent for the coconut mite. Over 90% of the nuts that received IMI391722 had <100 live coconut mites after 2 weeks of treatment and significant levels of mycosis on dead mites were found up to eight weeks after the 2$^{nd}$ application. A study was initiated to determine the suitable frequency of application.

Further improvements were made in developing a digital image processing system to estimate the coconut mite populations on a nut. Mites on the surface of the wash solution were successfully counted at the computer using Arc soft photo studio and Adobe Photoshop which is much easier than counting them directly under the microscope.

Spraying of a 20% emulsion of palm oil with 5g wettable sulpur reduced the coconut mite population significantly and the treatment did not affect the predatory mites. A study to evaluate the efficacy of two neem based botanicals i.e. Neemraj (1% azadirachtin) and Econeem plus (1% azadirachtin) by root feeding and spraying was initiated.

A new project was commenced to screen different coconut varieties and improved cultivars at different locations for resistance/ tolerance against coconut mite damage. Out of Dwarf yellow, Dwarf green and Ambakelle tall varieties Dwarf yellow variety had the lowest crop loss of 7.32 % nuts at harvest. There was no significant difference between Ambakelle tall and Dwarf yellow varieties with respect to the initiation of symptoms, but the level of population was significantly high in Ambakelle tall compared to Dwarf yellow. Compared to San Ramon and ordinary tall, Gon Thembili had a lower incidence of symptom initiation and damage expression. A study was initiated to evaluate cultivars Dwarf yellow X

Tall, Dwarf green X Tall, and Tall X Tall for tolerance against coconut mite. Studies are in progress to determine morphological characters of the nuts and to identify the mechanism for tolerance.

Financial support for coconut mite research was provided by coconut CESS, consolidated fund, CARP project and DFID project.

The study to understand the population fluctuation pattern of the parasitic nematode, *Radopholus similis* infesting coconut roots was completed. Populations of *R. similis* in both soil and roots declined over 3 years. The gas liquid chromatography method to identify differences in the components of the cell sap of healthy and Leaf scorch decline affected palms indicated a difference between the two.

A survey was initiated in Matara District to assess the severity of leaf rot disease and related factors in different areas.

The Division embarked on three new projects during the year. Testing of integrated management strategies for black beetle and Farmer Field Schools (FFS) were commenced with the funds of CFC/DFID/FAO/APCC project on integrated management of coconut pests. Five FFS in four districts were initiated as a tool to extend technologies in pest management. The collaborative research project with the Rinzen Laboratories (Pvt) Ltd to improve the electronic device to detect red weevil infested palms received funding from CARP. Improvement of the device using latest technologies was continued.

The Division continued to serve the coconut growers during the year. Advice on management of pests and diseases were given while field inspections were made in instances where specialized advice was required. Many infestations of coconut caterpillar were reported from several areas and they were successfully managed by releasing nearly 368,490 laboratory-bred parasitoids. A total of 6027 pheromone vials were sold and 304.6 l of monocrotophos was issued to the growers to manage red weevil.

## 2. RESEARCH PROJECTS

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

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

The experiment initiated to study the seasonal population fluctuation pattern of coconut mite and its predator, N. baraki was continued for the 6$^{th}$ consecutive year in 4 areas viz. Madurankuliya, Kalpitiya, Chilaw and Rajanganaya. In each area, nuts were collected from 3 coconut mite infested sites in February, June, August and November which are correspondent to the dry, wet but less intense rainfall, dry and wet with intense rainfall periods respectively. Populations of both pest and predator fluctuated over time. Pest and predator populations reached higher levels in 2005 (mean 1134 pest/nut,9.3 predators/nut). Except for Kalpitiya, both pest and predator reached the maximum density in June. In Kalpitiya the highest pest density was reached in February and the highest predator density was reached in August. In general a higher pest and predator densities were observed in Kalpitiya and Chilaw throughout the year.

in

*N. S. Arachchige, L.C.P. Fernando, K.F. G. Perera & P. H. A. R. de Silva*

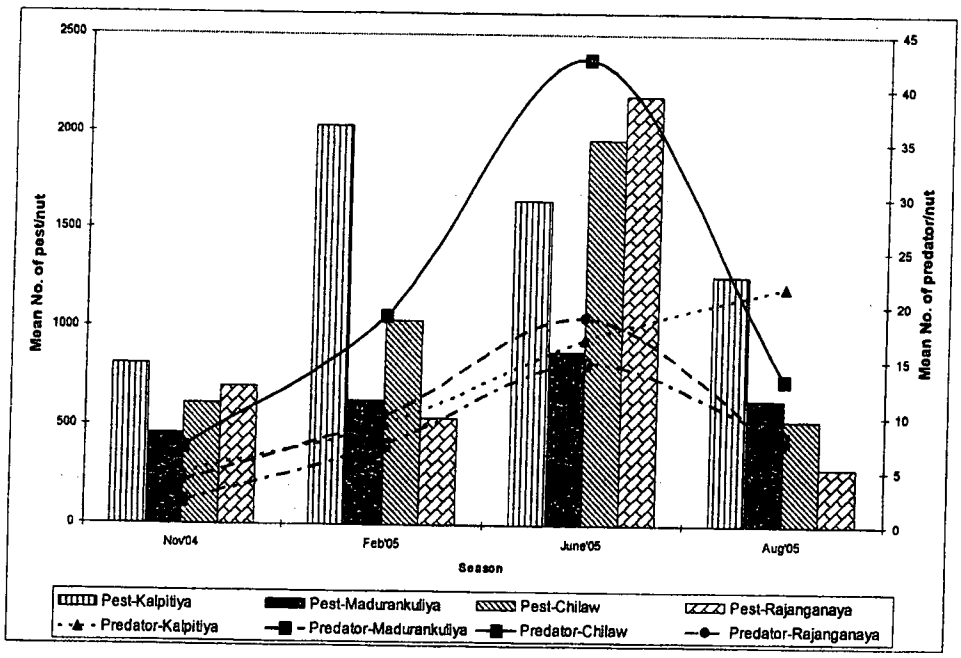


*Figure 1.* ***Mean numbers of coconut mite and N. baraki at different intervals of 2005 in four sites (predators/nut)***

**Experiment 27.30: Development of a digital image processing system to count coconut mites (2002)**

A study initiated in developing a computer-based technique to count coconut mites in a digital image was continued. Improvements were made to count the mites in the wash using different magnifications. Mites on the surface of the wash solution were successfully counted at the computer using Arc soft photo studio and Adobe Photoshop. This system of counting is much easier than counting them directly under the microscope. Whether all mites in all stages in the colony come to the surface is still not clear and improvements are being made to obtain as many mites as possible on to the surface.

Solutes such as sucrose and common salt dissolved in the wash solution which increase the density of the wash solution did not improve the number of mites coming on to the surface of the solution after keeping for two hours. Therefore, more solutes will be tested to improve the number of mites taken on to the surface.

Also images were taken on the nut surface and perianth surface to count the numbers on the patches that are marked using a cork borer for obtaining live and dead counts. It was not possible to distinguish between the live and dead mites in the image. Therefore, both the number of live or dead mites, which ever lower was counted manually and the total was counted using the image. This makes the counting of the entire patch much easier (than counting the entire patch manually under the microscope).

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**Experiment 27.59: Screening of different coconut varieties, forms and cultivars for tolerance/resistance against coconut mite (2005)**

Field observations have revealed that there is a difference in the severity of coconut mite infestation among different varieties, color forms and improved cultivars. The study was commenced to investigate the difference between levels of tolerance in those in terms of symptoms initiation and subsequent expression of symptoms and to understand the mechanism behind the tolerance by investigating the characters that could lead to the tolerance. Parental material at ISG Ambakelle (dwarf green, dwarf yellow and tall), three tall color forms at Bandirippuwa Estate (Gon Thembili, San Ramon and ordinary tall), and three improved cultivars (Dwarf Yellow X Tall, Dwarf green X Tall and Tall X Tall) at Tammennawa Estate, Puttalam were selected. Damage assessments in the fourth bunch and at harvest were obtained. The characters investigated were nut shape (ratio of length to breadth) and tightness of perianth. Yield data were collected to estimate the crop loss due to coconut mite damage in different varieties.

Preliminary results at Bandirippuwa estate indicated that Gon Thembili had a lower incidence of symptom initiation and subsequent expression of symptoms on the fourth bunch. Harvest record collected at one pick in ISG Ambakelle showed that the crop loss due to mite damage was significantly low in yellow dwarf (Table 1).

**Table 1:** ***Crop loss due to coconut mite in three varieties at Ambakelle Seed Garden***

| Variety | Percentage Crop Loss |
|---|---|
| Dwarf Yellow | 7.32 |
| Dwarf Green | 22.3 |
| Ambakelle special | 13.7 |
| LSD | 4.34 |
| CV | 18.78 |

Data showed that there was no significant difference in symptoms initiation among dwarf yellow and Ambakelle Tall, but the level of population was significantly higher in Ambakelle Tall than Yellow Dwarf. The experiment is in progress.

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**Experiment 27.60: Effect of releasing lab-bred *N. baraki* on coconut mite population (2005)**

A study was conducted in Margret estate and an estate at Battuluoya to determine the effect of releasing lab-bred *N. baraki* on the coconut mite population. In each estate a block consisting of 60 coconut mite infested palms were selected and each of 10,000 predatory mites were released on 5 infested palms. Two nuts from released palms and 5 palms in the released block were picked at 2-weekly intervals to assess the coconut mite and predatory mite populations. Several coconut rows apart from the released block, 10 nuts were collected as controls.

The results showed that in both sites the pest population in the released blocks were lower than the control blocks at many occasions following the releases (Figs. 2 & 3), but the reduction was not considerably high. The predatory mite population were higher in thé released palms than thé control palms in both sites at all times. Also pest : predatory mite ratio was always lower in the released block than the control. The results are being statistically analysed.

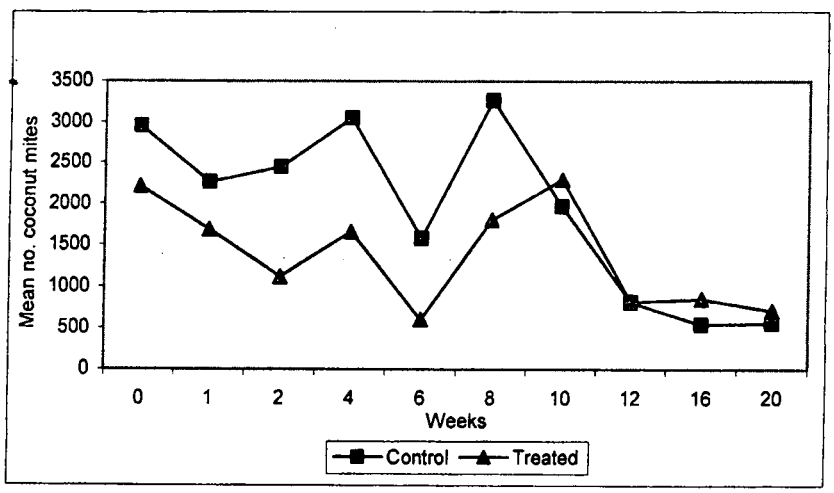


*Figure 2.* ***Mean number of coconut mites on treated and control blocks after release of predators at Margret estate***

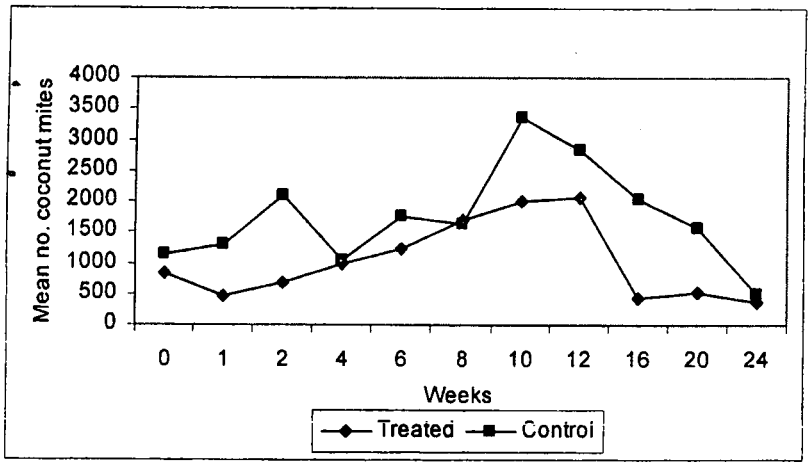


*Figure 3.* ***Mean number of coconut mites on treated and control blocks after release of predators at Battuluoya***

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**Experiment 27.61: Life cycle and fecundity of *P. bickleyii* (2005)**

The life cycle, fecundity and feeding efficiency of *P. bickleyii* were determined. Twenty five eggs of *P. bickleyii* were placed individually in arenas and checked every day to record different stages of the mite. Egg, larva, protonymph and deutonymph stages lasted 1.3±0.2, 1.4±0.1, 1.6±0.1 and 5.5±0.6 days

respectively. Nine female duetonymphs of *P. bickleyii* were mated and introduced on to areans individually. The arenas were observed every two days and the number of eggs laid were recorded. The females were maintained until their death. *P. bickleyii* has a preoviposion period of 22 days, fecundity of 36.2±4.3 eggs and a longevity of 53.9±4.0 days.

*L.C.P. Fernando, S. Mayadunne & R.P.N.P Sanjeewa (Wayamba University)*

**Experiment 27.54: Determination of the ability of the imported predatory mite *Proctolalaeps bickleyii* to move underneath the bracts of infested coconuts (2004)**

A laboratory trial in the previous year indicated that only 8% *P. bickleyii* that were released entered the nuts. A field study was conducted to investigate whether the same occurs in field conditions. Six 5-month old bunches were enclosed in insect proof muslin cloth and 500 *P. bickleyii* were released on to each bunch. The bunches were picked after 3 days and the number of *P. bickleyii* under the bracts were counted.

There were significant differences in the numbers of *P. bickleyii* found in different bunches ($P<0.05$, Kruskal-Wallis test). A total of 14, 2, 1, 1, 8, and 9 predators were found on the 6 bunches which is only 1.16% of the number released. Also they have entered in to 26.8% of the nuts. It indicated that in field conditions the number entered the nuts were far less than in the laboratory conditions. Also, most nuts that *P. bickleyii* present had cracks in the perianth region due to mite attack. The results clearly indicated that *P. bickleyii* could not readily enter the perianth suggesting that it is not a prospective bio control agent for coconut mite in Sri Lanka.

*P. Fernando, S. Mayadunne & R. Dissanayake*

**Experiment 27.62 : To determine interaction between *P. bickleyii* and *N. baraki* (2005)**

Two studies were conducted to determine whether *P. bickleyii* feeds on *N. baraki* .A single *P. bickleyii* was placed on an arena with abundant of coconut mites and 10 females of *N. baraki*. The arena was observed for 3 hours in 3 one hourly intervals under a stereomicroscope. The experiment replicated 10 times. The direct observations revealed that *P. bickleyii* feeds on *N. baraki*. *P. bickleyii* fed a mean of 2.9 *N. baraki* during the 3 hour period. But they have rarely fed on one to two coconut mites during the period.

In the second study bracts infested with coconut mites (>1000 mites) were placed on 20 individual arenas. On to each arena 20 *N. baraki* adults and 5 *P. bickleyii* females were introduced and were left for 6 hours. Similarly 20 *N. baraki* adults were released on to each of 20 arenas as the control. A mean number of 9.65±3.59 *N. baraki* was fed (and lost) by 5 *P. bickleyii* while in the control a mean number of 1.2±3.84 *N. baraki* was missing. After adjusted for the missing number it was found that 42.2% of *N. baraki* was fed by 100 *P. bickleyii* during the 6 hour period (1.69 *N. baraki/P. bickleyii*). The results suggested that in the laboratory conditions *P. bickleyii* feed a considerable number of *N. baraki* even in the presence of abundant coconut mites. However, the interaction in the field conditions cannot be tested since *P. bickleyii* has not been released in the field. Since there are chances that *P. bickleyii* could feed on *N. baraki* in field conditions it further shows that *P. bickleyii* is not a desirable bio control agent for Sri Lanka.

*L.C.P. Fernando, S. Mayadunne, R. Dissanayake & R.P.N.P Sanjeewa (Wayamba University)*

**Experiment 27.53: Survey to determine distribution of *N. baraki* and *N. paspalivorus* in different agro-climatic zones (2004)**

A study initiated to determine the distribution of *N. baraki* and *N. paspalivorus* in different agro-climatic regions over time was continued. The data collected during the year indicated that both species are found in many areas. But *N. baraki* was the most prevalent species. In Anuradhapura, Puttalum and Polonnaruwa districts only *N. baraki* was found whereas in Kurunegala, Ampara, Hambantota (Tissamaharama) and Gampaha districts both species were found. *N. paspalivorus* was more confined to wetter areas of these regions. In Gampaha district and Tissamaharama the prevalence of *N. paspalivorus* has increased over time. Very few species of natural enemies were found so far. Studies are being continued.

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**Experiment 26.56: Comparison of four isolates of *H. thompsonii* for the management of coconut mite in the field (2003)**

On the basis of culture and sporulation characteristics CABI selected 4 local isolates of *H. thompsonii* namely IMI 391722, IMI 390486, IMI 391723 and IMI 391942 for field-testing for effectiveness. Testing of these isolates was completed in 2 estates in Madurankuliya. Six palms were treated with each isolate (spore suspensions of $5 \times 10^6$ $ml^{-1}$) twice at a 2-week interval. The numbers of live coconut mites (low <100, medium 100-500 and high >500) and predatory mites, number of dead predatory mites and infection on dead coconut mites and predatory mites on 2 nuts of 4-month old bunches of all treated palms and 6 untreated control palms were recorded at different intervals.

Two weeks after the application, palms treated with isolates IMI 391722, IMI 390486 and IMI 391723 had significantly larger proportion of nuts with <100 live mites (considered a "low" level) compared to controls. The proportion of nuts with <100 mites remained significantly higher for IMI 391722 at 4 weeks but the same did not apply for others (Tables 2 & 3). Beyond 4 weeks differences between treated and control palms became erratic. However, the proportion of nuts with <100 mites was always higher in IMI 391722 than the control nuts, except at one sampling time. Mycosis on coconut mites was recorded up to 16 weeks in all the isolates, except IMI 391942. Up to 6 weeks after the proportion of nuts showing mycosis of mites was significantly higher in all treatments compared to the controls. Up to 8 weeks >90% of nuts treated with IMI 391722 had clear signs of mycosis, this was significantly higher than other isolates. The results showed that IMI 391722H2 isolate is superior to others.

*L.C.P. Fernando, D.C.L. Hapuarachchi & C. Senarathne*

**Table 2:** ***Percentage of nuts with <100 live coconut mites following 2 applications of H. thompsonii (isolates IMI 391722 and IMI 390486) and for control (untreated) nuts at FNF estate***

| Weeks after 2nd spray | Nuts with >100 mites (%) | | |
|---|---|---|---|
| | IMI 391722 | IMI 390486 | Control |
| 2 | 0.0[1] | 0.0[1] | 75.0[2] |
| 4 | 8.3[1] | 41.7[2] | 75.0[2] |
| 6 | 45.5[1] | 100.0[2] | 50.0[1] |
| 10 | 83.3[1] | 88.9[1] | 55.6[1] |
| 14 | 50.0[1] | 100.0[2] | 55.6[1] |
| 18 | 37.5[1] | 75.0[1] | 71.4[1] |
| 22 | 40.0[1] | 50.0[1] | 100.0[2] |
| 26 | 60.0[1] | 50.0[1] | 70.0[1] |
| 30 | 55.6[1] | 87.5[2] | 90.9[3] |

([1,2,3] if the horizontal numbers are different there is significance between values, $p<0.05$)

**Table 3:** ***Percentage of nuts with <100 live coconut mites following 2 applications of H. thompsonii (isolates IMI 391723 and IMI 391942) and for control (untreated) nuts at Manchadi estate***

| Weeks after 2nd spray | Nuts with >100 mites (%) | | |
|---|---|---|---|
| | IMI 391723 | IMI 391942 | control |
| 2 | 16.7[1] | 66.7[2] | 60.0[2] |
| 4 | 63.6[1] | 58.3[1] | 81.8[1] |
| 6 | 77.8[1] | 50.0[1] | 70.0[1] |
| 10 | 100.0[1] | 90.9[1] | 77.8[1] |
| 14 | 71.4[1] | 71.4[1] | 30.0[2] |
| 18 | 83.3[1] | 85.7[1] | 100.0[1] |
| 22 | 25.0[1] | 100.0[2] | 100.0[2] |
| 26 | 90.9[1] | 77.8[1] | 80.0[1] |
| 30 | 88.9[1] | 81.8[1] | 90.9[1] |

([1,2] if the horizontal numbers are different there is significance between values, $p<0.05$)

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

The experiment was commenced at three estates (Martin Farm, Chilaw, Ariyagama and Manchadi estate, Madurankuliya) to determine the most suitable frequency of application of IMI 391722 isolate. Two frequencies 2-monthly and 3-monthly are being tested. At Martin Farm and Ariyagama 20 palms were selected for each treatment and 10 palms were selected as untreated control. Samples of one nut per palm were collected every month from 10 palms of each treatment. In Manchadi estate approximately 60 palms were treated at each frequency and a single nut from each of 15 palms are sampled. The study is in progress.

*L.C.P. Fernando, D.C.L. Hapuarachchi, C. Senarathne, P. Damayanthi & S. Wijekoon*

**Experiment 27. 56: Field evaluation of carbosulfan 20% against coconut mite (2004)**

As preliminary results indicated that application of Marshal SC reduces both coconut mite population and its damage in newly developing bunches over time a large block of affected palms were treated with the chemical to verify the efficacy. One acre was sprayed at a rate of 4 ml per liter at monthly intervals for 12 months. In another 30 palms root feeding was conducted. A separate untreated block was maintained as the control. Total population of coconut mite, number of predatory mites on the fourth bunch and the percentage of damaged nuts of the same bunch was assessed.

The total number of coconut mites on the fourth bunch did not decrease over time. Further, there was a decline in the number of predatory mites in all blocks including the control. The degree of symptom initiation fluctuated. The yield data for five picks did not show a notable difference in the mean yield or different damage categories at harvesting stage. In general there was a decline in the percentage of damaged nuts but this was common for all three blocks including the untreated control. Therefore, carbosulfan could not be recommended for the management of coconut mite. However, a final attempt will be made to assess the status of the palm by using an index that is being developed to record the overall damage severity in palms.

*I.R. Wickramananda, S.R. Sarathchandra, A.D.N.T. Kumara & W.M. Pushpakumara*

**Experiment 27.64: Laboratory screening of prospective chemicals against coconut mite (2004)**

A laboratory study was conducted to evaluate Econeem plus (1% azadirachtin) Neem raj (1% azadirachtin) Ecotin (5% azadirachtin) and acaritouch a new acaricide received from Germany and re-evaluate Magister at the request of the suppliers and growers. Out of the chemicals tested, only Neem raj and Magister showed a reasonable mortality, which was 48.1% and 94.9% respectively. Other chemicals had no apparent mortality in comparison with the control.

The study initiated to test the efficacy of two neem-based botanicals i.e. Neemraj (1% azadirachtin) and Econeem plus (1% azadirachtin) in the field was continued. Neemraj was applied by root feeding and spraying at the rates of 10 ml/palm 4 ml/lit (2 l per palm) respectively. Econeem was applied by root feeding only (10ml/palm). There was a reduction in total coconut mite population on the nuts two months after the application of Neemraj by root feeding, but it was also decreased in the control. Therefore, the results were inconclusive at this stage. Neemraj had no apparent effect on the predatory mites. Spraying of Neemraj and root feeding of Econeem was not effective. Yield data are being collected.

*I.R. Wickramananda & W.M. Pushpakumara*

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

A study was conducted to determine the effectiveness of spraying an emulsion of palm oil and sulphur in managing coconut mite and its effect on the predatory mites. The emulsion was prepared by mixing palm oil with 5g of wettable sulpur and 12g soap powder. Three concentrations of the oil solution 20%, 25% and 30% were evaluated. Bunches of 5 palms were sprayed with each concentration of the mixture and the populations of live coconut mites and the predatory mites were assessed up to 2 months after application.

All treatments had significantly lesser number of live coconut mites than the untreated control up to 2 months ($P<0.01$, Kruskal_Wallis test). The concentrations 25% and 20% had the lowest live coconut mite numbers at all times than 10% concentration (Table 4). The 20% concentration had the lowest mean

number of live mites. There was no significant difference in the number of predatory mites in the treated and the untreated nuts at all times (Table 5). The results indicated that spraying of 20% palm oil with 5g of sulphur is effective in managing coconut mite. This has a major advantage over the used engine oil application in which predatory mites are killed.

**Table 4:** ***Mean number of live coconut mites on nuts treated with different concentrations of oil at different intervals***

| Concentration | Mean number live mites±S.E. | | | |
|---|---|---|---|---|
| | 10 days | 20 days | 30 days | 60 days |
| 25% | 5.4±3.9 | 9.6±7.9 | 4.4±3.7 | 73.2±22.1 |
| 20% | 4.6±2.7 | 7.0±3.5 | 11.0±6.0 | 22.6±13.1 |
| 10% | 63.2±16.8 | 65.6±24.7 | 77.8±27.1 | 7.0±2.7 |
| Control | 145.2±43.9 | 203.2±54.1 | 81.4±22.0 | 137.2±26.8 |
| Significance | P=0.002 | P=0.003 | P=0.019 | P=0.004 |

**Table 5:** ***Mean number of predatory mites on nuts treated with different concentrations of oil at different intervals***

| Concentration | Mean number live mites±S.E. | | | |
|---|---|---|---|---|
| | 10 days | 20 days | 30 days | 60 days |
| 25% | 1.8±0.6 | 2.8±1.2 | 1.8±1.8 | 1.8±0.7 |
| 20% | 3.0±1.0 | 7.0±1.8 | 2.0±1.3 | 4.0±1.4 |
| 10% | 4.6±2.0 | 5.0±1.7 | 1.6±0.9 | 4.0±1.6 |
| control | 2.8±1.2 | 3.2±1.2 | 2.2±0.6 | 2.6±1.2 |
| Significance | P=0.76 | P=0.21 | P=0.78 | P=0.54 |

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

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

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

The electronic device that has been developed needed to be improved in two aspects; developing a user-friendly detector head for the sensor and a digital display to indicate the presence of red weevil larvae. A study was commenced in collaboration with the Rinzen Laboratories, Moratuwa to make the improvements. More compact user-friendly design, which is lightweight and uses only a space of 10x8x4

cm and one 9V battery, was devised. Easy to use detector head and detection of sound by both visual and audible were developed. Large scale field-testing will be conducted to determine the effectiveness of the device.

*L.C.P. Fernando, Dr. N. Nanayakkara (University of Moratuwa/ Rinzen Laboratories), K.F.G. Perera & W.W.F.N. Fernando*

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

**Experiment B26.5.5: Survey on leaf rot disease in the Southern Province (2005)**

A survey was initiated to determine the disease severity of the leaf rot disease and the factors associated with the disease incidence in four Coconut Development Officer ranges namely Ahangama, Dickwella, Matara and Weligama are in progress.

*H.T.R. Wijesekara & N.G. Premasiri*

**PROJECT: SCREENING OF INSECTICIDES AGAINST COCOUT PESTS (2005)**

**Experiment 1: Evaluation of four insecticides as spray applications for the management of black beetle (2005)**

The chemicals and their method of application is not very effective in controlling black beetle. A study was commenced to determine whether the insecticides dimethoate (4ml/l), Marshall SC (4ml/l) and chlorpyrifos (2-3ml/l) are effective when treated as a spray. The insecticides were evaluated along with the recommended chemical carbofuran (15g per seedling) in 2 estates. For evaluating dimethoate 66 black beetle damaged seedlings were selected while 50 similar seedlings were used as the untreated control in one estate. In the other estate each of 40 black beetle affected seedlings were used for spraying chemicals while another 40 was kept as control. Spraying was done at 2 monthly intervals and the damage assessments on the newly opened fronds were taken at 4-monthly intervals.

The results showed that the percentage fronds affected after treatments in the dimethoate treated palms were 32%, 44% and 23.3% while in the untreated palms it was 44%, 55% and 39% at 1$^{st}$, 2$^{nd}$ and 3$^{rd}$ observations. The study is in progress.

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

**PROJECT: FIELD-TESTING OF IPM STRATEGIES FOR ORYCTES RHINOCEROS (2005)**

Under the Asian Pacific Coconut Community Project it has been agreed that Sri Lanka test the following components of suggested integrated management of black beetle in field conditions; *Oryctes* virus+ Green muscardine fungus +pheromone, *Oryctes* virus+ Green muscardine fungus, Green muscardine fungus, *Oryctes* virus, pheromone and control (minimum sanitation). For each treatment three 1 ha blocks were selected. Culturing of the fungus and collection of the virus was commenced. Experiment was commenced in few sites.

*L. Weerakoon, H.T.R. Wijesekara, N.I. Suwandhrathne, L.C.P Fernando & W.W.F.N Fernando*

**PROJECT: ORGANIZE FARMER FIELD SCHOOLS (2005)**

FFS is a participatory learning strategy of farmers which is intended to make the farmers experts in their own coconut grove. FFS was commenced in five locations Chilaw , Dambadeniya, Alawwa, Anuradhapura and Ratgama. For each class minimum of 25 farmers were included. First the socio-economic status of the farmers were identified and their knowledge on the field problems related to coconut pests were identified through ballot box test. Accordingly, priorities for the schools were identified. In each FFS, in addition to the disseminate knowledge through participatory approach a group dynamics and a special topic was conducted (Table 8). It has been found that FFS were very effective in transferring technology. Conducting of FFS is in progress.

**Table 8:** ***Progress of activities of Farmers Field School (FFS)***

| Activity |
|---|
| **1. Transect walk**<br>Identification of pests and diseases of coconut, nutrient deficiency symptoms, natural enemies and correct management practices. |
| **2. Coconut mite damage**<br>Field observation of mite damage - Presenting observations of farmers, Discussion on history of the problem and control methods<br>Special topics: Microscopic observation of coconut mite, Preparation of used engine oil mixture and field demonstration of application method<br>Group dynamics: Jony's game |
| **3. Importance of Fertilizer application**<br>•Questionnaire on fertilizer was given.<br>•Answers were found via farmer's group discussion and presentation of answers to others group wise.<br>•Discussion of answers<br>Field demonstration of correct method of fertilizer application.<br>•Distribution of fertilizer. 8 Kg per person.<br>Special topics: Identification of nutrient deficiency symptoms and remedial measures.<br>Group dynamics: Lifting the bucket |
| **4. Black beetle control**<br>•Field observation of black beetle damage palms and breeding sites.<br>•Presenting observations. •Discussion on life cycle, damage and control methods<br>Field application of control measures (field sanitation etc.)<br>Special topics: Insect zoo preparation |

| |
|---|
| **5. Red weevil control**<br>•Field observation of red weevil damage.<br>•Presentation of identification signs, known control methods, and their experiences on red weevil by farmers.<br>•Discussion on life cycle of red weevil.<br>Special topics: Introduction to control methods. |
| **6. Red weevil control**<br>•Brief introduction was given about red weevil control.<br>•Trunk injection and root feeding of monocrotophos for red weevil control was demonstrated.<br>•Farmer groups practiced the above two application methods.<br>Special topics: Safe use of pesticides |
| **7. Documentary video show**<br>The following videos were shown to farmers related to coconut.<br>•Red weevil control<br>•Coconut mite control<br>•Irrigation methods for coconut plantations<br>•Intercropping in coconut lands<br>•Animal husbandry in coconut lands<br>Problems aroused from above topics were discussed. |
| **8. Soil and moisture conservation**<br>Field observation of soil and moisture conservation methods.<br>Presentations of farmer observations<br>Importance of soil and moisture conservation was discussed.<br>Husk pit method for moisture conservation was demonstrated.<br>Special topics: Cover crops which can be used for moisture conservation was discussed. |
| **9. Planting a coconut seedling**<br>Selection method of a suitable soil type, location was discussed.<br>Preparation of a planting hole, application of Young Palm Mixture at planting and correct method of planting a seedling was demonstrated.<br>Special topics: Characters should be considered in selecting a good coconut seedling was discussed. |
| **10. Aftercare of planted coconut seedling**<br>Growth cycle of coconut was discussed with special reference to different requirements at |

different stages.

Pest and disease damages, which can be occurred at initial stage, were discussed.

Special topics: Importance of *Gliricidea* as a energy crop and as a nitrogen providing source for coconut lands.

**11. *Plesispa* beetle control**

•Field observation of *Plesispa* damage.

•Presentation of identified damage symptoms and known control methods.

Life cycle of *Plesispa* beetle was discussed.

Preparation of Mashal and application method was demonstrated.

*L. Weerasinghe, C. S. Herath (TTD) and P. Fernando*

## 3. CROP PROTECTION SERVICES

### Biological and chemical control

a. Coconut caterpillar: All infestations were successfully controlled by release of parasitoids and limited application of insecticides. The number of parasitoids released is given in the Table.

b. Synthesis and sale of red weevil pheromone: Pheromone synthesis in the CRI laboratory continued and a total of 6027 vials were sold to the growers and CCB regional offices.

c. Chemical control: Issue of monocrotophos by directly by CRI was restricted only to CRI estates and experimental blocks. A total of 304.6 l of monocrotophos was issued. The requirement of the growers was supplied to the Coconut Cultivation Board.

## 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.

**Table: Release of parasitoids in different provinces for the management of coconut caterpillar**

| ırasitoid | Wester n | North western | Southe rn | Eastern | Sabaraga muwa | Northe rn | Total |
|---|---|---|---|---|---|---|---|
| *ɾiborus ochanteratus* | 3000 | 19,050 | 4850 | 1650 | 800 | 0 | 29,350 |
| *ɾacon hebetor* | 23,000 | 1,75,000 | 9000 | 30,000 | 13,500 | 11,500 | 2,62,000 |
| *oniozus* | 9000 | 1,03,250 | 7000 | 16,000 | 5250 | 1250 | 1,41,750 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *ıephantidis* | | | | | | | |
| *Brachymeria ıephantidis* | 2000 | 46,600 | 5600 | 9400 | 1000 | 0 | 64,600 |
| Total | 37,000 | 3,809,000 | 26,450 | 57,050 | 20,550 | 12,750 | 4,97,700 |

## 5. ACKNOWLEDGEMENTS

I am grateful to the staff of Crop Protection Division for their dedication and valuable contribution to the research programmes of the Division. Their cooperation and assistance in research and other activities during the year is greatly acknowledged. I am grateful to the contract staff for their hard work in the coconut mite research programme. Sincere thanks are extended to the Head and staff of the Biometry Division for the assistance given in designing experiments and analysis of data and Head and staff of the Crop Processing Research Division in assisting with GC analysis. I thank Dr N. Nanayakkara of Rinzen Laboratories and Dr. M. Alahakoon, University of Peradeniya for collaborating in research projects. I acknowledge the funds provided by the Coconut CESS, Council for Agricultural Research Policy, and Department for International Development, UK and Asian Pacific Coconut Community for conducting several research projects.

## REPORT OF THE BIOMETRY DIVISION
**Head - T S G Peiris, Ph D FRS**

### 1. GENERAL

The Division assisted the research divisions in designing field experiments, designing sampling methodology and structured questionnaires for field surveys, analyzing statistical data and interpretation of results. A new experimental design called grouped restricted randomized design was introduced.

The computer network system (internet and emails) was administrated efficiently and a proxy server was installed to the network system. The institute website (www.cri.lk) was updated throughout the year and included few popular articles. Number of email accounts was expanded from 20 to 34. Division conducted classes on the use of various software, developed various application programs for non-research divisions and maintained and repaired computers and related hardware of the institute

Consumer survey on 'coconut and coconut oil' in collaboration with the Divisional Secretaries and Grama Niladaris and 'data capture' survey on coconut yield from the growers in collaboration with the Regional Managers and Coconut Development Officers of Coconut Cultivation Board (CCB) were carried out. Carried out the 'diagnostic' survey in 11 CCB regions to obtain grower's response on CRI technologies and technology transfer activities. Involved for the survey on 'decline of coconut palms' in Gampaha and Puttalam districts carried out by the Plant Physiology Division.

Four agro-meteorological stations and three rainfall stations were maintained. Databases on climate, CRI estates data, medical aid scheme (MAS) and division ledger were updated.

### 2. ASSISTANCE IN COMPUTER RELATED WORK

1. The website of the CRI (www.cri.lk) was maintained and updated several times.

   *T S G Peiris*

2. Continuous assistance was provided to all divisions on the use of Internet system and Emails.

   *S S Rajapakse, J D J S Kularatna & W S Wickramarachchi*

3. Co-ordinated the work in developing computer programs for analyzing databases related to personal management system and monthly transport system in the Establishment Division.

   *W S Wicramarachchi*

4. Assistance was provided for hardware and software, and co-ordinated activities of computers in the Institute.

   *S S Rajapaks, W S Wickrmarachchi & J D J S Kularatna*

5. Computerization of all the weather variables recorded at seven meteorological stations continued throughout the year. The computerized data were sent to the Meteorology Department, Colombo, regularly and also to some government and private organization.

   *W B P Fernand, & J H U Jayamaha*

6. Updated and modified computer programs for processing information of the databases on MAS and climate.

   *J D J S Kularatna & T S G Peiris*

7. Assistance was provided for maintaining and processing activities of MAS.

   *J D J S Kularatna*

## 3. STATISTICAL ASSISTANCE

Analyses of various long-term and short-term field experiments were carried out. Undergraduates and postgraduates from various universities were provided with statistical analysis in respect to their projects.

*T S G Peiris, J D J S Kularatna, and W E R C Fernando*

Four postgraduate theses on Applied Statistics at PGIA and PGIS were supervised. Various papers of the referred journals were reviewed.

*T S G Peiris*

## 4. RESEARCH PROJECTS

### THRUST AREA: CROP PRODUCTION/IMPROVEMENT/PROCESSING

**PROJECT 1: VARIABILITY OF YIELD/PALM BY DISTRICTS**

**Objective :** To identify yield variability between district x seasons as such information is not available for policy decision in the coconut industry.

**Methodology:**

Data capture survey was initiated with the assistance from Coconut Development Officers (CDOO) of the Coconut Cultivation Board. Five estates were identified from each CDO range within all CCB regions excluding Jaffna and Batticalao. Prior to identification of estates, division staff participated for each CDO conference in each CCB region and explained importance of the survey. However as this was started during second quarter of the year data from all regions were not received. In addition to the selected estates, data were acquired from selected estates in Puttlam, Gampaha and Kurunegala region by the division staff.

**Results**

**Table 1:** ***Observed yield in 2005 by district x pick***

| District | Yield per palm per pick | | | | | | Yield per palm per year |
|---|---|---|---|---|---|---|---|
| | Jan /Feb | Mar/ Apr | May /Jun | Jul/ Aug | Sep /Oct | Nov /Dec | |
| Puttalam | 7.1 | 9.2 | 12.0 | 12.1 | 9.5 | 9.1 | 59.1 |
| Gampaha | 4.1 | 7.1 | 10.8 | 10.3 | 6.6 | 4.9 | 43.7 |
| Kurunegela | 3.2 | 5.7 | 7.3 | 7.2 | 6.2 | 6.0 | 35.6 |
| Hambantota | 7.1 | 7.8 | 8.1 | 7.2 | 7.1 | 6.8 | 44.0 |
| Galle | 7.2 | 9.2 | 10.5 | 9.4 | 7.2 | 7.1 | 50.6 |
| Kalutara | 6.7 | 8.7 | 10.9 | 11.3 | 9.2 | 7.6 | 54.5 |
| Kegalle | 5.5 | 9.6 | 12.5 | 11.8 | 8.8 | 7.8 | 55.9 |
| Matara | 6.6 | 7.4 | 9.0 | 8.7 | 6.3 | 6.2 | 44.1 |
| Ratnapura | 7.6 | 8.2 | 10.6 | 9.5 | 9.7 | 7.4 | 53.1 |
| Mean | 6.1 | 8.1 | 10.2 | 9.7 | 7.8 | 7.0 | 48.9 |

This highest yield per palm was observed in Puttlam and the lowest yield was in Kurunegala. The yield per palm in four districts in wet zone was also higher than the national average of 49 nuts per palm. The highest yield per pick was observed during May/June in Kegalle and lowest yield per pick was during January/February in Kurunegala region. Based on the above information derived actual yield in 2005 (based on extent in land extent) was 2576 million nuts (Table 2). The contribution from the nine districts was 1751 million nuts (67%), which represents 75% of the total coconut extent (394836 million ha).

**Table 2:** ***Estimated annual national production by district***

| District | Nuts in million |
|---|---|
| Puttalam | 350 |
| Gampaha | 242 |
| Kurunegela | 576 |
| Hambantota | 110 |
| Galle | 102 |
| Kalutara | 70 |
| Kegalle | 100 |
| Matara | 94 |
| Ratnapura | 107 |
| Other districts | 825 |
| National | 2576 |

*T S G Peiris, J D J S Kularatna and W K M K Herath*

## THRUST AREA: CROP PRODUCTION/IMPROVEMENT/PROCESSING

## PROJECT 2: PREDICTION OF NATIONAL COCONUT PRODUCTION FOR 2006

**Results**

Rainfall distribution with respect to total rainfall and rainfall intensity per rainy day during the first quarter (Jan-Mar) and third quarter in all coconut growing areas was more beneficial to increase the national yield in 2006. Rainfall during second quarter (April-June) in 2005 had a poor distribution compared that in 2004. Over overall rainfall distribution in 2005 (up to September) was favourable for the coconut yield in 2006.

Using the integrated crop-forecasting model (Peiris, 2005), which incorporates climate effect and technology effect, the national coconut production for 2006 was predicted as 2866 million nuts during October 2005. For the first time it was able to predict national coconut production for 2006 by two monthly seasonal basis such as Jan/Feb, Mar/Apr, May/Jun, Jul/Aug, Sep/Oct and Nov/Dec as shown in Figure 1. This was estimated using a composite index based on yield bi-monthly yield distribution in 2005 and bi-monthly rainfall distribution in 2004 and 2005 in coconut growing areas. This composite index has to be further developed with more data.

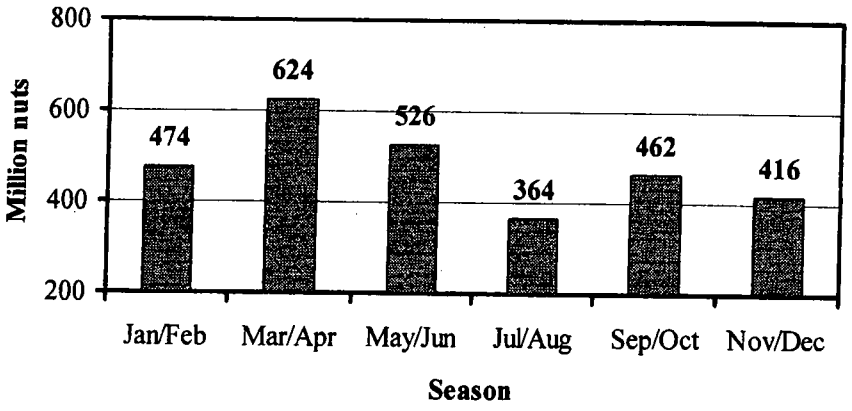


**Figure 1 .** ***Predicted bi-monthly yield for 2006 in Sri Lanka***

*T S G Peiris*

**THRUST AREA: CROP PRODUCTION/IMPROVEMENT/PROCESSING**

**PROJECT 3: IDENTIFICATION OF CONSUMPTION PATTERN OF COCONUT NUTS AND COCONUT OIL**

**Objective:**

At present, there is no proper method to estimate the above two important statistics annually. The impact due to fluctuation of these two values is more serious on computing actual annual national coconut production and so on the policy decision of the coconut industry. The variability of these two statistics between districts x months is also not known. Such information would be useful to control imports of substitute oils.

**Methodology:**

The amount of coconut oil and fresh nuts consumed by a family was monitored for five weeks. This was done though Grama Niladaris (GNN). Ten families were selected by each GN within Divisional Secretary in all districts. Data were collected by GN and posted to Biometry Division by the GN. In appreciation for the service of the GN, a certificate was given to each GN who posted the dully-filled questionnaires.

**Results**

Based on the area covered and information received during the year the following results were derived (Tables 3). Of the seven districts the rate of consumption of coconut was much higher in Polonnaruwa and Kalutara districts and that was very low in Badulla district. In contrast oil consumption was significantly higher in Badulla district.

**Table 3:** ***Consumption of coconut and oil by districts***

**(a) by districts**

| District | Number of householders | Consumption rate/person/year | |
|---|---|---|---|
| | | Number of coconut nuts | Amount of oil in bottles |
| Anuradhapura | 1177 | 105 | 7.77 |
| Badulla | 881 | 60 | 9.61 |
| Colombo | 569 | 98 | 7.04 |
| Kalutara | 864 | 112 | 6.62 |
| Kandy | 1352 | 89 | 7.30 |
| Matale | 699 | 108 | 8.02 |
| Polonnaruwa | 508 | 119 | 7.42 |
| Mean | 6050 | 97 | 7.70 |

**(b) by months**

| Month | Consumption rate/person/year | |
|---|---|---|
| | Number of coconut nuts | Amount of oil in bottles |
| January | 8.34 | 0.60 |
| February | 8.43 | 0.63 |
| March | 8.97 | 0.69 |
| April | 8.59 | 0.77 |
| May | 5.39 | 0.53 |
| June | 9.22 | 0.58 |
| July | 8.41 | 0.73 |
| August | 7.91 | 0.61 |
| September | 7.37 | 0.69 |

*T S G Peiris, J D J S Kularatna, W K M K Herath & W M L G Fernando*

**THRUST AREA: CROP PRODUCTION/IMPROVEMENT/PROCESSING**

**PROJECT 4: EFFECT OF MONTHLY PICKING AT FARM LEVEL**

**Objective:** To find the farm level impact of monthly picking (1M) vs bi-monthly picking (2M) at different land suitability classes (LSC) of coconut.

**Methodology:**

Three locations from each, from the LSC of coconut: S1-S4, were selected to test the hypothesis. The experimental design was single palm randomized block design and the number of block varied from location to location.

**Results**

**Table 4:** ***Yield obtained (nuts/period) under two harvesting intervals (1M vs 2M)***

| LSC of coconut | Location | Harvesting Frequency | | Sig. level | % Increase in 1M wrt 2M |
|---|---|---|---|---|---|
| | | 1M | 2M | | |
| S1 | Pambala | 136.6 | 76.1 | ** | 79.5 |
| | Marawila | 84.5 | 76.9 | Ns | 9.9 |
| | Sirigampola | 68.4 | 45.6 | ** | 50.0 |
| S2 | Madurankuliya | 111.9 | 76.1 | *** | 47.04 |
| | Kuliyapitiya | 62.8 | 53.1 | Ns | 18.27 |
| | Nattandiya | 70.5 | 61.5 | Ns | 14.63 |
| S3 | Mangalaeliya | 63.5 | 59.9 | Ns | 6.01 |
| | Kobeigane | 69.7 | 40.5 | *** | 72.10 |
| | Dunkannawa | 93.8 | 38.7 | *** | 142.4 |
| S4 | Sembukattiya | 59.6 | 44.8 | * | 33.04 |
| | Dunkannawa | 98.8 | 72.4 | ** | 36.46 |
| | Bingiriya | 71.2 | 46.3 | *** | 53.78 |

**Note:** Period is different from location to location as all experiments did not start at the same time of the year.

Results in Table 4 clearly indicated that the yield obtained using 1M picking was significantly higher than 2M picking. Similar trend was obtained when palm wise data were adjusted taking first set of observation as covariate. Thus it can be confirmed that 1M was significantly beneficial than 2M picking with respect to nut yield irrespective of LSC of coconut. Cost benefit analysis has to be carried out.

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**TRUST AREA: CROP PRODUCTION/IMPROVEMENT/PROCESSING**

**PROJECT 5: IDENTIFICATION OF POSSIBLE RAINY PERIOD IN COCONUT GROWING AERS**

**Objective:** To analyze past climate data on weekly basis for the development of suitable strategies for planning of management practices of coconut cultivation.

**Climate Data:** Rainfall data (1950 – 2005) from 23 stations within eight Agro Ecological Regions (AERs) were used. Locations were selected based on the availability of long-term data.

**Results:** The periods for 52 weeks are shown in Table 5.

**Table 5:** ***The week number and corresponding periods***

| Week number | Period | Week number | Period |
|---|---|---|---|
| 1 | 01 – 07 Jan | 27 | 05 – 11 Jul |
| 2 | 08 – 14 Jan | 28 | 12 – 18 Jul |
| 3 | 15 – 21 Jan | 29 | 19 – 25 Jul |
| 4 | 22 – 28 Jan | 30 | 26 Jul – 01 Aug |
| 5 | 29 Jan – 04 Feb | 31 | 02 – 08 Aug |
| 6 | 05 – 11 Feb | 32 | 09 – 15 Aug |
| 7 | 12 – 18 Feb | 33 | 16 – 22 Aug |
| 8 | 19 – 25 Feb | 34 | 23 – 29 Aug |
| 9 | 26 Feb – 04 Mar | 35 | 30 Aug – 05 Sep |
| 10 | 05 – 11 Mar | 36 | 06 – 12 Sep |
| 11 | 12 – 18 Mar | 37 | 13 – 19 Sep |
| 12 | 19 – 25 Mar | 38 | 20 – 27 Sep |
| 13 | 26 Mar– 02 Apr | 39 | 28 Sep – 04 Oct |
| 14 | 03 – 09 Apr | 40 | 05 – 11 Oct |
| 15 | 10 – 17 Apr | 41 | 12 – 18 Oct |
| 16 | 18 – 24 Apr | 42 | 19 – 25 Oct |
| 17 | 25 Apr – 01 May | 43 | 26 Oct – 01 Nov |
| 18 | 02 – 08 May | 44 | 02 – 08 Nov |
| 19 | 09 – 15 May | 45 | 09 – 15 Nov |
| 20 | 16 – 22 May | 46 | 16 – 22 Nov |
| 21 | 23 – 29 May | 47 | 23 – 29 Nov |
| 22 | 30 May – 05 Jun | 48 | 30 Nov – 06 Dec |
| 23 | 06 – 12 Jun | 49 | 07 – 13 Dec |
| 24 | 13 – 19 Jun | 50 | 14 – 20 Dec |
| 25 | 20 – 27 Jun | 51 | 21 – 23 Dec |
| 26 | 28 Jun– 04 Jul | 52 | 24 – 31 Dec |

As the water requirement of a coconut palm is 35mm/week, the effective rainfall week was considered as a week of which rainfall exceeds 35mm irrespective of number of wet days. Based on long term weekly means probability of receiving rainfall ≥35mm were computed for the eight regions IL1, IL3, WL2, WL3, WL4, DL3, DL5 and IL1-IL3 (Table 6, Table 7)

**Table 6:** ***Period corresponds to the weeks of which rainfall exceed 35 mm***

| AER | Range of weeks | Period corresponding to weeks |
|---|---|---|
| IL1 | 38-48 | 17 September - 2 December |
| IL3 | 41-48 | 8 October – 2 December |
| WL2 | 37-49 | 10 September - 9 December |
| WL3 | 37-49 | 10 September - 9 December |
| WL4 | 35-48 | 27 August - 3 December |
| DL3 | 41-48 | 8 October - 2 December |
| DL5 | 42-48 | 15 October - 2 December |
| IL1-IL3 | 39-52 | 24 September - 31 December |

**Table 7:** ***Periods, which gives rainfall with high probability in eight AERs***

| AER | Period of which weekly rainfall ≥35mm | Period of which P (weekly rainfall ≥35mm) ≥0.50 | Period of which P (weekly rainfall ≥35mm) ≥0.75 |
|---|---|---|---|
| IL1 | 2 April – 10 June (14-23) | 2 April – 6 May (14-18) 24 | 22 Oct- 11nov. (43-45) |
| | 17-Sep. – 2 Dec. (38-48) | Sep.-25 Nov. (39-47) | |
| IL3 | 2 April – 6 May (14-18) | 2 April – 29 Apr. (14-17) | 15-21 Oct (42) |
| | 1 Oct. – 25 Nov. (40-47) | 8 Oct. – 25 Nov. (41-47) | 29 Oct.-11 Nov. (44-45) |
| WL2 | 12 Mar. – 29 June (11-30) | 26 Mar. – 6 May (13-18) 14 | 15-21Oct. (42) |
| | 10 Sep. – 9 Dec.(37-49) | May –17June (20-24) 17- | 29 Oct.-4Nov.(44) |
| | | Sep. – 25 Nov..(38-47) | 12 -18 Nov. (46) |
| WL3 | 26 Mar. – 23 Jul (13-29) | 2 Apr.-17 June (14-24) 17- | 15 Oct – 11 Nov. (42-45) |
| | 10 Sep. – 9 Dec. (37-49) | Sep. –2 Dec. (38-48) | |
| WL4 | 26 Mar. – 29 June (13-30) | 2 Apr.-10June (14-23) 17- | 24-30 Sep. (39) |
| | 27 Aug. – 9 Dec (35-49) | Sep. –9 Dec. (38-49) | 15-21 Oct. (42) |
| | | | 29 Oct.-18 Nov. (44-46) |
| DL3 | 2 April – 6 May (14-18) | 15 Oct -25 Nov. (42-47) | - |
| | 8 Oct. – 2 Dec. (41-48) | | |
| DL5 | 15 Oct. - 2 Dec. (42-48) | 29 Oct-18 Nov. (44-46) | - |
| IL1- | 12 Mar. -8 Apr.(11-14) | 2-8 April (14) | 12 -18 Nov. (46) |
| IL3 | 16 Apr. – 10 June(16-23) | 15 Oct – 9 Dec. (42-49) | |
| | 17-Sep. – 31 Dec.(38-52) | | |

Based on the results in Tables 5, 6 and 7 the following conclusions can be made.

* Except in DI3, DL5 and IL1-II3 there is 50% chance that weekly rainfall during 1st to 4th week of April exceeds 35 mm.
* Rainfall during April (or May) is not reliable in DL3, DL5 and IL1-II3.
* In all regions there is 75% chance that weekly rainfall during 15th to 30th October exceed 35 mm.
* Further analysis to be carried out to obtain more specific details.

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**PROJECT 6: DIAGNOSTIC SURVEY ON COCONUT CULTIVATION**

**Objective:** To identify response from the growers on recommended technologies and technology transfer activities as such a survey had not been conducted after 1993.

**Methodology:**

A survey was conducted in 11 CCB regions with a sample of 545 during April to August. The sampling method was two-stage stratified random sampling where the first strata were agro-ecological region and second strata were land extent.

**Some results obtained:**

- The mean age of the bearing palms is 42 years. Age of coconut palms is over 60 years in about 7% of total extent. 5% of lands are senile. Mean density of bearing palms is 54.
- Private nurseries used to sell almost all seedlings without following the CRI recommendations.
- Mean mortality rate of seedling is 12%. The main reasons for mortality is no rain > black beetle damage > weak seedlings.
- 25% of under plantations were established before the age of old palms reached 35 years
- Efficiency of technology transfer for technologies such as use of mulch and use of fertilizer has improved from 1993 to 2005. No improvement for the use of husk pits
- Awareness for LSC for coconut, new fertilizer recommendation, new type of husk pits etc. was not satisfactory.
- There was a considerable gap (awareness – practice) for all technologies and it varied among CCBRR.
- Rates of awareness and use of all technologies decreased with the decrease of land extent.
- Blanket recommendations are not suitable for all locations.
- Growers need more training programs on Pest & diseases and Fertilizer applications
- Average number of holdings to serve for a CDO (2930) is too much to provide an efficient service to the grower.

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## 4. MISCELLANEOUS STUDIES

### 5.1 Decline of coconut lands

According to the latest agricultural census carried out by the Department of Census and Statistics in Sri Lanka, the extent under coconut in 2002 was 394,836 ha. With respect to the total coconut extent in 1982, the percentage of decline of coconut lands in 2002 was 5.4%. The rate of decline of coconut lands was 1070 ha per year. Based on the constant rate of annual decline of coconut lands the estimated coconut extent under smallholding and estate sector in 2005 is 325,044 ha and 66,580 ha respectively. The rate of decline of coconut lands was the highest in North Western Province (1060 ha/year). An average 600 ha/year was added to the national coconut extent from the North Central Province. Overall 250 coconut palms are lost per day in Sri Lanka and its distribution by districts is shown in Figure 2.

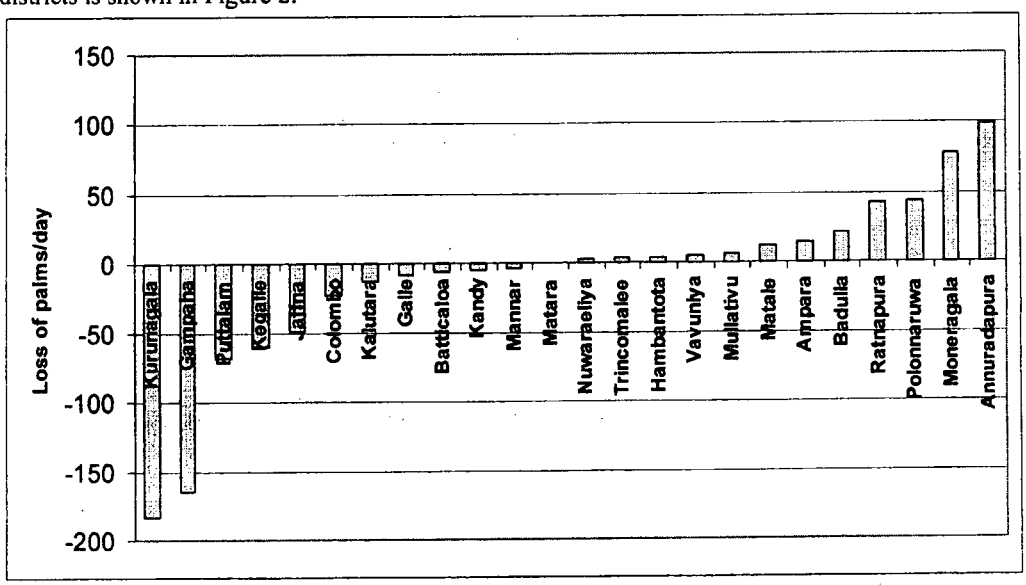


**Figure 2.** ***Rate of decline coconut palms per day in different districts***

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### 5.2 National coconut seedlings requirement

Amount of coconut seedling requirement for national planting program (NPP) was computed based on the coconut extent in 1982 and 2002. Further rate of seedling mortality rate was considered as 20% and 25%, under planting age was taken as 50 and 45 years, density of plantation was taken as 158 per hectare and rate of new planting equals to under planting rate was assumed in the calculation (Table 8).

**Table 8:** ***Requirement of coconut seedling for NPP under different scenarios***

| Census Year | Extent under coconut (ha) | Age for under planting | Mortality rate (%) | Seedling requirements ('000) |
|---|---|---|---|---|
| 1982 | 416253 | 50 | 25% | 1644 |
| 1982 | 416253 | 50 | 20% | 1578 |
| 1982 | 416253 | 45 | 25% | 1827 |
| 1982 | 416253 | 45 | 20% | 1754 |
| 2002 | 394836 | 50 | 25% | 1560 |
| 2002 | 394836 | 50 | 20% | 1497 |
| 2002 | 394836 | 45 | 25% | 1733 |
| 2002 | 394836 | 45 | 20% | 1664 |

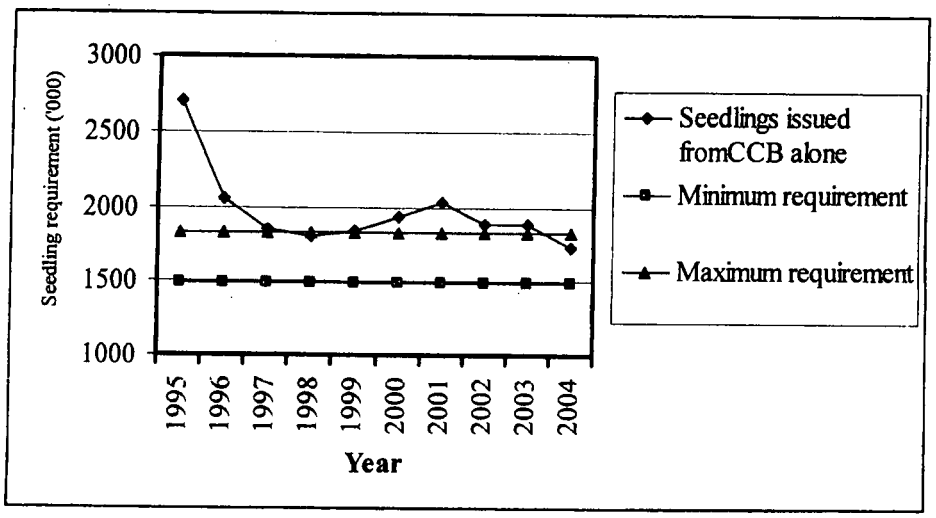


**Figure 3.** ***Distribution of coconut seedlings issued by CCB alone***

**Conclusion**

The analysis showed that coconut seedling issued by the CCB alone during 1995 to 2004 was higher than the maximum value of expected total requirement during the same period. On top of that, some growers use their own seedlings or seedling purchased from CRI or private nurseries. Thus, the percentage of additional seedling would be higher than what is shown in Figure 2. However, in reality there had been a shortage of coconut seedlings every year, particularly during October/November. Only reason one can thought is that mortality rate is higher than 25% which is very high or under planting at pre-mature age (below 45 years) which also too early. Thus, the question would arise

whether to increase the number seedlings or to educate the growers to manage their seedlings properly. It would be a national disaster if seedlings were issued more than requirement. Thus planning and issuing coconut seedlings should be carried out more efficient way.

## 6. CLIMATE IN CRI RESEARCH CENTERS

The four meteorological stations at Bandirippuwa Main Research Centre, Ratmalagara Research Centre, Ambakelle Genetic Resource Center and Maduru Oya Genetic Resource Center were maintained. Daily recordings were taken throughout the year on rainfall (mm), air temperature maximum and minimum ($^0$C), evaporation (mm), relative humidity morning and afternoon (%), sunshine duration (hrs/d) and soil temperature (morning and afternoon) at 5, 10, 20, 30, 60 and 120 cm depth. The rainfall, evaporation and sunshine duration were measured using rain gauge, class A evaporation tank and Campbell stokes sunshine recorder respectively. The maximum and minimum air temperatures were recorded in Stevenson Screen using mercury and alcohol-in-glass thermometers respectively. Relative humidity was obtained by transforming the current dry and wet bulb temperature recorded using ventilated mercury-in-glass psychrometer. Data were recorded at 9.00 hrs and 16.00 hrs daily.

### 6.1 Climate at Bandirippuwa Main Research Center (Table 9)

**Rainfall:**

The total rainfall for the year was 1682.9 mm. This rainfall is 2.6% lower than the last year rainfall and 3.4% lower than long-term (1994-2004) annual mean. The rainfall from April to September showed better distribution than the long-term distribution. The percentage contribution for three monthly seasons namely Jan-Mar, Apr-Jun, Jul-Sep and Oct-Dec were 9.9, 32.1, 17.5 and 40.5.

**Temperature:**

The monthly maximum temperature ranged from 30.5$^0$C during November to 32.7$^0$C during February and March. The monthly minimum temperature ranged from 19.9$^0$C during February and March to 24.1 during July.

**Sunshine:**

Sunshine hours ranged from 4.0 hrs/day (November) to 8.5 hrs/day (February) with a mean 6.5 hrs./day The year showed reduced sunshine hours compared to long-term average of 7.1 hrs/day.

**Evaporation:**

The lowest and highest evaporation was recorded in November and February with values 2.9 and 4.5 respectively. The average for the year was 3.8, which is lower than last year as well as long-term mean.

**Relative Humidity:**

The average relative humidity in the morning fluctuated between 80.8% during September to 86.4% during November. In the afternoon it varied around 70% during February to 82.2% during November.

## 6.2 Climate at Ratmalagara Research Center (Table 10)

**Rainfall:**

Total rainfall during 2005 (1909.1) has increased by 14.7% compared to long-term mean (1994-2004). Rainfall during first quarter in 2005 has increased by 151% compared to long-term average of the first quarter, but rainfall during third quarter has drooped by 58% compared to long-term mean during third quarter. The contribution from three monthly seasons to the total was 20.0%, 23.8%, 4.9% and 50.3% respectively.

**Temperature:**

The monthly maximum temperature ranged from 30.5$^0$C during November to 33.5$^0$C during March. The monthly minimum temperature increased from January to June and then decreased from June to December.

**Sunshine:**

Sunshine hours ranged from 4.3 hrs/day (November) to 7.9 hrs/day (February) with a mean 6.5 hrs./day The mean daily sunshine duration was higher compared to long-term mean of 5.6 hrs/day.

**Evaporation:**

The lowest and highest evaporation was recorded in November and February with values 1.9 and 3.8 respectively with a men 2.9 mm.

**Relative Humidity:**

The average relative humidity in the morning was 87.8% and the average relative humidity in the afternoon was 70.9%. Both morning and afternoon relative humidity was higher in November and lower in September.

## 6.3 Climate at Ambakelle Genetic Research Center (Table 11)

**Rainfall:**

The rainfall during 2004 is almost same as long-term (1994-2004) average. Less rainfall has occurred during September. The distribution of three monthly seasonal rainfalls was unusual and the contributions during Jan-Mar, Apr-Jun, Jul-Sep and Oct-Dec to the annual rainfall were 16.2%, 15.9%, 8.2% and 59.7% respectively. The contribution from Oct-Dec has increased by 32.6% compared to the corresponding percentage during 1994-2004.

**Temperature:**

Mean monthly maximum temperature was 31.60C and it varied from 29.40C during November to 33.6oC during March. Lowest minimum temperature was recorded during February and minimum temperature increased from February to June and then decreased up to December.

**Evaporation:**

Monthly evaporation was low during the year and mean daily evaporation was 3.1 mm. The highest evaporation was recorded during September (3.9 mm) and lowest was in December (2.2 mm).

**Relative Humidity:**

The average relative humidity in the morning was 80.9% and that in the afternoon was 71.3%. Both morning and afternoon relative humidity was higher in November. Relative humidity (afternoon) was lowest during September and relative humidity (morning) was lowest during September.

### 6.4 Climate at Maduru Oya Seed Garden (Table 12)

**Rainfall:**

Total rainfall during the year was 1288.5 and it is about 20% drop compared to mean during 1996-2004. Unlike other stations rainfall during March was low. Rainfall during January has dropped compared to long-term mean in January, but rainfall during July has increased compared to long-term mean during July. The contributions by four three monthly seasons were 15.8%, 18.0%, 13.2% and 53.0% respectively.

**Temperature:**

Maximum temperature was lowest during January (30.5$^0$C) and it showed increasing trend from January to September (36.0$^0$C) and then decreased up to December. Minimum temperature highly varied between months from 14.8$^0$C during May to 23.1$^0$C during November.

**Sunshine:**

Mean sunshine duration during the year was 6.0 hours per day and it varied from 4.2 hrs/day (in May) to 7.9 hrs/day (in August). Highest sunshine duration was recorded during March, June and August and average duration in these months was 8.3 hours per day.

### 6.5 Rainfall at Poththukulama, Walpita and Pallama Research Centers

The monthly rainfall distribution for the year 2005 along with long-term averages (based on data availability) for the above three stations are shown in Tables 13. The total rainfall during the year in all three stations is higher than the long-term average. Rainfall in May and August in 2005 at all three stations was lower than the corresponding long-term means.

The monthly rainfall distribution in 2005 in PRS is almost similar to the distribution of long-term monthly distribution, but rainfall during October and November in 2005 was significantly higher than the corresponding long-term means. Similar trend was found in Walpita as well with exceptional during November. In Pallama rainfall during March, July, October, November and December in 2005 was significantly higher than the corresponding long-term means.

**Acknowledgements**

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**Table 9:** ***Monthly climate variables in Bandirippuwa Main Research Centre in 2005***

| Variable | Period | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RF | 2005 | 45.5 | 64.3 | 218.2 | 131.8 | 159.9 | 148.3 | 30.0 | 2.0 | 33.2 | 449.5 | 310.1 | 90.1 | 1682.9 |
| | 1994-2004 | 59.0 | 46.7 | 67.2 | 223.9 | 204.5 | 130.8 | 78.6 | 80.5 | 146.1 | 340.8 | 281.7 | 83.0 | 1742.9 |
| Tmax | 2005 | 31.6 | 32.7 | 32.7 | 32.3 | 31.9 | 31.4 | 31.0 | 32.5 | 31.1 | 30.8 | 30.5 | 31.0 | 31.6 |
| | 1994-2004 | 31.4 | 32.3 | 32.9 | 32.2 | 31.6 | 30.9 | 30.5 | 30.4 | 30.7 | 30.4 | 30.8 | 31.1 | 31.3 |
| Tmin | 2005 | 20.3 | 19.9 | 19.9 | 23.2 | 22.5 | 22.5 | 24.1 | 23.9 | 24.1 | 23.4 | 22.1 | 21.5 | 22.3 |
| | 1994-2004 | 21.8 | 21.9 | 22.6 | 23.8 | 24.7 | 24.2 | 24.3 | 24.1 | 23.9 | 22.9 | 22.5 | 21.9 | 23.2 |
| Sunshine | 2005 | 7.8 | 8.5 | 4.7 | 6.4 | 5.8 | 6.0 | 7.0 | 8.3 | 7.4 | 5.4 | 4.0 | 6.9 | 6.5 |
| | 1994-2004 | 7.5 | 8.5 | 8.4 | 7.6 | 7.1 | 6.7 | 6.9 | 7.4 | 6.4 | 6.2 | 5.8 | 7.2 | 7.1 |
| Evap | 2005 | 4.1 | 4.5 | 4.3 | 3.7 | 4.1 | 3.6 | 3.8 | 4.0 | 4.1 | 3.2 | 2.9 | 3.4 | 3.8 |
| | 1994-2004 | 4.2 | 4.4 | 4.6 | 4.3 | 3.8 | 3.7 | 3.9 | 3.9 | 3.8 | 3.2 | 3.2 | 3.8 | 3.9 |
| RHam | 2005 | 83.3 | 83.0 | 81.5 | 83.9 | 82.2 | 83.6 | 86.5 | 81.5 | 80.8 | 84.2 | 86.4 | 84.3 | 83.4 |
| | 1994-2004 | 82.9 | 81.3 | 79.6 | 82.0 | 83.3 | 84.1 | 83.4 | 82.8 | 81.6 | 84.5 | 84.8 | 82.2 | 82.7 |
| RHpm | 2005 | 78.3 | 70.0 | 76.2 | 75.6 | 77.6 | 82.9 | 78.7 | 74.6 | 75.9 | 78.0 | 82.2 | 80.0 | 77.5 |
| | 1994-2004 | 67.8 | 67.3 | 68.3 | 73.3 | 78.6 | 79.7 | 77.9 | 76.8 | 76.4 | 78.1 | 78.0 | 70.8 | 74.4 |

**Table 10:** ***Monthly climate variables in Ratmalagara Research Centre in 2005***

| | Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RF | 2005 | 78.0 | 5.1 | 317.1 | 159.3 | 206.6 | 88.9 | 78.3 | 0.6 | 15.3 | 469.9 | 388.3 | 101.7 | 1909.1 |
| | 1994-2004 | 49.6 | 54.9 | 54.9 | 193.0 | 175.6 | 104.4 | 48.0 | 50.0 | 130.0 | 329.7 | 371.1 | 103.7 | 1664.8 |
| Tmax | 2005 | 32.2 | 33.6 | 33.5 | 32.6 | 32.8 | 31.1 | 31.0 | 32.0 | 31.9 | 31.4 | 30.5 | 30.9 | 32.0 |
| | 1994-2004 | 31.7 | 33.2 | 34.2 | 33.1 | 31.9 | 31.1 | 30.9 | 31.4 | 31.7 | 31.0 | 31.2 | 30.9 | 31.9 |
| Tmin | 2005 | 21.9 | 22.0 | 23.6 | 24.0 | 25.0 | 25.6 | 25.0 | 24.8 | 24.6 | 24.2 | 23.4 | 22.3 | 23.9 |
| | 1994-2004 | 21.5 | 22.1 | 23.1 | 24.1 | 25.2 | 25.0 | 24.8 | 24.7 | 24.3 | 23.7 | 23.0 | 22.0 | 23.6 |
| SS | 2005 | 6.5 | 7.9 | 7.2 | 7.2 | 6.7 | 6.7 | 6.6 | 7.6 | 6.7 | 5.0 | 4.3 | 5.2 | 6.5 |
| | 1994-2004 | 5.5 | 6.2 | 6.6 | 6.2 | 5.6 | 5.2 | 5.1 | 5.7 | 5.6 | 5.2 | 5.2 | 5.3 | 5.6 |
| Evap | 2005 | 2.8 | 3.8 | 3.3 | 2.9 | 2.5 | 2.6 | 2.7 | 3.4 | 3.7 | 2.5 | 1.9 | 2.3 | 2.9 |
| | 1994-2004 | 3.1 | 3.5 | 3.9 | 3.6 | 3.3 | 3.1 | 3.3 | 3.4 | 3.2 | 2.9 | 2.6 | 2.8 | 3.2 |
| RHam | 2005 | 88.7 | 89.4 | 91.0 | 92.1 | 88.5 | 85.8 | 86.4 | 82.9 | 82.0 | 86.0 | 91.5 | 88.7 | 87.8 |
| | 1994-2004 | 86.6 | 86.0 | 84.3 | 84.4 | 83.5 | 82.9 | 81.3 | 80.9 | 81.2 | 86.1 | 87.3 | 87.6 | 84.3 |
| RHpm | 2005 | 66.5 | 57.0 | 62.8 | 72.7 | 72.7 | 78.0 | 78.9 | 70.2 | 67.0 | 74.3 | 79.2 | 71.0 | 70.9 |
| | 1994-2004 | 66.6 | 62.9 | 64.5 | 70.8 | 76.2 | 76.6 | 75.1 | 72.9 | 72.6 | 76.8 | 77.5 | 72.9 | 72.1 |

**Table 11:** ***Monthly climate variables in Ambakelle Genetic Resource Centre in 2005***

| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RF | 2005 | 93.5 | 17.7 | 130.5 | 114.6 | 85.0 | 38.7 | 108.8 | 3.4 | 10.1 | 415.2 | 359.5 | 117.1 | 1494.1 |
| | 1994-2004 | 50.4 | 61.4 | 56.1 | 193.6 | 172.2 | 79.9 | 42.7 | 33.0 | 119.7 | 270.1 | 282.1 | 120.1 | 1481.3 |
| Tmax | 2005 | 31.5 | 32.8 | 33.6 | 32.4 | 33.1 | 31.4 | 30.8 | 31.4 | 32.0 | 31.1 | 29.4 | 29.7 | 31.6 |
| | 1994-2004 | 31.2 | 32.5 | 33.7 | 33.4 | 32.6 | 31.4 | 31.3 | 31.8 | 32.0 | 31.3 | 31.2 | 30.9 | 31.9 |
| Tmin | 2005 | 22.2 | 21.9 | 23.6 | 24.1 | 24.8 | 25.6 | 24.9 | 24.7 | 24.7 | 23.9 | 23.1 | 22.4 | 23.8 |
| | 1994-2004 | 21.6 | 21.8 | 22.8 | 24.0 | 25.1 | 25.2 | 25.0 | 25.0 | 24.5 | 23.7 | 23.1 | 22.5 | 23.7 |
| Evap | 2005 | 3.2 | 3.8 | 3.7 | 2.8 | 2.9 | 2.8 | 3.0 | 3.6 | 3.9 | 2.9 | 2.3 | 2.2 | 3.1 |
| | 1994-2004 | 3.0 | 3.5 | 3.9 | 3.6 | 3.3 | 3.3 | 3.5 | 3.9 | 3.5 | 4.0 | 4.6 | 3.5 | 3.6 |
| RHam | 2005 | 82.8 | 82.8 | 80.4 | 80.3 | 78.9 | 79.0 | 80.7 | 76.1 | 75.3 | 81.1 | 86.2 | 87.0 | 80.9 |
| | 1994-2004 | 86.7 | 85.3 | 81.6 | 83.4 | 84.4 | 84.3 | 83.0 | 80.8 | 80.1 | 85.1 | 86.0 | 85.7 | 83.9 |
| RHpm | 2005 | 63.2 | 56.4 | 66.5 | 73.4 | 70.6 | 74.4 | 73.6 | 71.6 | 68.2 | 76.0 | 84.3 | 80.0 | 71.5 |
| | 1994-2004 | 69.5 | 66.3 | 65.9 | 73.6 | 77.4 | 77.4 | 81.0 | 76.2 | 72.3 | 72.2 | 77.8 | 77.8 | 74.0 |

**Table 12:** ***Monthly climate variables in Maduru Oya Genetic Resource Centre in 2005***

| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RF | 2005 | 134.5 | 18.5 | 50.4 | 112.7 | 119.3 | 0.0 | 145.6 | 23.9 | 0.0 | 165.0 | 424.0 | 94.6 | 1288.5 |
| | 1996-2004 | 246.3 | 150.6 | 19.4 | 119.0 | 46.7 | 24.6 | 29.7 | 64.7 | 80.3 | 158.7 | 326.2 | 325.7 | 1591.9 |
| Tmax | 2005 | 30.5 | 32.5 | 34.6 | 34.8 | 35.7 | 35.8 | 35.0 | 35.7 | 36.0 | 34.4 | 31.4 | 31.3 | 34.0 |
| | 1996-2004 | 30.3 | 31.5 | 34.0 | 34.8 | 35.1 | 34.9 | 34.9 | 35.1 | 35.4 | 33.6 | 31.5 | 30.5 | 33.5 |
| Tmin | 2005 | 16.9 | 16.2 | 16.1 | 15.5 | 14.8 | 14.2 | 19.2 | 18.6 | 19.2 | 19.0 | 23.1 | 22.6 | 18.0 |
| | 1996-2004 | 21.1 | 20.8 | 20.9 | 22.7 | 23.1 | 23.6 | 23.5 | 23.1 | 22.7 | 22.3 | 22.2 | 21.6 | 22.3 |
| SS | 2005 | 4.5 | 7.7 | 7.1 | 5.5 | 4.2 | 5.3 | 7.5 | 7.9 | 6.1 | 5.9 | 4.9 | 5.6 | 6.0 |
| | 1996-2004 | 5.7 | 6.3 | 8.7 | 7.4 | 7.5 | 7.3 | 7.8 | 7.9 | 7.4 | 6.3 | 5.2 | 4.5 | 6.8 |
| Evap | 2005 | 3.2 | 4.2 | 4.0 | 3.8 | 4.2 | 5.3 | 4.9 | 5.2 | 5.0 | 4.6 | 3.7 | 3.6 | 4.3 |
| | 1996-2004 | 3.1 | 3.3 | 4.1 | 3.7 | 4.8 | 5.2 | 5.6 | 5.4 | 5.2 | 4.9 | 3.3 | 3.8 | 4.4 |
| RHam | 2005 | 85.5 | 86.1 | 83.8 | 84.4 | 81.9 | 65.4 | 71.6 | 68.9 | 64.9 | 76.1 | 87.0 | 88.4 | 78.7 |
| | 1996-2004 | 75.1 | 70.6 | 61.6 | 59.4 | 60.5 | 59.5 | 56.6 | 58.7 | 57.8 | 64.5 | 74.0 | 76.3 | 64.6 |
| RHpm | 2005 | 70.8 | 61.0 | 60.7 | 67.6 | 64.2 | 54.2 | 58.7 | 52.3 | 53.1 | 61.8 | 74.7 | 74.8 | 62.8 |
| | 1996-2004 | 89.6 | 89.4 | 86.5 | 71.2 | 74.0 | 71.8 | 68.9 | 67.9 | 69.3 | 76.7 | 85.1 | 88.3 | 78.2 |

**Table 13:** ***Monthly rainfall of the Research Centers at (a) Poththukulama (PRS), (b) Walpita and (c) Pallama in 2005***

| Location | Period | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PRS | 1995-2004 | 40.5 | 44.0 | 69.7 | 199.5 | 143.1 | 72.0 | 34.4 | 35.7 | 97.1 | 227.3 | 262.4 | 108.5 | 1334.0 |
| | 2005 | 61.2 | 25.6 | 128.4 | 196.1 | 66.3 | 51.1 | 102.5 | 5.3 | 15.4 | 412.2 | 336.0 | 93.6 | 1493.7 |
| Walpita | 1998-2004 | 95.7 | 80.6 | 95.4 | 293.9 | 242.5 | 172.2 | 114.4 | 133.8 | 247.4 | 394.8 | 290.4 | 88.1 | 2249.2 |
| | 2005 | 41.3 | 35.2 | 156.1 | 281.1 | 186.1 | 222.8 | 169.1 | 24.3 | 107.5 | 450.3 | 539.4 | 115.3 | 2328.5 |
| Pallama | 2001-2004 | 34.4 | 38.8 | 56.6 | 290.3 | 134.4 | 94.9 | 37.1 | 16.6 | 71.3 | 219.6 | 246.3 | 95.5 | 1335.6 |
| | 2005 | 71.9 | 5.0 | 171.8 | 243.1 | 85.5 | 45.2 | 152.4 | 0.0 | 39.5 | 366.3 | 304.8 | 155.0 | 1640.5 |

## REPORT OF THE TISSUE CULTURE DIVISION
**Head - L K Weerakoon, Ph D**

### 1. GENERAL

During the year, much emphasis was placed on raising plants from exotic germplasm. One hundred and twenty six plants obtained from embryos (of 4 coconut varieties) brought from India and 59 plants raised from embryos (of 4 coconut varieties) brought from PNG were successfully field planted. Twenty-seven plants obtained from PNG material are ready for field planting whereas 15 more plants are at different stages of acclimatization. Only a limited number of plants could be raised from the varieties brought from Ivory Coast due to very poor germination of embryos. Hundred and six of these plants are at different stages of acclimatization while some are still growing in culture.

A total of 138 Dikiri embryos were cultured during the year and 56 *in vitro*-raised plants were successfully acclimatized. Over 125 embryo-cultured Dikiri plants were distributed among growers.

The growth of the tissue-cultured plants established previously at Bandirippuwa Estate, Lenawa Estate, Daisy Valley Estate and Pallama Seed Garden was found to be satisfactory and several of them came in to bearing during the year. No abnormalities in vegetative growth or nut characters were observed in these palms. Arrangements have already been made to plant 22 more tissue-cultured plants at Bandirippuwa Estate.

The effect of several stress pretreatments on callus induction in plumule explants was investigated and the preliminary results indicated that heat pretreatment (38°C) of plumules and desiccation of embryos (prior to excision of plumules) enhanced the frequency of callusing. A suitable method for multiplication of plumule-derived callus was also identified.

A new basal medium (Amino acid medium) was tested for callus induction in immature embryo explants and the preliminary results revealed that callusing frequency is higher in Amino acid medium when compared to basal medium 72, that has been used previously for coconut tissue culture. The effect of the amino acid, glutamine on callusing in immature embryos was tested and the preliminary results indicated that application of glutamine increased the callusing frequency. Preliminary investigations also revealed that shoot regeneration from immature embryo-derived callus could be enhanced by the application of the growth regulator, 4-CPPU.

Attempts were made to induce callusing in male flowers obtained from immature inflorescence of -4 maturity stage (taking the youngest open inflorescence as 0) as a measure to minimize the damage caused to the palm during collection of explants. Different callus induction media were tested and white, transparent structures that resemble callus were observed in some of the media. With the application of certain stress pretreatments (cold and osmotic stress) it was possible to enhance the formation of callus-like structures. The preliminary results are promising and histological analysis will be undertaken to confirm whether the structures formed in culture are embryogenic callus.

Flow cytometric analysis of anther-derived callus revealed that they were haploid. This was the first time that haploid callus formation in coconut was reported. When cultured in the callus induction medium, a few of the anthers produced embryoid-like structures and two of them sprouted in culture. Several experiments are in progress to study the effects of different cytokinins (zeatin, 2iP, 4-CPPU, TDZ) and auxins (IAA, NAA, picloram) on androgenesis. Consistent callusing was observed in unfertilized ovary explants and the frequency of callusing could be enhanced further by application of the plant growth regulator, Thiadizuron (TDZ).

In collaboration with IRD, France, investigations on cryopreservation of coconut plumules and mature zygotic embryos were continued. The effect of ABA (in combination with sucrose) as a cryoprotectant was tested using mature zygotic embryos of coconut. The results indicated that ABA has a positive effect on the survival and recovery of cryopreserved embryos. Attempts were made to identify the most suitable method to transport coconut embryos (for excision of plumules later on) for cryopreservation work. Three different conditions (embryos in albumin cores, solidified agar and KCl solution) were tested. Based on the survival and recovery rates of cryopreserved plumules, transporting embryos in solidified agar was found to be the most effective method. The suitability of sorbitol as a cryoprotectant for cryopreservation of coconut plumules (using encapsulation/dehydration method) was also tested.

## 2. RESEARCH PROJECTS

**PROJECT 18: STUDIES ON THE VEGETATIVE PROPAGATION OF COCONUT**
**18.1: *In vitro* culture of coconut embryos**

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

A total of 138 Dikiri embryos were cultured during the year and 56 *in vitro*-raised plants were successfully acclimatized. Over 125 embryo-cultured Dikiri plants were distributed among growers. Arrangements have been made to establish a demonstration plot of Dikiri plants at Middeniya Research Station.

*L K Weerakoon, T R Gunathilake, K P I E Ambagala and E S Santha*

**Experiment 18.1.6: Cryopreservation of coconut embryos and plumules**

Investigations on cryopreservation of coconut plumules and mature zygotic embryos were continued. Previous studies indicated that ABA in combination with sucrose acts as an effective cryoprotectant agent for cryopreservation of coconut plumules. Thus, a study was undertaken with a view to improve a published protocol (Jayasinghe et al., 2002) for cryopreservation of mature zygotic embryos (in which the embryos were pretreated with 0.5 M sucrose for 120 hours and desiccated in silica gel for 15 hours) with the use of ABA. The embryos were pretreated in the sucrose solution supplemented with different concentrations of ABA (0, 10, 20 and 40 µM). As shown in Table 1, Pretreatment of embryos in sucrose solution (without ABA) and desiccation in silica gel for 15 hours showed a survival of 82% in cryopreserved embryos. The survival rate increased up to 91% and 100% with 10 µM and 40-µM ABA respectively (Table 1).

**Table 1:** ***Effect of ABA on survival and recovery of frozen and unfrozen embryos***

| Concentration of ABA in pretreatment solution (µM) | Mean percentage survival ± SD | | Mean percentage recovery ±SD | |
|---|---|---|---|---|
| | -LN | +LN | -LN | +LN |
| 0 (control) | 100 ± 0 | 82 ± 0.5 | 56 ± 2.7 | 0 ± 0 |
| 10 | 50 ± 80 | 91 ± 17.6 | 34 ± 2.0 | 3 ± 6.1 |
| 20 | 100 ± 0 | 4 ± 7.7 | 62 ± 0.6 | 0 ± 0 |
| 40 | 100 ± 0 | 100 ± 0 | 50 ± 0.7 | 3 ± 5.6 |
| CV% | 30.3 | | 29.4 | |
| Significance | P = 0.05 | | P = 0.05 | |

SD- Standard Deviation +LN- frozen in liquid nitrogen -LN – not frozen

As shown in Table 1, embryos pretreated in sucrose alone did not recover after freezing. However, Jayasinghe et al. (2002) reported 40 % recovery with this treatment. Pretreatment of embryos in sucrose in combination with ABA (10 and 40 μM) resulted in 3% recovery.

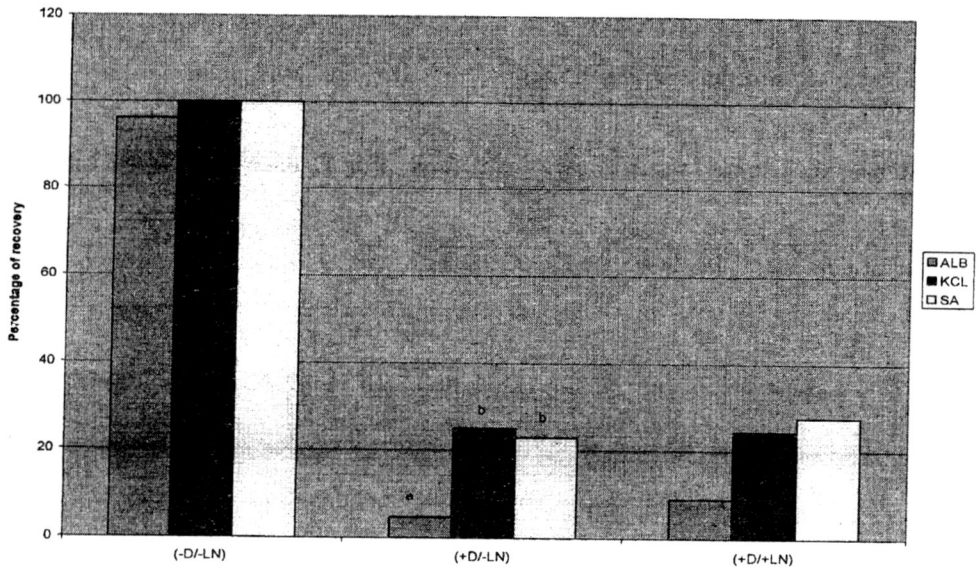
In the present study, most of the cryopreserved embryos (67 %) turned in to abnormal structures within 8 weeks of culture. This probably could be attributed to the complex morphology of the coconut embryo that consists of different parts (a highly parenchymatous haustorium, shoot and root meristems) with varying degree of sensitivity to desiccation and freezing.

The results of this study show that ABA has a positive effect on the survival and recovery of cryopreserved embryos. However, the absence of recovered embryos in the control treatment and high variation of results between replicates of the same treatment indicate the necessity of repeating the experiment with more samples.

Attempts were made to identify the most suitable method to transport/store mature zygotic embryos of coconut (for excision of plumules later on) for cryopreservation work. Three different conditions [embryos transported/stored in albumin (solid endosperm) cores, solidified agar {0.45% (w/v) agar}, and KCl solution (16.2 g/L)] were tested. Encapsulation/dehydration method was employed for cryopreservation. In this method, the plumules were excised from mature embryos (transported/stored under the 3 conditions indicated above) and encapsulated in sodium alginate. The beads were then pretreated with sucrose (0.75 M or 1.0 M). Prior to freezing in liquid nitrogen, the plumules were subjected to further dehydration by exposure to silica gel.

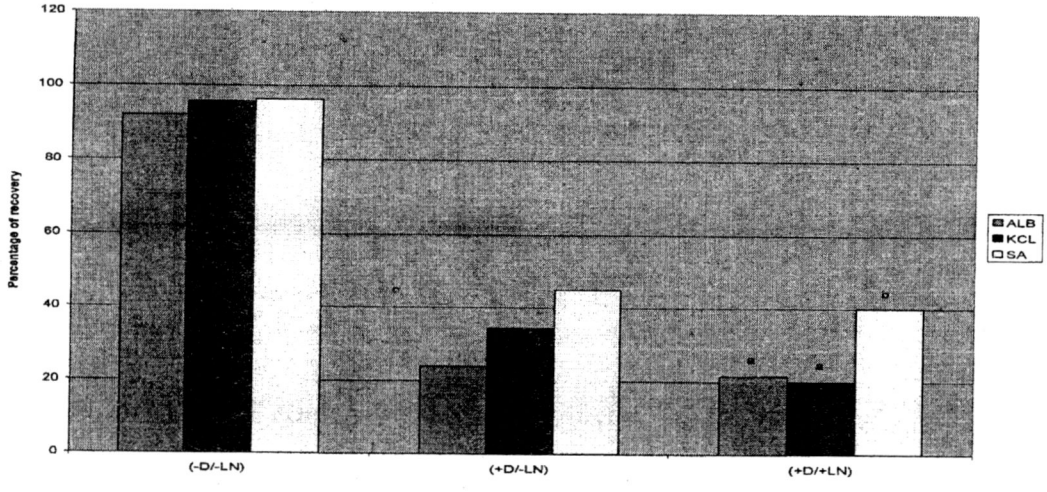
As shown in Figure 1, the condition used to transport/store embryos prior to excision of plumules has a significant effect on recovery of dehydrated but unfrozen plumules (+D/-LN) that were pretreated with 0.5 M sucrose. The plumules excised from embryos stored in KCl and solidified agar showed a significantly higher rate of recovery when compared to albumen cores. However, in frozen plumules (+D/+LN), there was no significant difference in recovery under the 3 conditions tested. In frozen plumules (+D/+LN), pretreated with 1.0 M sucrose, the rate of recovery (40 %) was significantly higher in the ones excised from embryos stored in solidified agar when compared to the other 2 conditions (Fig. 2). However, this difference is not reflected in unfrozen plumules (+D/-LN).

The suitability of sorbitol as a cryoprotectant for cryopreservation of coconut plumules (using encapsulation/dehydration method) was also investigated. Four different concentrations of sorbitol (0.03, 0.11, 0.27 and 0.55 M) were tested in combination with 0.75 M sucrose. However, the addition of sorbitol in preculture medium did not bring about a significant effect on survival and recovery of plumules.




**+D = Dehydrated (in silica gel) -D = Not dehydrated**
**+ LN = Frozen in liquid nitrogen -LN = Not frozen**

**Figure 1a.** ***Effect of embryo transport/storage method on recovery of frozen plumules (pretreated with 0.75 M sucrose)***




**+D = Dehydrated (in silica gel) -D = Not dehydrated**
**+ LN = Frozen in liquid nitrogen -LN = Not frozen**

**Figure 1b.** ***Effect of embryo transport/storage method on recovery of frozen plumules (pretreated with 1.0 M sucrose)***

**Experiment 18.1.7: Exchange of coconut germplasm through embryo culture**

One hundred and twenty six plants obtained from embryos (of 4 coconut varieties) brought from India (Table 2) and 59 plants raised from embryos (of the 4 varieties, Niaz Yellow Dwarf, Kar Kar Tall, Markham Valley Tall and Renell Tall) brought from PNG (Table 3) were successfully field planted. Twenty seven plants obtained from PNG material are ready for field planting whereas 15 more plants are at different stages of acclimatization.

**Table 2:** ***Performance of coconut embryos collected from India***

| Name of the Cultivar | Number of cultures initiated | Number of embryos germinated | Number of plants transferred to soil | Number of plants still at hardening stage | Number of plants transferred to field |
|---|---|---|---|---|---|
| **Andaman Ordinary** | 175 | 137 | 84 (27)* | 03 | 55 |
| **Laccadive Ordinary** | 191 | 100 | 37 (22)* | 0 | 21 |
| **Indian West Coast Tall** | 182 | 106 | 58 (22)* | 01 | 39 |
| **Banawali Green Round** | 121 | 68 | 35 (20)* | 0 | 11 |

* Weak/contaminated plants

Only a limited number of plants could be raised from the varieties brought from Ivory Coast (Polynesia Tall, Tagnanan Tall, Vanuatu Tall, Tacunan Green Dwarf, Tahitian Tall, Newlekha Green Dwarf, Tenga Tall, Malayan Red Dwarf, West African Tall and Catigan Green Dwarf) due to very poor germination of embryos. Hundred and six of these plants are at different stages of acclimatization while some are still growing in culture (Table 4).

In the case of germplasm brought from PNG and Ivory Coast, the recovery rate was low due to very poor germination of embryos. Some of the ungerminated embryos could be recovered by application of $GA_3$. Shoot tips were excised from enlarged, ungerminated embryos and some of them developed well in culture and gave rise to complete plants. Intense browning, premature senescence and poor growth of plants also contributed to the low success rate observed in raising exotic germplasm.

**Table 3:** ***Performance of coconut embryos collected from PNG***

| Name of the Cultivar | Number of embryo cultures successfully initiated | Number of embryos germinated | Number of in vitro plants transferred to soil *** | Number of plants still at hardening stage | Number of plants ready for field planting | Number of plants transferred to field |
|---|---|---|---|---|---|---|
| **Kar Kar Tall** | 235 | 49 | 30 (8)* | 04 | 0 | 12 |
| **Markham Valley Tall** | 267 | 31 | 30 (13)* | 0 | 0 | 22 |
| **Renell Tall** | 192 | 41 | 27 (05)* | 0 | 0 | 24 |
| **Gazell Peninsula Tall** | 200 | 33 | 15 (02)* | 0 | 12 | 0 |
| **Thalasia Semi Tall** | 178 | 05 | 01 (01)* | 0 | 0 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **PNG Brown Dwarf** | 193 | 46 | 19 (07)* | 03 | 07 | 0 |
| **PNG Yellow Dwarf** | 159 | 29 | 05 (05)* | 0 | 0 | 0 |
| **Malayan Yellow Dwarf** | 193 | 39 | 16 (6)* | 04 | 07 | 0 |
| **Malayan Red Dwarf** | 168 | 03 | 04 (04)* | 01 | 0 | 0 |
| **Niaz Yellow Dwarf** | 185 | 22 | 07 (06)* | 03 | 01 | 01 |

* No. Given in parenthesis indicate weak or contaminated plants out of the total number transplanted

*** Some shoot tip cultures were also established from ungerminated embryos and the number of plants indicated in the column are those obtained from embryo cultures as well as from shoot tip cultures.

**Table 4:** ***Performance of coconut embryos collected from Ivory Coast***

| **Name of the Cultivar** | **Number of embryo cultures initiated** | **Number of embryos germinated** | **Number of shoot tip cultures established** | **Number of in vitro cultures showing good growth** | **Number of in vitro cultures showing poor growth** | **Number of plants transferred to soil** | **Number of plants survived in soil** |
|---|---|---|---|---|---|---|---|
| **Polynesia Tall** | 214 | 01 | 156 | 03 | 18 | 01 | 0 |
| **Tagnanan Tall** | 212 | 09 | 179 | 05 | 50 | 39 | 25 |
| **Vanuatu Tall** | 236 | 09 | 138 | 08 | 36 | 23 | 14 |
| **Tacunan Green Dwarf** | 40 | 05 | 27 | 02 | 11 | 08 | 01 |
| **Tahitian Tall** | 263 | 01 | 190 | 10 | 53 | 18 | 04 |
| **Newlekha Green Dwarf** | 280 | 02 | 225 | 09 | 63 | 24 | 09 |
| **Tenga Tall** | 61 | 15 | 37 | 01 | 18 | 27 | 17 |
| **Malayan Red Dwarf** | 178 | 01 | 115 | 01 | 28 | 06 | 04 |
| **West African Tall** | 236 | 10 | 193 | 06 | 52 | 32 | 17 |
| **Catigan Green Dwarf** | 90 | 17 | 55 | 03 | 15 | 28 | 15 |

*L K Weerakoon, S C Fernando, E S Santha, T R Gunathilake , K P I E Ambagala, J M D T Everard, L Perera and C Bandaranayake*

## 18.2. Studies on clonal propagation of coconut

### Experiment 18. 2. 1: *In vitro* culture of immature zygotic embryos of coconut

A new basal medium (Amino acid medium) was tested for callus induction in immature embryo explants and the preliminary results revealed that callusing frequency is higher in AA medium when compared to basal medium 72, that has been used previously for coconut tissue culture. Furthermore, AA medium was shown to be better in regard to the size and morphology of callus.

The effect of the amino acid, glutamine on callusing in immature embryos was tested and the preliminary results indicated that application of glutamine increased the callusing frequency. Preliminary investigations also revealed that shoot regeneration from immature embryo-derived callus could be enhanced by the application of the growth regulator, 4-CPPU.

According to recent reports by the Mexican Coconut Tissue culture Group, an efficient protocol has been developed for callus multiplication and somatic embryogenesis in plumule explants. Thus experiments were undertaken to test the 'Mexican protocol' with immature embryo explants.

*V Vidhanaarachchi, and E S Santha*

### Experiment 18. 2. 4: Culture of floral meristem explants (1995)

According to previous results, inflorescences having a length of about 10 cm (that usually falls within the maturity stages -6 to -8, considering the youngest open inflorescence as 0 and the inflorescence that is to be opened next as -1) respond best for callusing. However, a considerable damage is caused to the palm when collecting such tender inflorescences. Thus attempts were made to induce callusing in male flowers obtained from immature inflorescences of -4 maturity stage, as a measure to minimize the damage caused to the palm during collection of explants. The male flowers of -4 maturity stage were selected, based on a recent histological study on inflorescence development that indicated the presence of some meristematic cells in the above explants.

Initially, male flowers were crushed and cultured in three different basal media (72, Y3 and AA) supplemented with varying levels of 2,4-D (50, 75 and 100 µM ) for 2 months. After about 4 weeks in culture, small, whitish, transparent structures that resemble callus were observed in some of the media. These structures appeared to arise from the anthers of the male flowers. The frequency of callusing in the explants cultured in different basal media supplemented with 50-µM 2,4-D was 10 %. Based on the results, basal medium 72 supplemented with 50-µM 2,4-D was selected for further experiments.

In order to improve the callusing response in these explants, the effect of stress pre-treatments, cytokinin and pluronic was studied. As shown in Table 5, the application of cold stress (4 °C) for seven days or osmotic stress induced by 0.75 M sucrose for 3 or 7 days enhanced the frequency of callusing.

**Table 5:** *Effect of various stress pre-treatments on the production of callus-like structures in male flowers of -4 maturity stage*

| Treatment | Level | Duration (days) | Callusing (%) |
|---|---|---|---|
| Control | | | 10.0 |
| Heat | | 3 | 0.0 |
| | | 7 | 0.0 |
| Cold | | 3 | 20.0 |
| | | 7 | 50.0 |
| Desiccation | | 1 | 20.0 |
| | | 3 | 0.0 |
| Sucrose | 0.75 M | 3 | 38.4 |
| | | 7 | 48.4 |
| | 1.0 M | 3 | 11.7 |
| | | 7 | 0.0 |
| Mannitol | 0.7 M | 3 | 0.0 |
| | | 7 | 0.0 |
| | 1.0 M | 3 | 0.0 |
| | | 7 | 0.0 |
| PEG | 1 % | 3 | 0.0 |
| | | 7 | 0.0 |
| | 3 % | 3 | 0.0 |
| | | 7 | 0.0 |
| Significance | | | 0.03 |
| CV (%) | | | 53.8 |
| LSD (%) | | | 28.2 |

Cytokinin had no positive effect whereas pluronic had an inhibitory effect on callusing.
Attempts to multiply the callus-like structures (by subculturing them in to the same callus induction medium) were not successful.

The preliminary results are promising and histological analysis will be undertaken to confirm whether the structures formed in culture are embryogenic callus.

*S C Fernando and H D D Bandupriya*

**Experiment 18. 2. 5: Culture of plumule explants (1997)**

The effect of several stress pretreatments on callus induction in plumule explants was investigated. Pre-germinated zygotic embryos (prior to plumule excision) were subjected to desiccation or osmotic stress induced by sucrose (0.75 and 1.0 M), mannitol (0.7 and 1.0 M) and polyethyleneglycol (1 and 3 %) for 1, 3 or 7 days. Alternately, plumules (excised from pre-germinated embryos and cultured in callus induction medium) were subjected directly to heat (38 °C) or cold (4 °C) stress for 3 and 7 days.

Preliminary results revealed that heat pre-treatment of plumules for 7 days and desiccation of embryos for 1 or 3 days (prior to plumule excision) could increase the frequency of callusing (over 75 and 40% respectively) when compared to the control (about 40 %). Cold stress completely inhibited callusing. The callusing frequency in plumules subjected to stress by different osmotica varied from 20 to 50 %. The experiment is still in progress to conclude the effect of osmotic stress on callus induction.

A study was undertaken to select an effective method for callus multiplication. Primary/initial callus (both crushed and uncrushed) were subcultured to callus induction medium (supplemented with the same level of 2,4-D that was used to obtain initial callus). In addition, initial callus (uncrushed) was transferred to the same basal medium supplemented with a reduced level of 2,4-D. Fresh weight gain of callus was determined after a month.

Statistical analysis (covariant analysis) of the results indicated that the weight gain of callus depended on the initial callus weight. Subculturing of crushed callus into the same medium or uncrushed callus into the medium containing lower level of 2,4-D had significantly higher weight gains when compared to subculture of uncrushed callus into the same medium. Considering the fact that lower level of 2,4-D might induce re-differentiation of callus, subculturing of crushed callus in to the same callus induction medium can be selected as an effective method of callus multiplication.

Experiments are also in progress to test the recently developed 'Mexican protocol' using plumules of a few local varieties of coconut.

*S C Fernando and V Vidhanaarachchi,*

**Experiment 18. 2. 7: Studies on coconut anther, unfertilized ovary and ovule culture (1997)**

Anthers collected from inflorescences at 3 Weeks Before Splitting (3 WBS) stage were used as explants for callus induction. They were cultured in Y3 liquid medium supplemented with 100 µM 2, 4-D and 0.1% activated charcoal, after heat pretreatment at 38 °C for 6 days. Initiation of Callus/embryoids was observed after 3 months of culture initiation. The embryoids were whitish, globular structures whereas the callus was highly convoluted and transparent. A few of the embryoids sprouted in culture to produce plantlets.

Flow cytometric analysis revealed that the callus derived from anthers were haploid. This is the first time that haploid callus formation in coconut was reported.

The effect of anther density and physical status of the culture medium on androgenesis are being tested. Furthermore, different plant growth regulators (zeatin, 2iP, 4-CPPU, Thiadizuron {TDZ}IAA, NAA, and picloram), different carbohydrate sources (sucrose, maltose and glucose) and glutamine are being tested with the aim of improving the frequency of androgenesis.

Consistent callusing was observed in unfertilized ovary explants when cultured in basal medium 72 supplemented with 100 µM 2,4-D, 0.1% (w/v) activated charcoal and 4% (w/v) sucrose. As shown in table 5, frequency of callusing could be enhanced further by application of TDZ.

The effect of two different charcoal-free media (containing PVP and ascorbic acid) on induction of callus in unfertilized ovary explants was tested but no callus production was observed in these treatments.

**Table 5:** ***Effect of TDZ on callus production in unfertilized ovary explants***

| Concentration of TDZ in callus induction medium (mg / l) | Percentage callus production |
|---|---|
| 0 (control) | 54 |
| 2 | 76 |
| 4 | 66 |

The effects of epibrassinolide (a novel plant growth regulator), pluronic (a surfactant) and type of activated charcoal used in the medium on callogenesis were also tested but none of the factors had any positive effect on callusing.

Experiments on ovule culture of coconut were initiated. Different culture media with varying levels of growth hormones, sucrose and pluronic were tested for induction of callus in these explants. However, no callus production was observed in any of the media tested.

*P I P Perera and L K Weerakoon*

**Experiment 18. 2. 14: Micropropagation of high-value crops (2002)**

In addition to the routine research program in the division, work was undertaken to develop micropropagation protocols for some ornamental plants (4 commercial varieties of *Quisqualis indica*, *Ananas comosus*, *Combretum comosum* and *Cordyline terminalis*). Effective sterilization methods for in vitro culture of these plants have been determined and cultures have been initiated. Different culture conditions are being tested to develop efficient in vitro regeneration protocols for these plants.

*V Vidhanaarachchi, S C Fernando, L K Weerakoon, T R Gunathilake, K P I E Ambagala and E S Santha*

## 3. ACKNOWLEDGMENT

The assistance and co-operation of the staff of the Tissue Culture Division in conducting the experiments and compiling this report are gratefully acknowledged. Thanks are due to the Head and the staff of the Biometry Division for their assistance in designing experiments and statistical analysis of data. The assistance provided by the Head and the staff of the Genetics and Plant Breeding Division in the germplasm exchange program is gratefully acknowledged.

# REPORT OF THE COCONUT PROCESSING RESEARCH DIVISION

**Officer-in-Charge-J M N Marikkar,PhD**

## GENERAL

The research program of the Coconut Processing Research Division during the year 2005, has given more emphasis on developing kernel based products out of normal and 'dikiri' coconut, value added oil based products and fermented products out of coconut sap and water.

Studies were conducted to formulate a low-cost spread cheese from coconut skim milk. It showed that coconut spread cheese can be made easily even without addition of emulsifiers. Thus the product becomes cheaper and good for low-income consumers as a nutritious modified food.

Studies were initiated on 'dikiri' coconut. The characterization studies showed that from the gelatinous form of 'dikiri' endosperm as high as 22% of pectin can be isolated. Further, the product development studies showed that the endosperm could be used as for prepare bread spread.

Development of a low-fat coconut milk powder using defatted kernel residue was also investigated. As a fat-substitute in culinary preparation fat content of 18% (w/w) and above were mostly preferred by the panelists as possessing better quality with respect to taste, smell, colour, and overall acceptability.

Isolation of high alcohol yielding yeast strains was of interest in toddy fermentation. It was attempted to prepare a ready-to-use form in order to distribute it to the industry. Results of this study showed that high alcohol yielding yeast can be made into a palletized form by coating the yeast on half boiled rice.

### Experiment 01: Formulation of a Spread Cheese with the Highest Possible Substitution of Coconut Skim Milk with Non-Fat Dry Milk

Studies were conducted to formulate a low-cost spread cheese from coconut skim milk and to determine its storability. Prepared coconut skim milk was used to develop two formulations of spread cheese with 30 % of non-fat dry milk (NFDM) with 70 % of coconut skim milk (CSM) and 20 % of NFDM with 80 % CSM respectively. Sensory evaluation (5-point hedonic scale) was conducted to select the more acceptable formulation (Table 1.1).

**Table 1.1:** *Probability values and mean scores of sensory attributes of two formulations of spread cheese*

| Attributes | p Value | Mean scores | |
|---|---|---|---|
| | | C1 | C2 |
| Appearance | <.0001 | 50.1 | 30.9 |
| Colour | 0.0001 | 49.7 | 31.3 |
| Taste | 0.0116 | 46.8 | 34.2 |
| Texture | 0.0096 | 46.9 | 34.1 |
| Overall acceptability | 0.0162 | 46.4 | 34.6 |

*Probability value ($p \leq 0.05$) significantly different, N = 40*
*C1 = 70 % CSM + 30 % NFDM*
*C2 = 80 % CSM + 20 % NFDM*

The results indicated that all the sensory attributes for both formulations were significantly different. Out of two formulations, 30 % NFDM + 70 % CSM (C1) showed higher mean scores for all the sensory attributes; appearance, colour, taste, texture and overall acceptability (50.1, 49.7, 46.8, 46.9 and 46.4 respectively). Among the mean scores of all the sensory attributes of C1 formulation, the highest mean score (50.1) was obtained for the appearance followed by the colour and more or less similar values were obtained for the other sensory attributes. Comparatively lower mean scores for all the sensory attributes for C2 formulation may be due to increased coconut flavour and characteristic white colour with higher substitution of CSM. C1 was selected as the better formulation for further studies and was subjected to 4 different antioxidant levels and the best level was selected through a sensory evaluation (Table 1.2).

**Table 1.2:** *Probability values and mean scores of sensory attributes of four types of spread cheese with different level of antioxidants*

| Attributes | p Value | Mean scores | | | |
|---|---|---|---|---|---|
| | | T1 | T2 | T3 | T4 |
| Appearance | <.0001 | 53.3 | 70.0 | 104.6 | .94.2 |
| Colour | 0.0009 | 61.9 | 73.7 | 99.7 | 86.7 |
| Taste | 0.0050 | 63.7 | 80.8 | 99.5 | 78.0 |
| Texture | <.0001 | 58.4 | 71.2 | 104.7 | 87.6 |
| Overall acceptability | 0.0013 | 59.2 | 78.5 | 97.4 | 87.0 |

*Probability value ($p \leq 0.05$) significantly different, N = 40*
*T1 – Not treated (Control)*
*T2 – Treated with 0.1 % antioxidant*
*T3 – Treated with 0.5 % antioxidant*
*T4 – Treated with 1 % antioxidant*

The appearance, taste, colour, texture and overall acceptability were significantly different among the four treatments (T1, T2, T3 and T4). The control (T1) scored the lowest, while the one which was subjected to 0.5 % of antioxidant showed the highest

mean score value for all the sensory attributes. The mean score for appearance, colour, taste, texture and overall acceptability were 104.6, 99.7, 99.5, 104.7 and 97.4 respectively. Therefore, T3 (treated with 0.5 % antioxidant) could be regarded as the best treatment for further analyses.

The selected coconut spread cheese was compared with a market available spread cheese through a sensory evaluation served with no carriers and the final sensory evaluation was conducted to compare the both samples with carriers (Table 1.3).

**Table 1.3:** *Probability values and mean scores of sensory attributes of formulated and the market available spread cheeses*

| Attributes | p Value | Mean scores | |
|---|---|---|---|
| **Without carriers*** | | **SC1** | **SC2** |
| Appearance | 0.0562 | 36.0 | 50.0 |
| Colour | 0.0482 | 35.7 | 45.3 |
| Taste | 0.0002 | 31.6 | 49.4 |
| Texture | 0.1156 | 36.8 | 44.2 |
| Overall acceptability | 0.0001 | 31.8 | 49.2 |
| **With carriers**** | | **SC1** | **SC2** |
| Appearance | 0.1764 | 32.6 | 38.4 |
| Colour | 0.0002 | 26.9 | 44.1 |
| Taste | 0.0928 | 31.9 | 39.1 |
| Texture | 0.1334 | 32.3 | 38.7 |
| Overall acceptability | 0.0903 | 32.2 | 38.8 |

*Probability value ($p \leq 0.05$) significantly different, *N1 = 40, **N2=35*
*SC1 = Formulated spread cheese*
*SC2 = Market available spread cheese*

Results of the sensory evaluation of both spread cheeses served without carriers showed that, colour, taste and overall acceptability of formulated spread cheese were significantly different from those of market available spread cheese. No significant difference was observed in appearance and texture between the two samples. SC2 showed higher mean scores for taste, colour and overall acceptability (49.4, 45.3 and 49.2 respectively). The lower score for taste of SC1 (31.6) compared to that of SC2 (49.4) could be due to its distinct coconut oily taste. It was observed that there was no significant difference ($p \leq 0.05$) for appearance, taste, texture and overall acceptability except for colour between the 2 samples served with carriers. However, the SC2 showed higher mean scores for all sensory attributes (38.4, 44.1, 39.1, 38.7 and 38.8 respectively).

Chemical and microbiological analyses were conducted to check protein (%), fat (%), sugar (%), mineral (%), moisture (%), salt content(Table 1.4), fatty acid profile(Table 1.5); total yeast and mould count.

**Table 1.4**: *Chemical composition of formulated spread cheese and market available spread cheese*

| Parameters | SC1 | SC2 | p Value |
|---|---|---|---|
| Moisture (%) | 78.84 | 52.20 | <0.0001 |
| Crude protein (%) | 13.10 | 16.00 | 0.0528 |
| Crude fat (%) | 2.76 | 26.00 | 0.0014 |
| Total sugar (%) | 2.00 | 2.50 | 0.0125 |
| Salt (%) | 2.00 | 1.90 | 0.424 |
| Mineral (%) | 1.30 | 1.40 | 0.4818 |
| pH | 5.05 | 5.35 | <0.0001 |

*Each value represents the mean of triplicate analyses.*
*Probability value ($p \leq 0.05$) significantly different*
*SC 1 = Formulated spread cheese*
*SC 2 = Market available spread cheese*

The results of chemical analysis of the both spread cheeses showed that there was significant difference in moisture, crude fat, total sugar and the pH value between the two samples (Table 1.5). The coconut spread cheese showed higher moisture (78.84 %) than that of market available spread cheese (52.20 %). It may be due to considerably lower fat content in SC2 (2.76 %) compared to that of market available (26 %). Total sugar content was slightly higher in spread cheese made from dairy milk. The pH value SC1 was slightly low since it was fermented.

**Table 1.5:** *Fatty acid composition of formulated spread cheese (SC1) and market available spread cheese (SC2)*

| Name of fatty acid | | Peak area (%) | | Ratio SC1 : SC2 |
|---|---|---|---|---|
| | | SC1 | SC2 | |
| Caproic acid | (C06:0) | 0.5 | 0.8 | 1: 1.6 |
| Caprylic acid | (C08:0) | 7.8 | 0.9 | 8.7:1 |
| Capric acid | (C10:0) | 6.3 | 2.6 | 2.4:1 |
| Lauric acid | (C12:0) | 45.4 | 3.2 | 14.2:1 |
| Myristic acid | (C14:0) | 20.9 | 10.6 | 2.0:1 |
| Palmitic acid | (C16:0) | 9.1 | 25.7 | 1: 2.8 |
| Stearic acid | (C18:0) | 0.6 | 3.0 | 1: 5.0 |
| Oleic acid | (C18:1) | 7.1 | 22.4 | 1: 3.2 |
| Linoleic acid | (C18:2) | 2.3 | 8.4 | 1: 3.6 |
| Others | | - | 22.4 | |

Analysis of fatty acid composition of both spread cheeses showed that Lauric acid was the most abundant fatty acid (45.4 %) found in the formulated spread cheese whereas it was Palmitic acid (25.7%) in the market available spread cheese made out of dairy milk

(Table 1.6). The content of Caproic, Palmitic, Stearic, Oleic, and Linoleic fatty acids of the SC1 (0.5 %, 9.1 %, 0.6 %, 7.1 % and 2.3 % respectively) were lower than those of SC2 while composition of Caprylic, Capric, Lauric and Myristic acids were higher than those of SC2. Calculations showed that higher ratio of Caprylic, Lauric acid (8.6:1, 14.2:1) and lower ratio of Stearic acid (1:5.0) between SC1 and SC2. Results indicated that the market available spread cheese contained other unidentified fatty acids. The difference in fatty acid composition in the two products resulted in the distinct flavour and taste for those products.

Total yeast and mould count below 3 colonies /g was observed during the 3 months period (Table 1.6). The international microbial legislation for soft cheese should not exceed $10^2$-$10^3$ cfu /g with their freedom from all pathogenic microorganisms (Law, 1999). Since the colony count was within the standard limits,

The spread cheese could be kept for 3 months under refrigeration. FFA and moisture contents increased on storage (Table 1.6). However, the increments were very small. 1 % of FFA is the critical limit for most of food commodities. Peroxide value was negligible over the 3 months of storage.

**Table 1.6:** *Physico-chemical and microbiological parameters of the formulated spread cheese on storage*

| WAP | Moisture % | FFA % | Peroxide value (meq/kg) | Yeast & Mould Count (YMC)/g |
|---|---|---|---|---|
| 1 | 73.68 | 0.0016 | 0 | 0 |
| 2 | 75.35 | 0.0059 | 0 | $1x10^2$ |
| 3 | 78.14 | 0.0077 | 0 | $1x10^2$ |
| 4 | 80.05 | 0.0086 | 0 | $2x10^2$ |
| 5 | 82.10 | 0.0098 | 0 | $2x10^2$ |
| 6 | 83.56 | 0.0143 | 0 | $2x10^2$ |
| 7 | 84.93 | 0.0154 | 0 | $2x10^2$ |
| 8 | 85.10 | 0.0256 | 0.0001 | $3x10^2$ |
| 9 | 86.35 | 0.0543 | 0.0001 | $3x10^2$ |
| 10 | 85.10 | 0.0723 | 0.0001 | $3x10^2$ |
| 11 | 85.00 | 0.0956 | 0.0002 | $3x10^2$ |
| 12 | 85.40 | 0.1630 | 0.0002 | $3x10^2$ |

*WAP = Weeks After Preparation*
*FFA % = Free Fatty Acids*

This modified food product possesses good quality and high consumer acceptance. The development of formulated cheese from CSM and NFDM must be viewed as a challenge rather than a threat to the local developing dairy industry since this could make available the highly nutritious, yet cheaper food product for low-income consumers.

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Experiment 02: Use of Pure Yeast Strains in Ready to Use Form with Long Shelf Life to increase Ethanol Production in Coconut Toddy

Studies were conducted to develop ready-to-use yeast from high alcohol producing yeast strains. Increment of alcohol content in coconut toddy was the main consideration. Among several isolated yeast strains (Table 2.1), yeast strain with highest alcohol production was determined.

**Table 2.1:** *Average ethanol production in selected yeast isolates.*

| Yeast isolate Number | Average ethanol production (on day 5) % (v/v) |
|---|---|
| Y1 | 8.0 c |
| Y2 | 8.2 b, c |
| Y3 | 8.0 c |
| Y4 | 8.4 b |
| Y5 | 7.5 d |
| Y6 | 8.0 c |
| Y7 | 8.8 a |
| Y8 | 8.3 b |

*Each value represents mean of duplicate. Values donated in same letter (s) are not significantly different ($P \leq 0.05$)*

Based on the results the alcohol productivity of yeast isolate Y7 is significantly different from other isolates and it shows the highest ethanol production over the other yeast isolates on fifth day of fermentation and it was mass cultured under different treatments (Table 2.2).

**Table 2.2:** *Alcohol productivity of ready- to- use yeast mass cultured under different treatments*

| Treatment | Average ethanol production (at day 5) % (v/v) |
|---|---|
| T1 | 8.50 b |
| T2 | 8.20 b |
| T3 | 8.25 b |

| | |
|---|---|
| T4 | 8.95 a |
| T5 | 7.75 c |
| T6 | 7.20 d |
| T7 | 8.05 b, c |
| T8 | 1.40 e |

Each value represents mean of duplicate. Values donated in same letter (s) are not significantly different ($P \leq 0.05$)

T1- Aerobic, 7.5 % Brix, 4.5 pH, 66 hrs

T2- Aerobic, 7.5 % Brix, 4.5 pH, 90 hrs

T3- Aerobic, 15 % Brix, 4.5 pH, 66 hrs

T4- Aerobic, 15 % Brix, 4.5 pH, 90 hrs

T5- Anaerobic, 7.5 % Brix, 4.5 pH, 66 hrs

T6- Anaerobic, 7.5 % Brix, 4.5 pH, 90 hrs

T7- Anaerobic, 15 % Brix, 4.5 pH, 66 hrs

T8- Anaerobic, 15 % Brix, 4.5 pH, 90 hrs

Results indicate that T4 yielded the highest mean alcohol percentage. Yeast masses so produced were converted to ready-to-use form by coating on half boiled rice and were stored at both room and refrigerated temperature for 4 weeks and tested for alcohol production.

**Table 2.3:** *Average alcohol production on 4 weeks of storage at room and refrigerated conditions*

| Week | Average alcohol production % (v/v) | | | |
|---|---|---|---|---|
| | Room Temperature | | Refrigerated temperature | |
| | Control | Yeast | Control | Yeast |
| 1 | 7.65 | 9.22 | 7.45 | 8.55 |
| 2 | 6.45 | 8.58 | 7.45 | 8.42 |
| 3 | 5.40 | 8.08 | 7.35 | 8.20 |
| 4 | 7.40 | 8.08 | 7.60 | 8.28 |

Higher mean value for alcohol content at refrigerated temperature reveals that the storage is better at refrigerated temperature than at room temperature.

High alcohol producing yeast strains can be converted to ready-to-use form and can be used in the industry successfully. Further studies are needed to evaluate packaging requirements of the finished product.

**Experiment 03: Comparing the Effect of Virgin Coconut Oil and Soybean Oil Diets on the Serum Blood Cholesterol of Wistar Rats**

Virgin coconut oil (VCO) is produced from the dried comminuted kernel free from brownish testa using a screw pressing oil expeller operating under mild temperature conditions. As compared to normal coconut oil VCO has a slightly lower degree of unsaturation which is mainly due to the removal of brownish testa of the coconut kernel. In this study we intend to see whether lower degree of unsaturation of VCO has any negative effect on serum blood cholesterol using wistar rats as animal models.

Sixteen wistar rats were divided into 2 groups and one group was fed with an experimental diet containing soybean oil (control) while the other group was fed with the same diet containing virgin coconut oil instead of soybean oil for a period of 4 weeks. On the $5^{th}$ week the rats were taken out to draw blood samples for cholesterol assay. To confirm the reproducibility of the results, another series of experiment was performed in the same way.

Preliminary studies show that there is no significant difference ($p > 0.05$) in total cholesterol level between the control and test animals (table 3.1).

**Table 3.1:** *Total cholesterol level of test sample against the control after 4 weeks of feeding*

| Sample | Total cholesterol, mg/dl |
|---|---|
| Test | 52.78 |
| Control | 51.70 |

Each value represents the mean of 8 replicate analyses.

The results obtained from the second trial confirmed that there is no significant difference ($p>0.05$) in total cholesterol level between the control and the test animals (table 3.2).

**Table 3.2:** *Total cholesterol level of test sample against the control after 8 weeks of feeding*

| Sample | Total cholesterol, mg/dl |
|---|---|
| Test | 57.21 |
| Control | 61.78 |

Each value represents the mean of 8 replicate analyses.

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**Experiment 04: Utilization of Defatted Kernel Residue as Raw Material for Spray-dried Low-fat Milk Powder**

Development of a low-fat coconut milk powder is highly demanded as a fat substitute in culinary and confectionary preparations for people suffering from hypertension and obesity. In this study, it was attempted to produce a low-fat coconut milk powder out of edible grade defatted kernel residue left after the extraction of virgin coconut oil. After evaluating the proximate composition (Table 4.1), the defatted coconut residue was grounded into fine particles and sieved to obtain the defatted flour.

**Table 4.1:** *Proximate Composition of Defatted Kernel Residue*

| Constituent | % (w/w) |
|---|---|
| Moisture | 4.5 |
| Fat | 6.55 |
| Protein | 19.7 |
| Sugar | 25.45 |
| Other carbohydrates | 43.8 |

Since the defatted kernel residue is white in colour and has a low amount of fat, there is a possibility to use as low-fat milk powder for culinary or confectionary applications. However, the presence of higher proportion of insoluble fibrous material makes it organoleptically less attractive. Therefore, it was attempted in this study to reconstitute the defatted kernel residue with water to obtain a spray-dried low-fat milk powder. Samples for spray dryer operation were prepared according to the mixing ratios shown in Table 4.2.

**Table 4.2:** *Mixing Ratios of Diluted Coconut Milk and Concentrated Coconut Milk*

| Treatment | Diluted Coconut Milk (ml) | Concentrated Coconut Milk (ml) |
|---|---|---|
| $T_1$ | 1000 | 0 |
| $T_2$ | 1000 | 30 |
| $T_3$ | 1000 | 60 |
| $T_4$ | 1000 | 70 |
| $T_5$ | 1000 | 150 |
| $T_6$ | 1000 | 250 |

When these samples were fed into a spray dryer, a series of low-fat milk powders were obtained (Table 4.3).

**Table 4.3:** *Yield Data of Spray Dryer Operation*

| Treatment | Spray Dryer Time (min/L) | Yield (g/L) |
|---|---|---|

| | | |
|---|---|---|
| $T_1$ | 45 | 75 |
| $T_2$ | 60 | 100 |
| $T_3$ | 75 | 125 |
| $T_4$ | 80 | 155 |
| $T_5$ | 90 | 175 |
| $T_6$ | 105 | 200 |

The sample series was subsequently evaluated by a 46-member sensory panel for different sensory attributes using a 7-point hedonic scale. The statistical analysis of the sensory data showed that there were significant differences between different treatments (ie. six treatments based on the variation of fat content). Out of the six treatments, samples having fat content of 18% (w/w) and above were mostly preferred by the panelists as possessing better quality with respect to taste, smell, color and overall acceptability. In the evaluation of shelf life stability based on the free fatty acid (FFA) content and peroxide value (PV), it was found that FFA and PV of all the samples did not vary much over a period of six weeks.

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**Experiment 05: Determining the Critical Level of Fortification of Sesame in Virgin Coconut Oil**

Although virgin coconut oil could be useful as instant energy provider, lack of essential fatty acids in it is an important disadvantage. In this context, fortification of VCO with a suitable source rich in essential fatty acid (EFA) is one of the promising means of alleviating the shortage of EFA is our diet. Sesame seed (*Sesamum indicum*) for instance, is an attractive option for this purpose as it is cheap and belongs to the high-fat seed category with more than 50% of its dry matters being oil. Since it contains high proportions of linoleic acid, it can be profitably used for formulation of EFA enriched-virgin coconut oil. However, certain odor characteristics associated with sesame seed remains as a hurdle for its utilization in Sri Lanka. Therefore, the objective this study was to produce an EFA-enriched oil to fulfill the daily requirement of people and to evaluate acceptance in terms of its sensory attributes. Or this purpose, micro-expelling process was employed to extract oil blends out of dried coconut gratings mixed with varying proportions of sesame seed (Table 5.1).

**Table 5.1:** *Mixing Proportions of Desiccated Coconut (DC) and Sesame Seed*[1]

| Oil Blend (Treatment) | Sesame(g) | DC(g) | Ratio of Sesame: DC |
|---|---|---|---|
| $T_0$(VCO) | 0 | 10000 | 0:100 |
| $T_1$ | 100 | 9900 | 1:99 |
| $T_2$ | 200 | 9800 | 2:98 |
| $T_3$ | 300 | 9700 | 3:97 |
| $T_4$ | 400 | 9600 | 4:96 |

| | | | |
|---|---|---|---|
| $T_5$ | 500 | 9500 | 5:95 |
| $T_6$ | 700 | 9300 | 7:93 |
| $T_7$ | 1000 | 9000 | 10:90 |

[1]Abbreviations: VCO, virgin coconut oil.

After determining the fatty acid composition and chemical parameters (iodine value and free fatty acid content), the oil series was subjected to sensory evaluation to detect characteristic sesame odor by a 30 member panel in order to select more acceptable oil blend using a 7- point hedonic scale. Statistical analysis of the sensory data showed that the point indicating unpleasant order of sesame appears at 4% level of sesame seed in coconut kernel mixture.

**Experiment 06: Compositional analysis of Dikiri Coconut**

'Dikiri' is an abnormal coconut variety with soft gelatinous endosperm. The present study was carried out to compare the kernel composition of 'dikiri' with that of ordinary variety.

**6.1 Proximate composition:**

The samples of triplicates were analyzed, and the statistical analysis was done using t-test of Minitab. The proximate composition of 'dikiri' and normal coconut was compared as shown in table 6.1.

**Table 6.1:** *Proximate composition of Dikiri and normal coconut kernel*

| Constituent | Dikiri | Normal |
|---|---|---|
| Moisture % | 61.2 ± 0.96 | 55.3 ± 0.32 |
| Ash % (db) | 1.2 ± 0.1 | 0.8 ± 0.07 |
| Crude fat % (db) | 59.8 ± 3.68 | 66.4 ± 6.64 |
| Crude fibre % (db) | 17.6 ± 0.24 | 16.3 ± 0.23 |
| Crude protein % (db) | 6.6 ± 0.33 | 7.8 ± 0.22 |

(db) – dry weight basis
Mean of determination ± standard deviation

According to the table 6.1, there is a significant difference ($p < 0.05$) only in moisture content between 'dikiri' and ordinary coconut variety. 'Dikiri' coconut showed significantly high amount of moisture (61.2 %) compared to ordinary coconut. Other chemical constituents were fairly similar to those of ordinary coconut.

**6.2 Isolation and characterization of 'dikiri' pectin:**

Isolation of pectin from 'dikiri' was done according to two methods. In the first method, pectin was isolated from mature 'dikiri' using hot acid solution (pH 4.5) with sodium hexametaphosphte followed by ethanol precipitation. In the second method, hot acid solution (pH 1.34) and 96 % ethanol solution was used. Pectin was also extracted from passion fruit, apple and pumpkin using the first method. Isolated pectin was subjected for chemical characterization.

In the case of 'dikiri' 22.36 % and 14.35 % of pectin recovery reached using method one and method two, respectively. Passion fruit, apple and pumpkin gave 12.96 %, 4.08 % and 10.12 % pectin respectively on dry weight basis using the first method. The isolated 'dikiri' pectin contained 85.78 %moisture, 0.82 % ash, 8.72 methoxyl value and 0.09 acetyl value with equivalent weight of 1052.71. 'Dikiri' contained considerable amount of extractable high methoxyl pectin, which can be used as a gelling agent in food industry. The total dietary fibre content of 'dikiri' contained 56.29 % on dry weight basis.

### 6.3 Mineral composition:

Mineral composition and total dietary fibre content of Dikiri and ordinary coconut were determined. Dikiri contained 0.15 % Na, 2.58 % K, 0.02 % Ca and 0.36 % Mg on dry weight basis.

## Experiment 07: Development of Bread Spread using 'Dikiri' coconut

'Dikiri' is a unique form of coconut variety available in the southern coastal belt of Sri Lanka such as Galle & Matara districts. However this has not been fully exploited for value addition. So, an experiment was done to develop a healthy bread spread (Mustard cream) by replacing the margarine base by 'dikiri' pulp. The process includes mixing of 'dikiri' pulp with powdered spices and subsequent heat treatment to preserve for longer time. The product was evaluated and compared with commercial bread spreads for sensory properties and proximate composition.

**Table 7.1: *P* value of sensory attributes compare with commercial sample**

| Sensory attributes tested | *P* value (Probability Value) |
|---|---|
| Color & Appearance | 0.000 |
| Taste | 0.029 |
| Texture | 0.868 |
| Overall acceptability | 0.007 |

The detailed sensory evaluation of the 'dikiri' based sample and the commercial sample was done using 5 point Hedonic scale. Results shows that appearance, taste and overall acceptability of the 'dikiri' based product was significantly different from the commercial sample.

**Table 7.2: Proximate compositional analysis**

| Proximate compositions | 'Dikiri' based Sample | Commercial sample |
|---|---|---|
| Moisture | 31.70% | 19.70% |
| Ash content | 7.95% | 5.90% |
| Crude fat | 11.35% | 35.10% |
| Crude protein | 2.68% | 1.00% |
| Crude fiber | 2.95% | 2.94% |

Commercial sample contains margarine as the base, which is around 90% rich in fat. Lesser amount of crude fat in the sample seems to be beneficial factor. Mustard gives a sharp flavor, and inhibits the growth of certain yeasts & moulds and act as an antioxidant. The shelf life study is being carrying out.

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## REPORT OF THE PLANT PHYSIOLOGY DIVISION

**Head – C S Ranasinghe, Ph D**

### GENERAL

The divisional research programme was assisted by government-consolidated funds and the coconut CESS fund. The evaluation of dwarf brown (DB) with two other dwarf (DG and CRD) and one tall accession (Clovis) revealed the greater drought tolerance of Clovis with respect to other three cultivars. However, out of the three dwarfs tested, dwarf brown appeared more resistant to environmental stress condition with the ability to maintain higher rate of photosynthesis even under moisture stress. With this high potential of DB, it is expected to evaluate the hybrids of DB, from a physiological point of view to identify hybrids with potential for higher vegetative growth and putative drought tolerance.

The effect of drip irrigation on micro climatic conditions of the canopy and nut setting of adult coconut palms during dry periods was determined at Ratmalagara Research Station. The irrigation appears to have a definite impact on lowering the temperature at the canopy and manure circle and also on the female flower production and nut setting during dry spells. Moreover, irrigation @ 80 litres per palm per day show much enhanced effect compared to that of 40 litres per palm per day. Two new long-term experiments were started at Bingiriya (S4) and Wanathavilluwa (S2 with Gambura and Mavillu series) to determine the effect of drip irrigation on the vegetative growth, flowering time and yield under different land suitability classes. A new project on water harvesting in coconut lands was started, and this project primarily expects to construct small tanks for collecting runoff in CRI estates (nine sites – Middeniya, BE, PRS, Ambakelle GRC, PSG, RE, WE, Makandura and Maduru Oya) which will be followed by the post evaluation of the improvement of yields and their consistency along with the improvement in soil moisture retention during dry spells. An experiment was started at Middeniya Research Station with the objective to assess a model drought management system for coconut lands which can be recommended in the future as an overall drought management package for drought prone areas in mini coconut triangle the Southern province while remaining it as an *in situ* model (a demonstration site) which would automatically prove and convince growers over the benefits of adopting such techniques.

The study on the evaluation of growth and performance of root system of coconut seedlings under different land suitability classes (LSC) revealed that there are clear differences in development of root system, and other physiological process of the palm among the three LSC, S2, S3 and S4. A new experiment was started in the wet and intermediate zones, to determine the physiological mechanisms of drought tolerance in CRIC 60 (drought tolerant) and CRIC 65 (drought-susceptible), under S2 and S4 land suitability classes with particular reference to root physiology.

The protocol for quality preservation of tender king coconuts for a period of one month was obtained by 10 growers/ exporters during the year. Vacuum packing of disinfected coconuts (with Benlate 0.6 g/L) under cold storage (13-15 °C) was identified as a suitable protocol for extending shelf life of up to 36-38 days for export purposes. Captan (0.6 g / L) was found to be an equally suitable fungicide to replace Benlate for disinfection. The fungus on the nut surface and the perianth of infected nuts was identified as *Fusarium* species. Identification of coconut cultivars with the potential for use in the tender nut industry was commenced with Dwarf Green, Dwarf Yellow, Dwarf Red, Dwarf Brown, Brazilian Green Dwarf, King coconut, Bodiri, Murusi, Bothal Thembili, Dothalu and Juvan nuts collected from BE, PRS and Galle. A study was initiated to compare total sugars and polyphenol content in the mite-feeding area of nuts (soft tissues under the perianth) of mite-infested and mite-free nuts, and among different cultivars.

**THRUST AREA: CROP IMPROVEMENT**

**PROJECT:** **STUDIES ON FACTORS LIMITING DRY MATTER PRODUCTION IN COCONUT VARIETIES AND HYBRIDS**

**Experiment:** **Evaluation of different varieties of coconut for drought tolerance (PRS)**

The objective of the study was to compare the performance of dwarf brown variety with two selected dwarf varieties and a putative drought tolerant tall variety. The drought tolerant characteristics of Dwarf Brown (DB) was compared with two other dwarf forms (Dwarf Green (DG), Cameroon Red Dwarf (CRD)) and one tall form (Clovis) using physiological and biochemical traits. The drought tolerance of Clovis was higher compared to other three dwarf cultivars. However, out of the three dwarfs tested, DB appeared more resistant to environmental stress conditions with the ability to maintain higher rate of photosynthesis even under moisture stress (Fig 1).

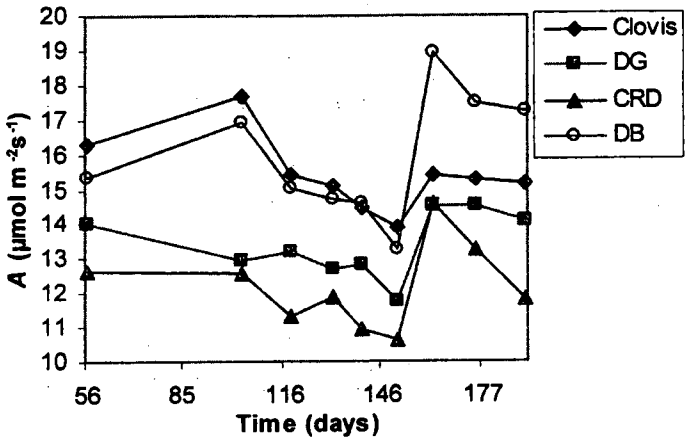



**Figure 1.** ***Variation in net assimilation rate (A) of Clovis, DG, CRD and DB with withholding water (up to day 150) and during re-watering***

The experiment was terminated.

*A Nainanayake, W G D Luckmini, R D N Premasiri, L R S Silva, P S A de Saram*

**Experiment:** **Evaluation of hybrid vigour of Dwarf Brown x Tall, Tall x Dwarf Brown and Dwarf Brown x San Ramon for yield and tolerance to moisture stress in different agro-ecological zones** (Raddegoda and RE)

From a breeding perspective, Dwarf Brown appears a more promising variety to employ as a parent material in developing new hybrids due to some characteristics such as non seasonality, high yielding capacity (higher number of nuts per bunch and higher no of inflorescence per palm per year) and relatively high of tolerance to water stress conditions compared to those of other dwarf varieties. This higher potential of dwarf brown prompted plant breeders to develop more hybrids of Dwarf brown, crossing with identified tall varieties. It is expected to evaluate these hybrids from a physiological point of view to identify hybrids, which possess potential for higher vegetative growth and putative drought tolerance. Therefore, present study was commenced with a view to identify potential varieties with greater hybrid vigour (vegetative growth) and putative drought tolerance under different agro-ecological regions by investigating on physiological and water relations aspects which can later be correlated with yield aspects.

**Varieties under evaluation:**

Dwarf Brown x Tall, Dwarf Brown x San Ramon, Tall x Dwarf Brown
Dwarf Green x Tall, Dwarf Green x San Ramon, Tall x San Ramon
Tall x Tall, Dwarf Brown
Only one set of data has been collected so far and it is premature to make any inferences. However, the preliminary data analysis showed higher rates of photosynthesis and water use efficiency in Dwarf Brown x Tall compared to the rest.

*A Nainanayake, C S Ranasinghe, R D N Premasiri, L R S Silva*

**Experiment:** **Coconut Genome mapping (collaborative experiment with GPBD)**

A mapping population of coconut was obtained from crosses between single tall pollen donor and 26 genetically identical dwarf mothers by GPBD. Seedlings are now in the glass house for characterization of net assimilation rates, water use efficiency and related biochemical parameters of each family.

*A Nainanayake, C S Ranasinghe, C Bandaranayake (GPBD)*

**THRUST AREA: CROP PRODUCTION**

**PROJECT:** **STUDIES ON WATER, LIGHT, HEAT STRESS AND ELEVATED $CO_2$ EFFECTS ON PRODUCTIVITY**

**Experiment:** **Effect of drip irrigation on micro climatic conditions of the canopy, soil temperature, button nut setting and yield (RE).**

The study aimed to evaluate the effect of drip irrigation on the micro climatic conditions of the canopy, in the effective root zone and button nut setting of coconut palms. The drip irrigation trial conducted at Ratmalagara Research Station, by the Soils and Plant Nutrition Division, CRI was used for the study.

**Treatments** (source: SPND, CRI):

| Treatment | Irrigation interval (days) | Application of water (L per day/ palm) | Application of water (hrs per day/ palm) | Application of fertilizer g / yr | No. of time of fertilizer application / yr |
|---|---|---|---|---|---|
| T1(control) | - | - | - | 3000 | 1 |
| T5 | 6 | 40 | 2 | 250 | 12 |
| T6 | 3 | 80 | 2 | 250 | 12 |

*The following data were collected.*

1. Canopy temperature (at 7th bunch and 10th bunch levels)
2. Nut surface temperature (topmost nuts of 7th and 10th bunch, exposed to sunlight)
3. Soil temperature (1 m away from the base of the palm, at 30 cm depth, 7-10.00 and 13.00-14.00 hrs.)
4. Number of female flowers produced and button nut setting
5. Leaf stomatal diffusive resistance

Soil temperature ($T_{soil}$) was low with no significant differences between three treatment plots when the soil was completely wet after heavy rains (Fig. 2a). However, $T_{soil}$ was increased by about 4°C (15%) in control plots during the dry spell whereas an increase of only 2°C and 1°C were observed in T5 and T6 treatment plots, respectively. Accordingly, the drip irrigation has been effective in reduction of $T_{soil}$ by 2°C (7%) and 3°C (10%) in T5 and T6 treatment plots with respect to that of the control plot.

The nut surface temperature ($T_{nut}$) of both 7th and 10th bunches also showed no significant differences between treatments when soil was completely wet (Fig. 2b&c). But, $T_{nut}$ of the 7th bunch was increased by approx. 3°C in control plots during the dry spell whereas the increase was only 1.5°C and 0.4°C in T5 and T6 plot, respectively and the pattern was similar in 10th bunch also. Thus, the drip irrigation has been significantly effective ($P < 0.01$) in maintaining the $T_{nut}$ at substantially lower value. The impact of irrigation has also been effective in lowering the air temperature in the micro climate created within the coconut canopy where only 0.8 and 0.4°C increase was observed in T5 and T6 plots, respectively while the increase was about 2°C in control plots (Fig. 2d & e). Only a slight increase of air temperature was observed in the lower canopy both in T5 and T6 plots.

The impact of irrigation on physiological processes was phenomenal. When the stomatal diffusive resistance was increased by 6-fold in control plots during dry spell, only 55% and 30% increases were observed in T5 and T6 plots respectively which indicates a substantial impact of irrigation in maintaining gaseous exchange almost uninterrupted during dry spell (Fig. 2f).

The effect of irrigation is reflected in the number of female flowers produced and the number of set nuts. Almost 90% and 130% increase in number of female flowers were observed in T5 and T6 plots with respect to that of control plots while more than 120% nut setting (final yield) was observed in both T5 and T6 treatments (Fig. 3a & b). Hence, the irrigation appears to have a definite impact on lowering the temperature at the canopy microclimate and also on the female flower production and nut setting during dry spells. Moreover, irrigation @ 80 liters per palm per day showed much enhanced effect compared to that of 40 liters per palm per day

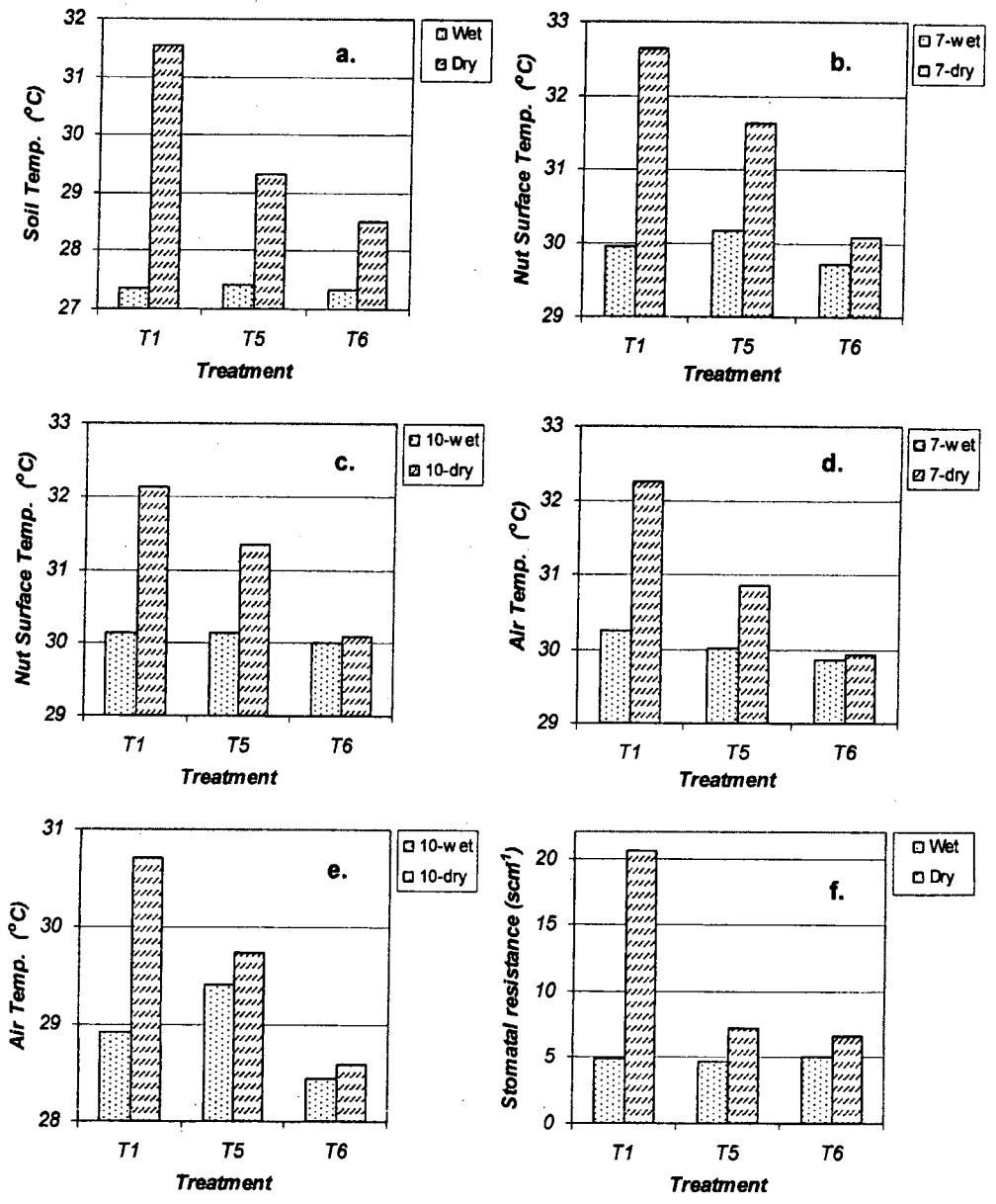



**Figure 2.** *Effect of drip irrigation during dry period on soil temperature(a), nut surface temperature of 7th bunch (b) 10th bunch(c), air temperature surrounding the 7th bunch(d) 10th bunch(e) and stomatal diffusive resistance(f) , compared to those during wet period*

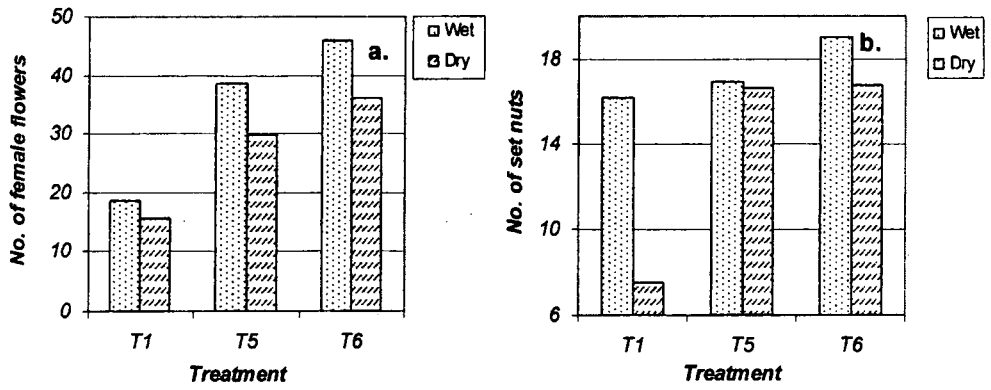



**Figure 3.** ***Effect of drip irrigation during dry period on the No. of female flowers produced(a) and the nut setting(b) compared to those during wet period***

The experiment was terminated.

*C S Ranasinghe, A Nainanayake, R D N Premasiri, L R S Silva*

**Experiment:** **Effect of irrigation on physiological, vegetative and yield characters of Tall x Tall and Dwarf Green X Tall**

Although the practice of irrigation, especially drip irrigation has taken a momentum in coconut estates, its benefits are not appropriately quantified by a detailed study on commonly available commercial coconut varieties when grown in different soils under irrigation. Therefore, the main objective of the study is to identify and quantify potential benefits of irrigation on two commercially available coconut cultivars in different land suitability classes by investigating physiological, vegetative growth and yield so that to provide site-specific recommendations for profitable coconut cultivation under irrigation.

**Treatments**

T1 - Control (No irrigation but with general management practices)

T2 - Irrigation @ 40 liters / palm / day during dry spell
(Irrigation @ 10 liters / palm / day for first two years, 20 liters / palm / day until 5 years of age & thereafter 40 liters / palm / day)

T3 - Irrigation @ 80 liters / palm / day during dry spell
(Irrigation @ 20 liters / palm / day for first two years, 40 liters / palm / day until 5 years of age & thereafter 80 liters / palm / day)

Irrigation will be started after a continuous rain-free period of 15 days.

Location : Thapal watta, Wanathawilluwa,
DL3 (Latasol & regosol region of the dry low country region)

Soil type and land suitability:

**a.** *Mavillu* series

S2 (suitable to highly suitable)

Imperfectly drained

Very deep (> 120 cm)

Sandy loam to sandy clay loam soil

Slope approx. 3%

Potential yield 12,500 – 15,000 nuts/ha/year (5,000 – 6,000 nuts/ac/year)

**b.** *Gambura* series

S3 (suitable)

Well drained

Very deep (> 120 cm)

Sandy loam to sandy clay loam soil

Slope approx. 3%

Potential yield 10,000 – 12,500 nuts/ha/year (4,000 – 5,000 nuts/ac/year)

Physiological and biochemical measurements, vegetative growth, root growth data (No. of roots, rooting depth, root length, root length density) and yield will be monitored. Seedlings were planted in December 2005 at Wanathavilluwa site. Installation of the irrigation system is underway and until then seedlings are being irrigated manually at scheduled rates. Other data are yet to record.

*A Nainanayake*

**Experiment:** **Yield improvement in coconut lands by Rainwater harvesting techniques**

Water harvesting (WH) is the collection of runoff for productive purposes instead of being left to cause soil erosion and nutrient loss. The intermediate zone of Sri Lanka where coconut is highly concentrated, receives substantial amount of rainfall but they are high-intensity, short-duration convective rainfalls between which the time gap is fairly longer. Hence, the effective harvesting of the runoff during the rainy period would maintain a higher water table and significantly improve the deep percolation and soil moisture retention in the deeper soil layers in coconut growing soils, which would substantially lessen the impacts of droughts. Even in soils with low infiltration rate, which results in surface water collection if the runoff is arrested, it is inevitable to gain long-term replenishment of deeper layers and favourable changes in the microclimate. This project primarily expects to construct small tanks for collecting runoff in CRI estates (nine sites – Middeniya, BE, PRS, Ambakelle GRC, PSG, RE, WE, Makandura and Maduru Oya) which will be followed by the post evaluation of the improvement of yields and their consistency along with the improvement in soil moisture retention during dry spells.

The main objectives of this study are to increase annual coconut yields of CRI owned estates by about 20% through minimizing the effects of dry spells by improved soil moisture content with effective management of rain water, the reduction of soil erosion and the nutrient loss and to develop a strategy

to make a package of site specific recommendations for water harvesting in coconut Site selection and preliminary investigations on construction of water harvesting tanks are in progress.

*A Nainanayake, A Tennakoon (SPND), N Liyanage (Est. Mgmt)*

**Experiment:** **Evaluation of a model drought management system in Middeniya research station**

Although the Middeniya area receives an average rainfall of about 1300 mm with two peak periods in October- December and March-May periods in between receive substantially low rainfall. However, monthly mean rainfall for last 22 years reveals that even the month June, the driest month of the year, also receives a rainfall of about 40 mm (Fig. 4). Therefore, according to the amount of rainfall and its distribution, the area is not so marginal for coconut cultivation due to rainfall pattern. However, preliminary survey work conducted in the surrounding area showed that problems in seedling establishment, low yields and death of even adult palms were common and the lack of a proper management of available water appeared as a key factor for the above limitations.

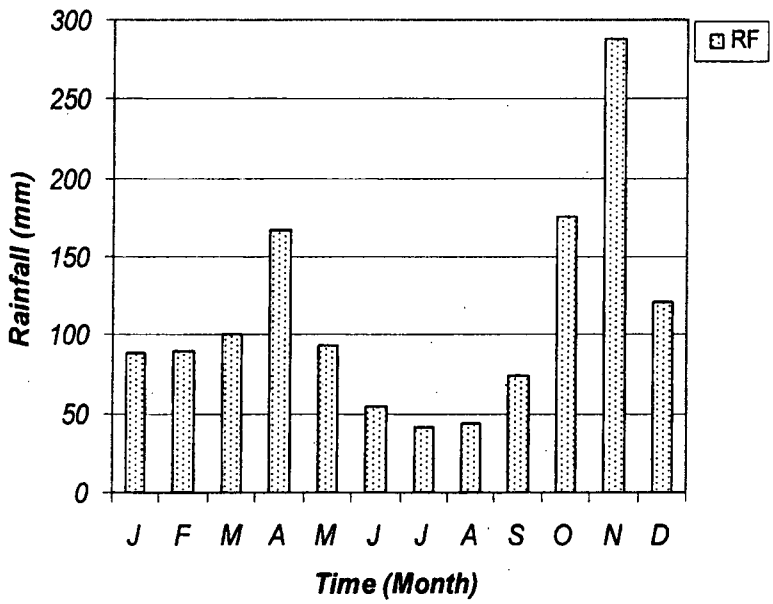



**Figure 4.** ***Monthly mean rainfall for last 22 years (1983 – 2005) at Middeniya research centre.***

Implementation of an overall drought management system (mulching, husk burial, improvement of moisture holding capacity by incorporation of organic material which is amply available in the region, introduction of cover crops (*Peuraria*) and some nitrogen fixing trees (*Gliricidia*) would substantially nullify the impact of the drought allowing palms to remain productive and less affected during prolonged droughts. Since the availability of deep underground water has already been identified, coconut cultivation under irrigation is also a possibility for people who can afford for high input coconut cultivation. Thus, the experiment was started with the objective to assess a model drought management system for coconut lands which can be recommended in the future as an overall drought management package for mini coconut triangle in the Southern province while remaining it as an *in situ* model (a demonstration site) which would prove and convince growers over the benefits of adopting such techniques.

Therefore, a study was started with the following objectives.

1. Assessment and quantification of the beneficial effects of a model drought management system in a coconut plantation in a drought prone area by investigating on physiological, vegetative and yield aspects so that to recommend a common drought management package for those areas.

2. Evaluation of selected commercially available coconut cultivars and recently introduced new hybrids (TT, DGxT, TxSR, DGxSR, Rumassala accession).

3. Establishment of a properly maintained coconut land with a model drought management system, which would encourage and persuade growers in mini coconut triangle in a more convincing way.

**Treatments**

a. Control with only fertilizing but without any soil moisture conservation practices
b. Application of overall soil moisture conservation and improvement practices
   Mulching, husk burial (10 x 4 x 4 pits in alternative rows)
   Improvement of soil texture and moisture holding capacity by incorporating organic material (cow dung, goat manure etc)
   Introduction of cover crops and NFTs (*Peuraria* and *Gliricidia)*
c. Irrigation @ 10 - 15 liters per seedling a day during droughts for first 2 years, 20 - 30 liters per seedling a day during droughts until the age of 5 years and thereafter 40 - 60 liters per palm per day during droughts. Irrigation will be started after a continuous rain-free period of 15 days.

Seedlings have already been raised. Land clearing and lining works are over and planting is scheduled to complete within the 2nd quarter of this year.

*A Nainanayake*

**Experiment:** **The effect of $CO_2$ elevation in the atmosphere on acclimatization of embryo-cultured plants.**

The main objective of the experiment is to determine the effect of atmospheric $CO_2$ elevation during the period of acclimatization of embryo-cultured coconut plants on leaf production rate, leaf area development, growth of root system and gas exchange rates. Embryo cultured plants were placed in two open top chambers (4.3 m diameter x 2.8 m height, covered with UV treated polythene) at Bandirippuwa Estate, exposed to either elevated $CO_2$ (500-550 ppm) or ambient $CO_2$ (350-360 ppm). Vegetative and physiological performances of the plants are being monitored. The results of this experiment will be used for improving the acclimatization protocol of embryo-cultured plants.

*C S Ranasinghe, W S Indika (Sabaragamuwa University), L R S Silva*

**PROJECT:** **STUDIES ON ROOT GROWTH, ROOT ACTIVITY AND ROOT FUNCTIONS IN RELATION TO WATER AND NUTRIENT UPTAKE**

**Experiment:** **Investigation of growth performances of Tall x Tall coconut seedlings grown in different land suitability classes, with particular reference to root system.**

The study aims to determine the effect of land suitability class (LSC) on growth of root system and the physiology of the whole plant. One year after seedling establishment in LSC 2, 3 and 4, destructive sampling was done. Seedlings in S2 showed the highest dry weight and volume of primary roots and, lowest dry weight of tertiary roots, shoot and shoot/ root ratio. Seedlings in S4 showed the

lowest dry weight and volume of primary roots and, highest dry weight of shoot and shoot/ root ratio (Table 1).

**Table 1:** ***Dry weights of primary, secondary and tertiary roots, shoot and shoot/root of seedlings grown in LSC 2, 3 and 4 for one year***

| | Root dry weight | | | Root volume | | | Shoot dry weight | Shoot/Root ratio |
|---|---|---|---|---|---|---|---|---|
| Suitability class | I ry | 2 ry | 3ry | I ry | 2 ry | 3ry | | |
| S2 | 23.36 [a] | 11.03 | 2.69 [c] | 112.67 [a] | 40.0 | 8.25 | 121.98 [c] | 3.28 [b] |
| S3 | 20.13 [a] | 12.02 | 6.71 [a] | 76.17 [b] | 45.6 | 6.37 | 187.42 [b] | 4.82 [b] |
| S4 | 19.25 [b] | 12.49 | 4.87 [b] | 62.83 [c] | 32.5 | 5.2 | 248.92 [a] | 6.79 [a] |
| Significance | * | NS | *** | * | NS | NS | *** | ** |

*** Significant at p<0.001 ** p<0.01 * p<0.05 Ns Not Significant

Seedlings grown under suitability class 2, 3 and 4 did not show any significant differences in number of primary, secondary and 3ry roots (Figure 5a). However, the highest fresh weight (Fig 5b) and the lowest dry weight (Table 1) of the primary roots were observed in seedlings grown in S2 soils implying that the water content of these roots are higher than the roots grown in other two suitability classes. The primary roots were the shortest and secondary roots were the longest in seedlings grown under all three-land suitability classes (Fig 6a). Though the secondary and tertiary roots were higher in number (Fig 5a) and the longer than primary roots (Figure 6 a), the highest volume of roots was observed in primary roots irrespective of LSC (Fig. 6b). The total root length and volume was at the highest in the seedlings grown in S2 soils and the lowest in S4 indicating that there is a restriction for root growth and development created by the physical properties of the LSC (Fig. 7a & b).

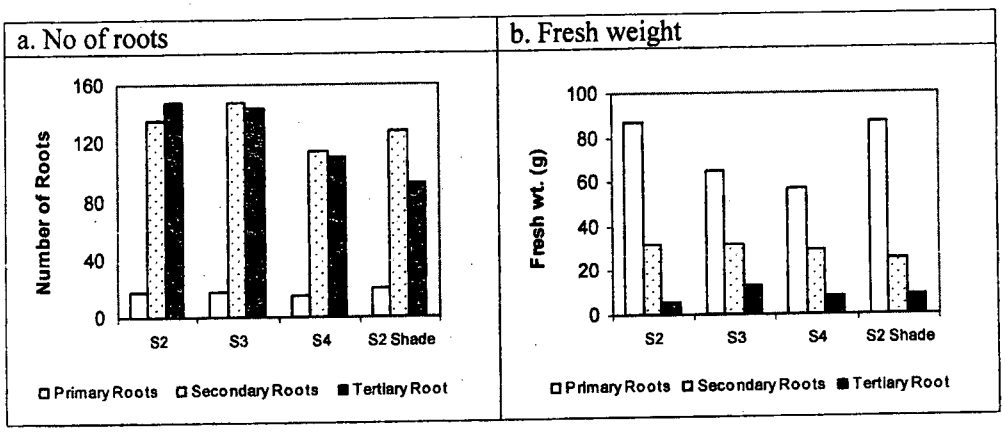



**Figure 5..** ***Number of roots (a) and the fresh weight of roots (b) of seedlings grown under three different land suitability classes***

a. Root length b. Root volume

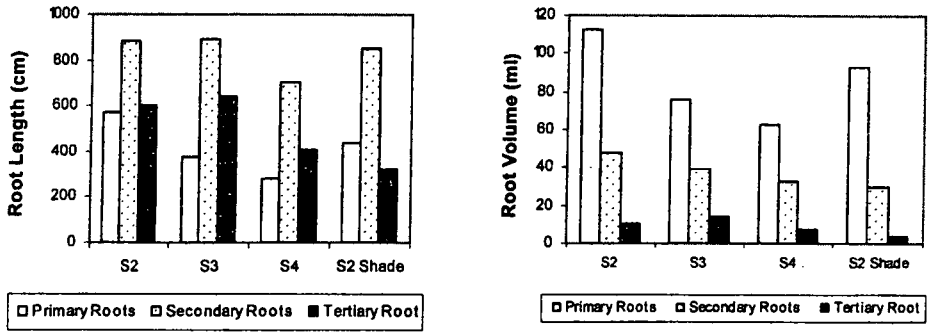



**Figure 6.** ***Length (a) and volume (b) of primary, secondary and tertiary roots of the seedlings grown under S2, S3 and S4 land suitability classes***

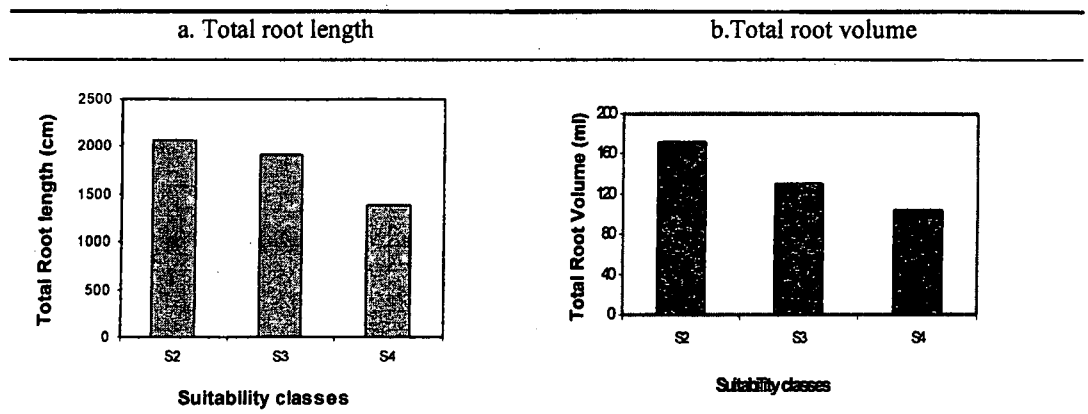



**Figure 7.** ***Total root length (a) and volume (b) of the seedlings grown in different land suitability classes***

Leaf area development was highest in the seedlings under S2 LSC whilst it was lowest in S4 (Fig 8).

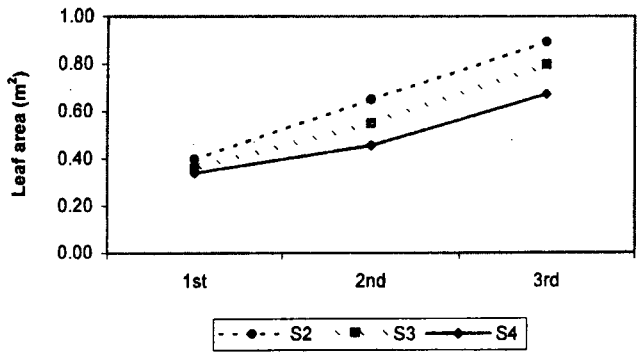



**Figure 8.** ***Leaf area development of the seedlings grown under three different LSC with time***

The physiological parameters of seedlings grown in three different soil types are being measured at regular intervals to investigate the effect of soil types on physiological performance of seedlings. There was significantly lower leaf water potential in seedlings grown under S3 and S4 compared to that of S2 during dry periods. Under field capacity (FC), high RWC was observed in leaves compared to roots in all soil types. There was no significant difference among the RWC of different root types; mature roots with different diameters (5mm & 2-3 mm) and immature white root with 5-6mm diameter under FC. This has to be repeated in a drying cycle.

*W S Madurapperuma, R D N Premasiri, P S A de Saram, M Gunawardane*

**Experiment:** **An Investigation of drought tolerance mechanism in coconut (*Cocos nucifera* L); with particular reference to roots**

When investigating coconut varieties for their drought tolerance, it is a combined effect of many factors including environment, soil properties, capacity of roots for water uptake and transport, leaf water status and demand and canopy characters. Therefore, a study was started to investigate the drought tolerance mechanism of CRIC 60 genotype under different soil types and agro climatic zones. This will be done by studying the effects of different soil types and agro climatic conditions on three major adjustments of the plant's functioning to drought. They are hydraulic (hydraulic conductivity, percentage of embolism in roots and xylem sap flow), physiological (photosynthesis, rate of transpiration, leaf water potential, stomatal conductance, water use efficiency) and biochemical (starch, sugar, ABA content) adjustments.

The aims of the study are;

1. To determine the variation of the above-mentioned physiological, biochemical and hydraulic adjustments of drought-tolerant CRIC 60 and drought-susceptible CRIC 65 at contrasting locations having different soil types and agro climatic conditions;
2. To relate the above parameters to yield performance of these two varieties in the contrasting locations and thereby identify key parameters (physiological, biochemical or hydraulic) or adjustments that confer drought tolerance to CRIC 60;
3. To develop a composite index (i.e. a selection index) consisting of key traits and adjustments to screen coconut palms for drought tolerance.

Sites were selected in Wallawa; representing Intermediate Zone Low country (IL1) where it receives annual rainfall of 1400 mm and Rambukkana representing Wet Zone Low Country that receives annual rainfall of 2200 mm. Six palms from each variety; CRIC 60 and CRIC 65 were selected in S2 and S4 soil types. Measurements were started on rate of transpiration and leaf water potential in both sites. Leaf and root samples were taken to measure relative water content, cell membrane stability, sugar, starch, solute potential and ABA content and root native hydraulic conductivity. Analysis is being continued. Soil pits were cut in two land suitability classes in both sites and identified the major horizons. Soil physical properties will be characterized for each of the major horizons. Bulk density, soil texture, moisture retention and saturated hydraulic conductivity for each horizon will be determined.

*W S Madurapperuma, R D N Premasiri,L R S Silva, ,M Gunawardane*

**PROJECT:** **IMPROVEMENT OF THE PROTOCOL FOR SHELF LIFE OF TENDER COCONUTS**

**Experiment:** **Improvement of shelf-life of tender king coconut**

The protocol for quality preservation of tender king coconuts for a period of one month was obtained by 10 growers/ exporters during the year. The experiments were continued to improve the existing protocol for shelf-life improvement of tender king coconut for 1-2 months. Vacuum packing of disinfected coconuts (with Benlate 0.6 g/L) under cold storage (13-15 °C) was identified as a suitable protocol for extending shelf life of up to 36-38 days for export purposes. Captan (0.6 g / L) was found to be an equally suitable fungicide to replace Benlate for disinfection. The fungus on the nut surface and the perianth of infected nuts was identified as *Fusarium* species.

*C S Ranasinghe, W S Madurapperuma, PS A de Saram, W P K K Fernando, M Gunawardane*

**Experiment:** **Identification of different coconut cultivars for beverage purposes**

A new experiment was started to select suitable cultivars that could be used in tender nut industry. Tender nuts (seven and eight months after pollination) of *Dwarf Green, Dwarf Yellow, Dwarf Red, Dwarf Brown, Brazilian Green Dwarf, King coconut, Bodiri, Murusi, Bothal Thembili, Dothalu and Juvan* were collected from BE, PRS and Galle area. The analysis of sugar profile, vitamins and minerals of nut water is in progress.

*C S Ranasinghe, W P K K Fernando*

**PROJECT:** **MITE INFESTATION IN COCONUT**

**Experiment:** **Comparison of biochemical contents of mite-infested and mite free nuts**

A study was started to compare total sugars and polyphenol contents in the mite-feeding area (soft tissues under the perianth) of mite-infested and mite-free nuts in different locations. Samples collected from Maampuri, Thammana and Madurankuliya revealed that the sugar contents were 318, 402, and 358 µg / g dry wt in mite-free, mite-damaged, and undamaged area of mite infested nuts, respectively. The polyphenol contents were 136, 202 and 160 µg / g dry wt in mite-free, mite-damaged, and undamaged area of mite infested nuts, respectively.

Determination of sugar and polyphenol content in the mite-feeding area (beneath the perianth) of different varieties, which have different sensitivity to mite infestation, was started. Dwarf Yellow, Gon thembili, (tolerant), dwarf red (very sensitive), San Ramon (less sensitive) and tall (sensitive) cultivars are being analyzed in the first phase.

*C S Ranasinghe, W P K K Fernando*

## MULTI DISCIPLINARY PROJECTS

**Project Coordinator – C S Ranasinghe, Ph D**

## THRUST AREA: CROP PRODUCTION

**Participating Divisions:** Plant Physiology Division
Crop Protection Division
Soils and Plant Nutrition Division
Agronomy Division

## GENERAL

Experiments stated to determine the presence of sub-cellular pathogens and cellular abnormalities, Transmission Electron Microscopy (TEM) analysis of Leaf Scorch Decline (LSD), Tapering Disorder (TD) and Coconut Rapid Decline (CRD) affected palms are in progress. The pattern of water transport in LSD affected palms was studied using Li and $^3H_2O$ as tracers. There is a reduction of water quantity transported to canopy in moderate-LSD palms and the roots of these palms retained more water compared to healthy and mild-LSD palms. Also there is a delay in transporting water from base of the trunk to canopy in moderate LSD-affected palms compared to healthy palms. This implies that there is a restriction to water transport from roots to other tissues in moderate-LSD palms. There was no significant difference in water movement to coconut fruit between healthy and LSD- affected palms. When LSD and TD- affected palms were sprayed with nutrient solution, the nutrient levels (macro and micro) of 14$^{th}$ leaf did not increase consistently and were below the critical levels even after two years. Therefore, it was decided to double the strength of nutrients in the spraying solution and to analyze the nutrient contents of 6$^{th}$, 14$^{th}$ and 20$^{th}$ from January 2006. On the other hand, the number of affected fronds in mild LSD-affected palms showed a decreasing trend with time indicating a positive treatment effect. Total chlorophyll content of LSD-affected palms (mild and moderate) and moderate TD-affected palms improved with nutrient spraying. Relatively higher population of *Radopholus similis* nematodes was recorded in root zone of LSD-affected palms than that of apparently healthy palms and LSD free estates. The pruning of affected roots seems to have a positive effect on the reduction of scorching fronds in LSD-affected palms and experiments are in progress to assess this condition. The presence of Fusarium toxins in cell sap of LSD-affected palms was tested. Three toxins were present in both LSD-affected and unaffected palms, but in varying concentrations. Zearalenone was found in low concentrations in all the samples. T2 (Trichothecenes), and Fusaric acid were found in higher concentrations in LSD-affected palms than in healthy palms. Confirmation of results is in progress. Financial assistance was received from CARP for this study.

A comparative assessment of six soil types in Makandura Research Station (MRS) and adjacent undisturbed (virgin) soils was conducted to identify the significant changes that occurred in coconut growing soils with respect to physical, chemical and biological properties. Although the land was regularly fertilized with major nutrients it was very clear that the depletion of both major as well as minor nutrients over the time from its original status in MRS. There was an increase in bulk density by 18%, the reduction of organic carbon content by 22% and the reduction of pH or the soils becoming more acidic by 6% contributing more negatively for survival as well as better yields of coconut palms. Virgin soils retained higher moisture contents compared to those in coconut lands. Reduced organic carbon content and increased bulk density appeared to contribute in this regard. A New experiment was started to assess the impacts of charcoal and poultry manure, vermicompost, commercial compost, oxytetracycline and Irrigation on recovery of LSD, TD and CRD palms at MRS. Financial assistance was received from cocont CESS for this study.

A survey was conducted in Gampaha, Marawila, Kuliyapitiya and Kurunegala CCB regions, BE and ISG to determine the % incidence and possible causes of LSD, TD, Coconut Rapid Decline (CRD) and weak palms (W). In growers' fields the incidence of TD and W was higher than LSD. Higher % of LSD is associated with highly suitable soils for coconut and TD and Weak palms are mostly associated with marginally suitable soils.

**PROJECT:** **STUDIES ON PLANT DISORDERS, LEAF SCORCH DECLINE (LSD), TAPERING DISORDER (TD) AND COCONUT RAPID DECLINE (CRD) OF COCONUT**

**Experiment:** **Detail anatomical studies on cellular and vascular abnormalities**

The objective of this study is to determine the presence of sub-cellular pathogens and cellular abnormalities of LSD, TD and CRD-affected palms by Transmission Electron Microscopy (TEM). Tender flower stalk, mid rib (ekel), root tip and trunk samples of mild and moderate stages of Leaf Scorch Decline (LSD), Tapering Disorder (TD), Coconut Rapid Decline (CRD)-affected palms and apparently healthy palms were collected from BE, MSG and PRS, fixed in a buffer solution (3% Glutaraldehyde, 3% Formaldehyde in 0.1 M Phosphate buffer, pH 7.0), stored in ice for 3 days and sent for TEM analysis to Iowa State University USA. One set of images was received. TEM analysis of more number of palms and confirmation of results in consultation with phytoplasma and virus (TEM) experts are in progress.

*C S Ranasinghe, H C Mendis*

**Experiment:** **Investigations on the pattern of water transport**

The study was conducted with the objective of detecting the pattern of water transport and vascular blockages to water flow in LSD, TD and CRD- affected palms using Li and $^{3}H_2O$ as tracers.

(a) **Using Li as a tracer:** 1% of LiCl was root fed on healthy, LSD-mild and LSD-moderate palms. To trace the water movement pattern, Li concentration in leaf, 'treated roots' and 'untreated roots' of the same palm, nut water and coconut husk was analysed. The pattern of water movement to fronds of different maturity stages was similar in all three types though the quantity was different; Li concentration increased gradually up to 14$^{th}$ frond and declined thereafter, according to the pattern of water demand by different ages of fronds of the canopy. The water transported to canopy was highest in mild-LSD palms whilst it was lowest in moderate-LSD palms (Fig 1).

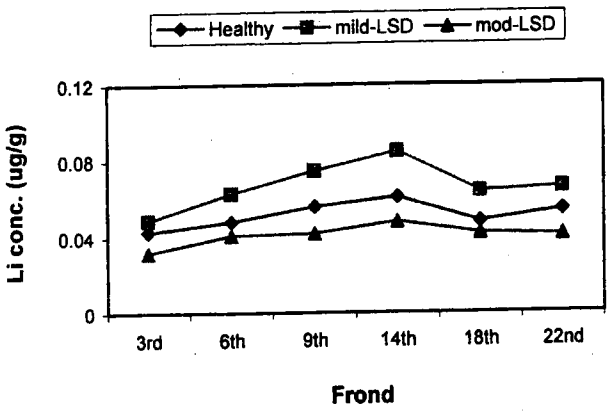



**Figure 1.** ***Li concentration in fronds of different maturity stages of healthy, mild-LSD and moderate-LSD palms***

When 'Li treated' roots and 'untreated' roots of same palms were analysed, 'treated' roots had higher Li content compared to 'untreated' roots of all three types. This indicated that the lateral movement of water in the root system is limited in both healthy and LSD-affected palms. However, in 'treated' roots of moderate-LSD palms, more Li content was retained compared to healthy and mild-LSD palms. This implies that there is a restriction to water transport from roots to other tissues in moderate-LSD palms. Water movement pattern in mild-LSD palms was similar to that of healthy palms (Fig. 2). There was no significant difference in Li content of nut water and coconut husk between healthy and LSD- affected palms, all three stages of palms showed a similar pattern and quantity in water transport to the nuts. The Li content in nut water was higher in five-month-old nuts and lower in maturing and matured nuts, but in the husk an inverse pattern was observed (Fig. 3).

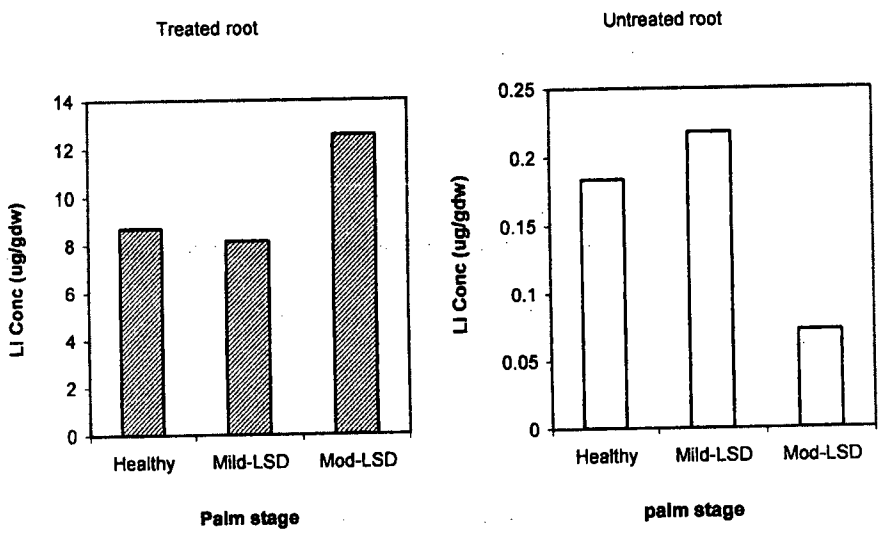
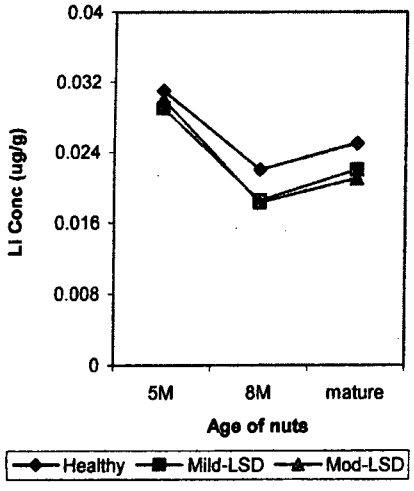



**Figure 2.** ***Li concentration in 'treated' and 'untreated' roots of healthy, mild-LSD and moderate-LSD palms.***

a. Li concentration in nut water




b. Li concentration in coconut husk

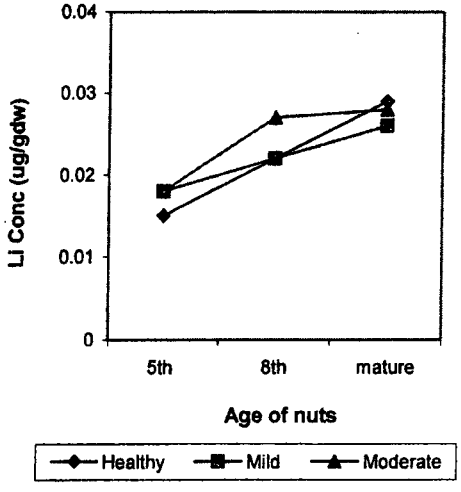



**Figure 3.** ***Li concentration in nut water and husk o 5-month-old (5M), 8-month-old (8M) and 12-month-old (mature) nuts of healthy, mild-LSD and moderate-LSD palms.***

**(b) Using $^3H_2O$ as a tracer:** $^3H_2O$ was trunk injected on healthy and moderate-LSD palms and tritium content in transpired water of 9th frond was determined. The preliminary experiment data reveled that there is a delay in transporting water from base of the trunk to canopy in moderate LSD-affected palms compared to healthy palms. The maximum $^3H_2O$ content in leaves was detected on 3rd and 8th day after trunk injection of healthy and LSD-affected palms, respectively. Another experiment is in progress to determine the $^3H_2O$ transport to different levels of the trunk, and developing nuts of LSD-affected and healthy palms. The study will be repeated for TD and CRD-affected palms.

*C S Ranasinghe, H C Mendis, W S Madurapperuma, R D N Premasir, M Gunawardane*

**Experiment:** **Evaluation of the effect of nutrient application on expression of LSD and TD symptoms (Plant Physiology Division)**

The objective of this study was to evaluate the effect of leaf spraying of macro and micronutrients on the expression of palm decline symptoms. Previous experiments have revealed that all three types of decline-affected palms were deficient in micronutrients, especially Zn, and spraying are the best method of supplying micronutrients to the palm. Therefore, nutrients were sprayed on LSD and TD-affected palms at BE, PRS and WE at 3-monthly intervals and changes in nutrient content of the 14th frond were monitored. Even after two years of nutrient application, the nutrient levels (macro and micro) of decline-affected palms did not increase consistently in all the locations (BE, PRS, WE) and were below the critical levels, irrespective of the stages (mild or moderate). The Zn content of palms was increased only at PRS (Fig. 4). Therefore, the nutrient concentration of the spraying solution was doubled and the sampling fronds were extended to 6th, 14th and 20th from January 2006.

Visual observation on % scorching of leaf canopy of LSD-affected palms was conducted throughout the experimental period with nutrient spraying. Untreated palms of LSD-mild and LSD-moderate were also used as controls. At the initial stages, % scorching showed an increasing trend in both

treated (LSDT) and untreated (LSDUT) palms. But after four times of nutrient application, there was a reduction in % scorching in nutrient treated, LSD-mild stage (LSDT-mild) palms while LSDT-moderate and untreated (LSDUT) palms still showed a comparatively high % of scorching in the canopy. The data was plotted against the rainfall to determine whether the reduction in % scorching was due to climatic effect. But even during the dry period LSDT-mild palms showed a low % of scorching indicating that there was a treatment effect on LSD-mild palms, but not on the LSD-moderate stage palms (Fig 5).

a. LSD-PRS - Zn

b. TD-PRS-Zn

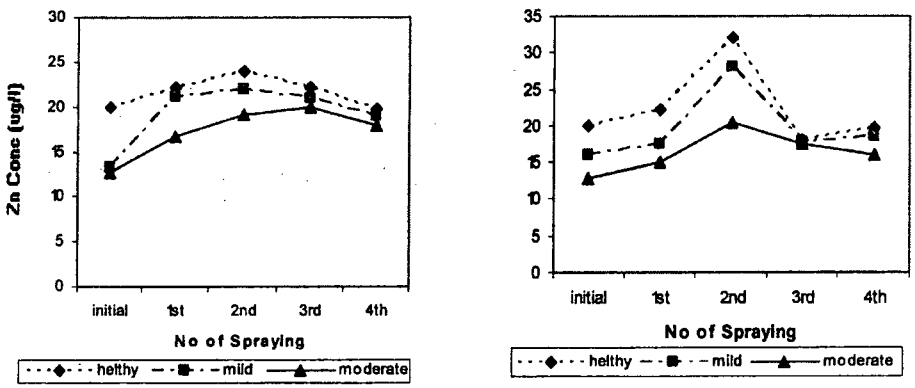



**Figure 4.** ***Variation in Zn content in LSD-and TD- affected and healthy palms at PRS with nutrient application (4 times)***

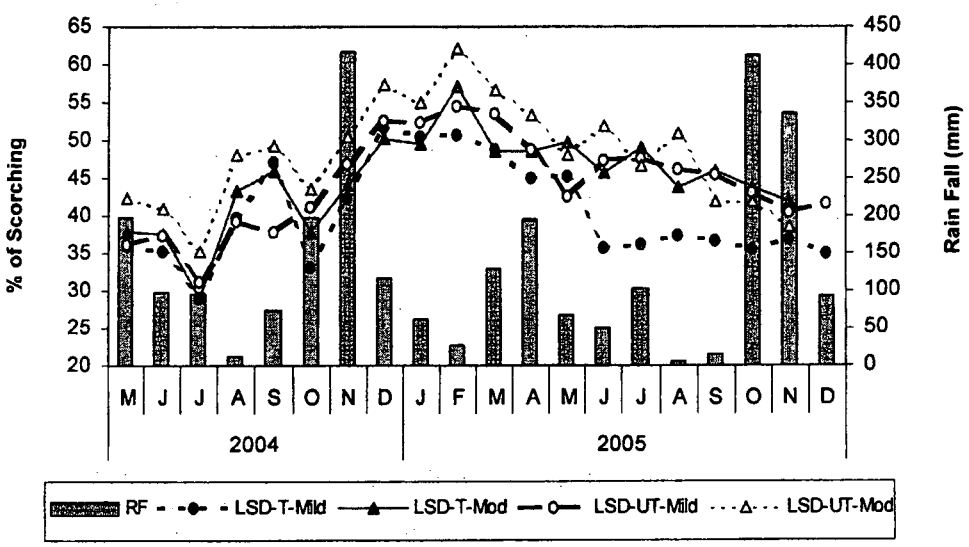



**Figure 5.** ***Variation in % scorching of leaf canopy in nutrient-treated (T) and -untreated (UT) LSD affected (mild and moderate) palms***

Total chlorophyll content of LSD-affected palms (mild and moderate) improved with nutrient spraying in all three sites (Figure 6a, c, d). However, in TD only the moderate stage palms showed a

significant improvement of total chlorophyll content (Figure 6 b) while mild-TD affected palms did not show any improvement.

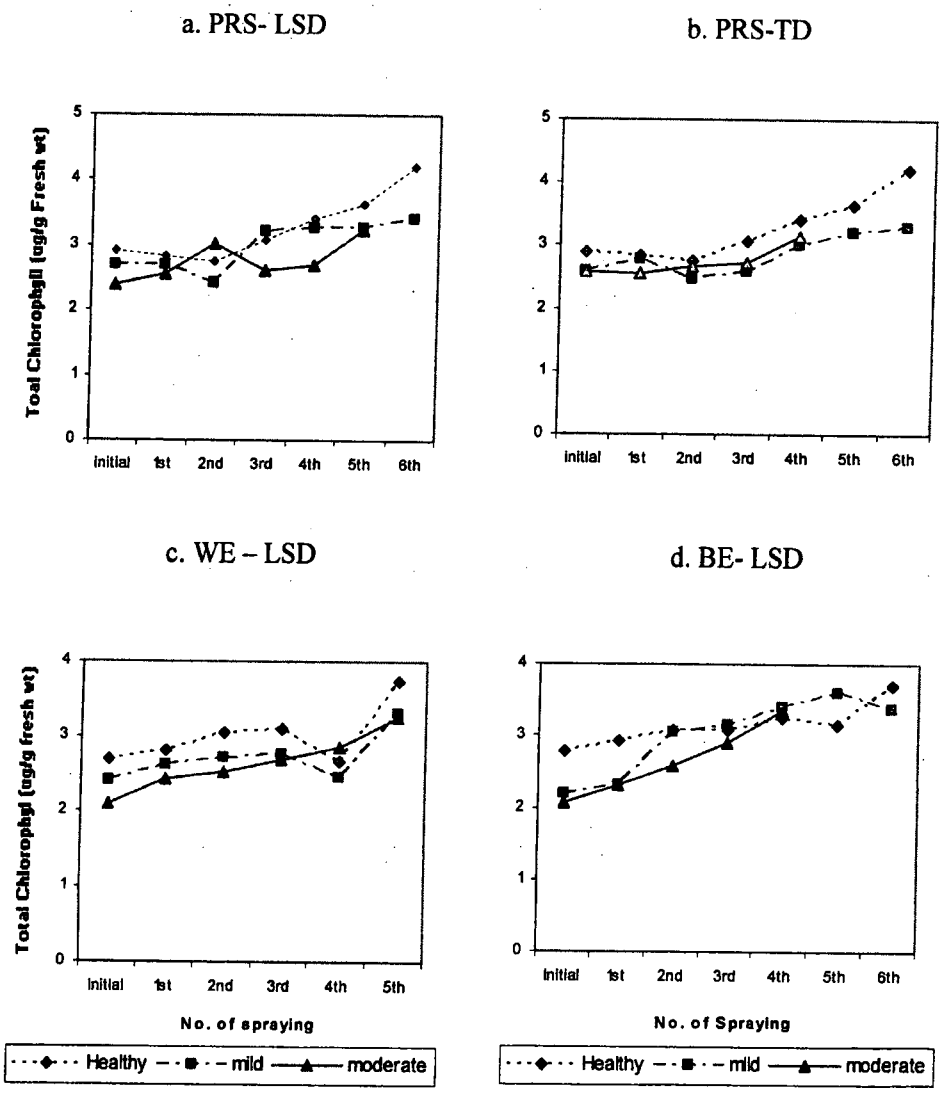



**Figure 6.** ***Variation in total Chlorophyll content of LSD- and TD- affected palms at BE, PRS and WE with nutrient application***

Based on the above results, it can be concluded that there is a positive treatment effect on LSD-mild stage palms though the nutrient levels of the leaves are below critical levels. Therefore, it was decided to continue the spraying only with mild stage palms of LSD and TD with increased (doubled) strength of nutrients in the spraying solution.

*W S Madurapperuma, H C Mendis, C S Ranasinghe, R D N Premasiri, M Gunawardane*

**Experiment:** **Studies on the association of parasitic nematodes and fungi with Leaf Scorch Decline (LSD) of coconut (Crop Protection Division)**

## 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 experiment conducted to study the fluctuation pattern of the burrowing nematode populations in the roots and the soil of the root zone of LSD-affected palms and healthy palms was completed. Each of 15 affected palms, 5 apparently healthy palms and 5 seedlings from Arachchikattuwa, Walpita and Bandirippuwa estate and each of 15 palms from sites free from LSD (Nawagattegama, Kurunegala and Kegalle) were sampled at 3-monthly intervals. The degree of new root formation (high, medium, low) and the number of newly affected leaves on each palm were recorded at same intervals.

Throughout the period of study relatively higher population of nematodes were found in the December-January period than in other periods in LSD-affected palms at Arachchikattuwa and Bandirippuwa estates while in Walpita it was higher in March (Table 6). The nematode populations decreased in all the sites over time. In apparently healthy palms and seedlings of affected estates, nematodes were recorded but in very low numbers. In palms of LSD free estates the nematodes were found occasionally at very low levels. In all the experimental sites nematodes were found in the soil at all times. The numbers of nematodes in the root zone of affected palms were higher than in all other palms.

The percentage of palms with high number of newly formed healthy roots increased over time in LSD-affected sites (Table 7). Also, the mean number of unaffected fronds in LSD-affected palms decreased gradually with time (Fig. 3). The results point that pruning of affected roots and soil around roots has a positive effect on the affected condition of the palms. A large amount of soil around the roots is removed to collect suitable roots for the study. This operation may have broken down the life cycle of the nematodes or the causal agent of LSD due to their removal and disturbance of the soil around it.

**Table 6:** ***Mean number of Radopholus similis in 50 g of roots of affected and unaffected palms in different periods from 2002-2004***

| Period | LSD-affected | | | Unaffected | | |
|---|---|---|---|---|---|---|
| | Arachchi. | BE | Walpita | Kegalle | Kurunegala | Nawagattegama |
| 2002 | | | | | | |
| Dec-Jan. | 9.3 | 1.6 | 1.8 | - | - | - |
| March | 1.5 | 0 | 3.7 | - | - | - |
| June | 0.06 | 0.13 | 0.06 | - | - | - |
| September | 0 | 0 | 0 | - | - | - |
| 2003 | | | | | | |
| Dec-Jan. | 24.4 | 0.8 | 0 | 0 | 0.06 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| March | 0 | 0 | 7 | 0 | 0 | 0 |
| June | 0 | 0 | 0 | 0 | 0 | 0 |
| September | 0 | 2.2 | 0 | 0.1 | 0 | 0 |
| 2004 | | | | | | |
| Dec-Jan. | 0.53 | 0.6 | 0.8 | 0 | 0 | 0.3 |
| March | 0 | 0 | 0 | 0 | 0 | 0.06 |
| June | 0.9 | 0 | 0 | 0.7 | 0 | 0 |
| September | 0 | 0.26 | 0 | 0 | 0 | 0 |

**Table 7:** ***Percentage of palms with high root formation in each year from 2002-2004***

| Estate | 2002 | 2003 | 2004 |
|---|---|---|---|
| Arachchikattuwa | 13.3 | 73.3 | 80.0 |
| Walpita | 13.3 | 82.2 | 76.6 |
| Bandirippuwa | 20.0 | 0 | 60.0 |

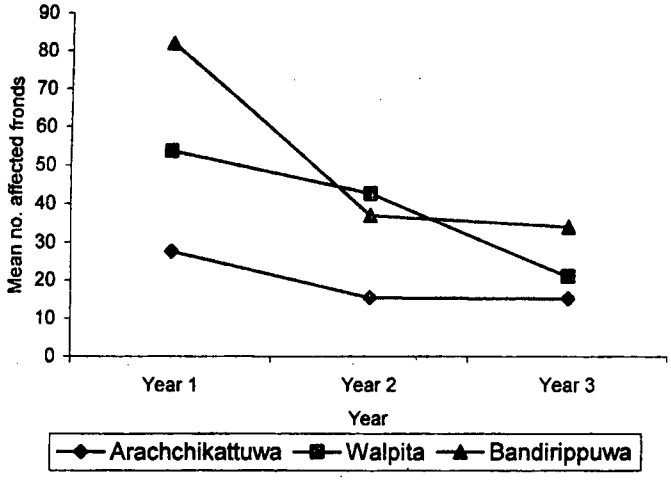



**Figure 3.** ***Mean number of affected fronds per 15 palms at Arachchikattuwa, Walpita and Bandirippuwa estates from 2002-2004***

*L.C.P. Fernando, P.H.A.P. Siriwardena & W.W.N. Fernando*

(CPD)

**Experiment 28.4:** **Determination of whether toxins of *Fusarium* spp. are present in the tissues of LSD affected palms (2005)**

It has been found previously that high levels of *Fusarium* spp. are associated with roots of LSD-affected palms. A study was initiated to determine whether the toxins produced by the fungus are present in the tissues of affected palms. Root, stem and leaf samples from each of 5 LSD affected and

healthy palms were collected. Each sample was crushed with methanol 70% and centrifuged at 8000 rpm for 20 minutes to extract the cell sap. They were filtered through sep-pak cartridges to separate the toxins T2, Fusaric acid and Zearalenone of *Fusarium* if present. GC analyses (qualitative) were done, comparing with standards of the above toxins using a glass capillary column and flame ionization detector.

The GC Chromatograms showed that all the three toxins were present in both LSD-affected and unaffected palms, but in varying concentrations. Zearalenone was found in low concentrations in all the samples. T2 and Fusaric acid were found in higher concentrations in LSD-affected palms than in healthy palms. In affected palms concentrations of T2 and Fusaric acid were higher in stem and if not higher in leaf. In healthy palms the two toxins were higher in the roots but not in the stem or leaf. Presence of high concentrations of T2 and Fusaric acid in the stem and leaf of affected palms may be directly or indirectly causing scorching symptoms. The study is being repeated to confirm findings.

*C.S. Ranasinghe (PPD), L.C.P. Fernando, P.H.A.P. Siriwardena & W.W.N. Fernando*(CPD)

**Experiment:** **Physico-chemical and nutritional status and the occurrence of arbuscular mycorrhiza in coconut palms affected with Leaf Scorch Decline (LSD), Coconut Rapid Decline and healthy palms in Makandura Research Station (Soils and Plant Nutrition Division)**

The objectives of this study were to understand the difference in nutritional status and soil conditions of LSD, CRD and healthy palms, to investigate whether there is a toxicity of Al in affected palms and to investigate the presence of arbuscular mycorrhizal fungi (AMF) in palms subjected to this study, hypothesizing the healthy palms are benefited by AMF. The experiment was conducted in Field No. 4 of Makandura Research Station. Three soil types ($S_2$, $S_3$ and $S_4$) were considered as blocks, and Leaf Scorch Decline (LSD), Coconut Rapid Decline (CRD), and apparently healthy (H) palms were considered as treatments. Three replicate palms were selected for each treatment from each block (soil type). Soil samples were collected from the manure circle of each palm from top (0-20) and sub (20-30) soil and analyzed for the following parameters; $pH_{(H2O)}$, $pH_{(KCl)}$, electrical conductivity, cation exchange capacity, organic carbon, total nitrogen, available phosphorus, exchangeable K, Ca, Mg and the micronutrients, Zn, Cu, B, Mn, Fe, Na and Al. Leaf samples were analyzed for N, P, K, Ca, Mg, Zn, Cu, B , Mn and Fe. Root samples were collected and stained to observe mycorrhizal fungi to determine infection ratio. Soil samples collected from the rhizosphere soil were used to extract AMF spores to determine AMF spore density.

Total N and available P in soil were significantly high in LSD palms compared with CRD and H. This is supposed to be due to the inability of the roots of LSD to absorb N and P or any other disability related to soil condition. This observation was in consistence with the low levels of N in the leaves of LSD palms. But leaf P was not significantly different from CRD and H. No Al toxicity was observed in LSD affected palms. But all the micronutrients except Fe were significantly lower in the leaves of LSD and CRD palms compared with H. But in soil no significant difference in micronutrients were observed between LSD, CRD and H.
several types of spores of AMF were observed in the rhizosphere soil of LSD, CRD and H palms, but no fungal colonization was observed in roots. Therefore, the spores observed could not be confirmed as AMF spores and much sophisticated study is needed in this regard.

*C Fernando, K Karunanayake, (Univ of Kelaniya), A Tennakoon, R Jayasekara (Univ of Kelaniya)*

**Experiment:** **Identification of physical, chemical and biological changes leading to soil fertility decline and palm decline in Makandura Research Station (Plant Physiology Division, Soils and Plant Nutrition Division, Agronomy Division)**

Soil Fertility Decline in coconut lands has been recognized as one of the main causes for poor production and productivity of coconut in most coconut lands. An in depth assessment of soil fertility decline in coconut lands is essential for developing suitable measures for improvement of such soils. A detailed soil map was prepared for MRS. There are six major soil types (1-6) of 'very suitable' to 'not suitable' for cultivation of coconut and their LSC and soil properties of each category are give in the Table 2 in brief.

| Soil Type | Properties |
|---|---|
| 1 (Halpe series) | S2 (Suitable to very suitable)<br>Well drained, deep (>120 cm), Sandy loam, sandy clay loam |
| 2 (Kandetiya series) | S3 (Suitable)<br>Moderately well drained, deep (>100 cm), sandy clay loam to clay loam |
| 3 Kandetiya series (moderately deep phase) | S4 (Moderately suitable)<br>Moderately well drained, moderately deep (70-100 cm), sandy loam to sandy clay loam |
| 4 Makandura series | S4 (Moderately suitable)<br>Imperfectly drained, moderately deep (60-80 cm), sandy loam to sandy clay loam |
| 5 Mahayaya series | NS (Marginally or not suitable)<br>Poorly drained, moderately deep (60-70 cm), Loamy sand to sandy loam |
| 6 Toppuwa series | NS (Not suitable)<br>Poor to very poor drained, moderately deep to shallow, Sandy clay loam, silty clay loam |

The study has following objectives.

- To make a comparative assessment of 6 soil types in MRS and adjacent undisturbed (virgin) soils to identify the significant changes that occurred in soils with respect to physical, chemical and biological properties.
- To make a comparative assessment of treatments on the improvement of soils and thereby the palm decline

There is approx. 15 % lesser N and K contents while P is in excess (47%) in coconut lands with respect to those of virgin soils (Fig. 7). Out of other major nutrients, both Ca and Mg were significantly low in coconut land (47% and 63% respectively) while contents of some of the micronutrients such as Na, Zn, Cu and Mn were also significantly low in coconut lands. Two micronutrients, Fe and Cl were found to be in excess in cultivated soils. Although the land was regularly fertilized only with major nutrients it is very clear that the depletion of both major as well as minor nutrients over the time from its original status in MRS.

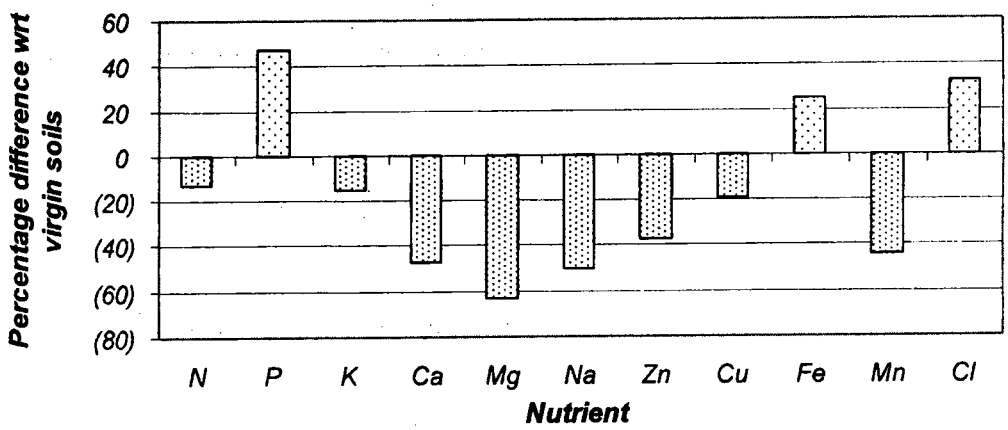



**Figure 7.** ***Percentage difference of some major and minor nutrients in MRS with respect to those of virgin soils***

Not only the nutrient depletion but also the increase in bulk density by 18%, the reduction of organic carbon content by 22% and the reduction of pH or the soils becoming more acidic by 6% will contribute more negatively for survival as well as better yields of coconut palms (Fig. 8). However, no significant difference was observed in electrical conductivity between coconut land and virgin soils probably due to the regular fertilizing of the coconut estate. So either single or combined effect may be a contributory factor resulting in the existence of LSD and TD in large numbers in MRS, which needs further research. It is important to note that the situation in neglected or no fertilizing lands would be far worse.

The differences in some major and minor nutrient contents between coconut land and virgin soil (*e.g.* Mg, Zn, Mn) reveal some possible factors for these diseases of unknown etiology which received not much attention so far, specially in minor nutrient category (Fig. 9).

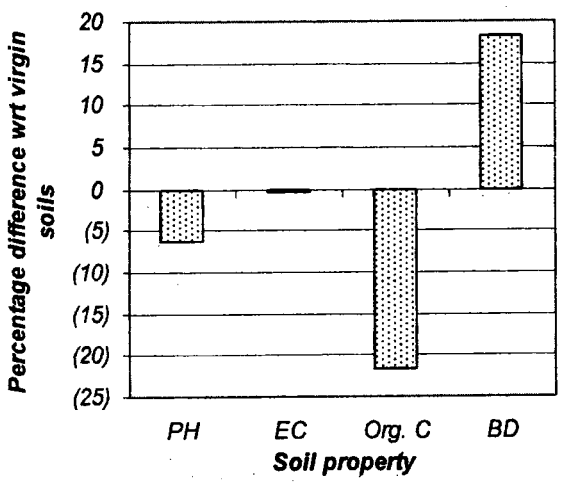



**Figure 8.** ***Percentage difference of some soil physical properties in MRS with respect to those of virgin soils***

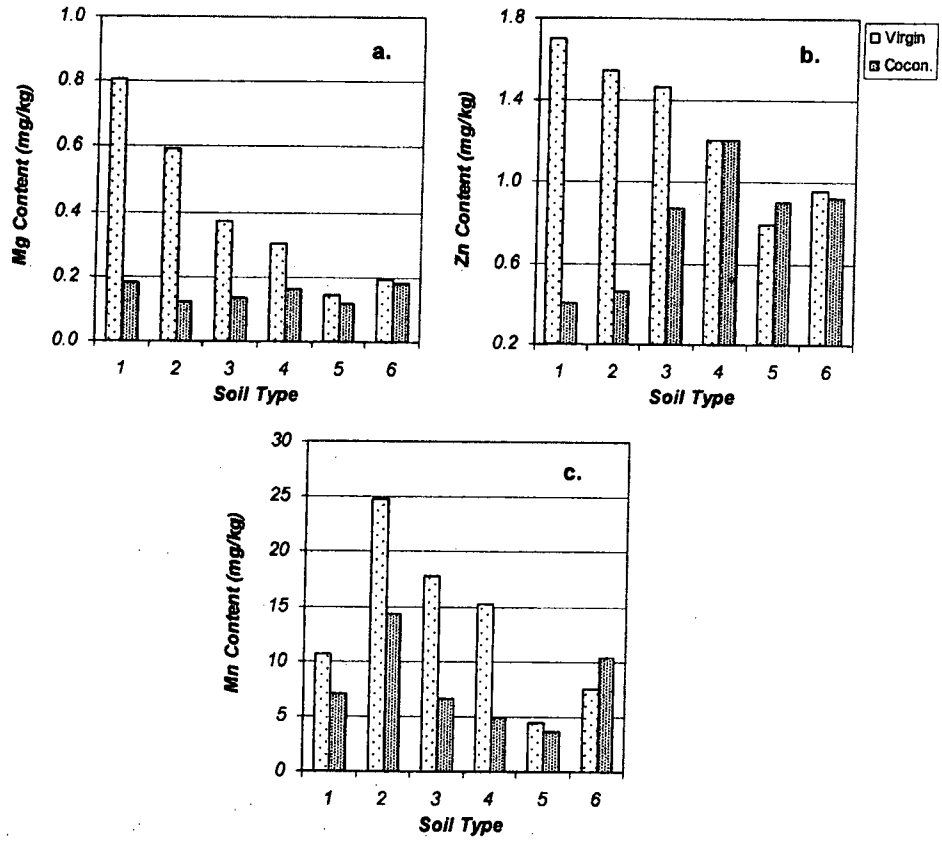



**Figure 9.** ***Nutrient contents of (a) Mg (b) Zn and (c) Mn of different soil types in MRS with those in virgin soils***

Studies on the soil moisture content revealed that there were significant differences in field capacity between six different soils types (Fig. 10). These values were markedly low in cultivated soils with respect to those in virgin soils (7 – 18%). The reduction in organic carbon content of MRS soils may be a major factor in the reduction of moisture holding capacity.

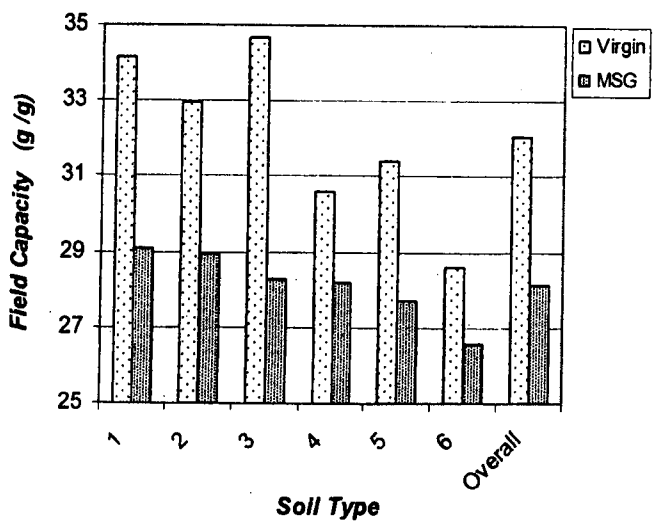



**Figure 10.** ***Field capacity of six different soil types in MRS with the same of the virgin soils***

The soil moisture depletion pattern of six different soil types compared to those in virgin soils clearly show the greater moisture holding capacity of virgin soils throughout the dry spell in six soil types tested (Fig. 11). Although there was a sharp decline in moisture content within the first 7 weeks in all soil types, the depletion rate was very low, virtually zero, after eight weeks, yet all virgin soils retained higher moisture contents compared to those in coconut lands. Reduced organic carbon content and increased bulk density appeared to contribute in this regard.

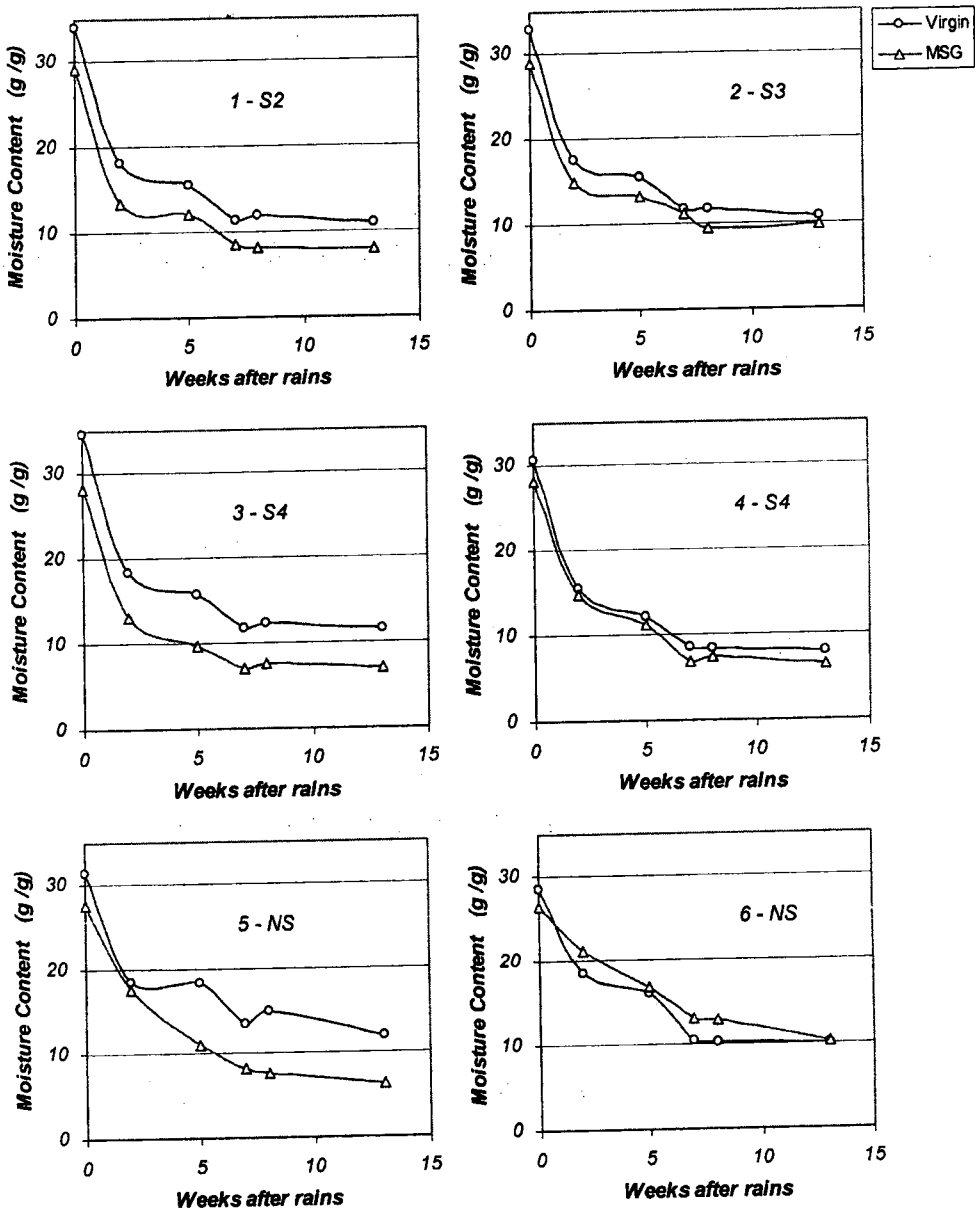



**Figure 11.** ***Soil moisture depletion pattern of 6 different soil types in MRS with the progress of the drought***

*C S Ranasinghe, A Nainanayake, A Tennakoon, H C Mendis, C Fernando, K de Silva, D Paramasivam, L R S Silva, U S S Perera, A Jayatillake*

**Experiment:** **Assessment of the efficacy of various treatments on improvement/recovery of LSD, TD and CRD-affected palms (Plant Physiology Division, Soils and Plant Nutrition Division, Crop Protection Division)**

Out of the six major soil types at MRS, soil types 5 and 6 are not suitable for cultivation of coconut. Furthermore, evaluation of any treatment on recovery of LSD, TD and CRD palms on such soils would not be useful. Therefore, the following treatments were identified for imposing on LSD, TD and CRD palms in 1-4 soil types to evaluate the effect of different treatments on the recovery of decline symptoms. The treatment application is in progress.
Treatments:

T1- Control (no treatment)

T2 - Charcoal and poultry manure

T3 - Vermicompost

T4 – Oxytetracycline

T5 – Commercial compost

T6- Irrigation

*C S Ranasinghe, A Nainanayake, A Tennakoon, R Wijesekara, H C Mendis, C Fernando, D Paramasivam, R D N Premasiri, U S S Perera, D P Panditaratne, K R E M Fernando*

**A survey: Assessment of the prevalence and probable causes of coconut palm decline**

Palm decline, especially in young bearing coconut plantations, is a serious concern among growers in certain parts of the country. The situation is said to be alarming in the Gampaha, Kurunegala and Puttlam districts. The probable causes for this condition and management strategies to curb the situation are not yet clearly identified. Therefore, a comprehensive survey was carried out in Gampaha, Marawila, Kurunegala and Kuliyapitiya CCB regions, and two CRI estates, BE and ISG to assess the prevalence of coconut palm decline, LSD, TD, CRD and weak palms, the incidence with regard to soil factors, management practices, source of planting material etc. and to identify researchable areas for developing management strategies.

**Incidence**: The major disorder was TD and the prevalence of CRD was <0.2% (negligible). The highest percentage of LSD-affected palms was found in BE and Marawila CCB region. The highest percentage of weak and TD–affected palms was found in Gampaha CCB region. The incidence of decline-affected palms (total of LSD, TD, CRD and weak palms) in four CCB regions and two CRI estates is 23%, 20%, 15%, 12%, 4.6% and 40% in Gampaha, Marawila, Kuliyapitiya, Kurunegala, ISG and BE, respectively.

**Association with soil factors**: Higher % of LSD is prevalent in highly suitable soils for coconut while TD and Weak palms were mostly found in marginally suitable soils. This suggests that LSD is different from other two decline conditions and it's associated with high removal of nutrients from palms due to high yields. TD and weak palms seem to be associated with unfavourable soil conditions.

| Soil factor | % LSD | % TD | % Weak |
|---|---|---|---|
| Texture | **High** in sandy loam and loamy sand | Equally found in all types | **High** in sandy clay loam |
| % Ironstone gravel | **High** in low % gravel | Equally found in all types | **Increase** with increasing % gravel |
| Land Suitability Class | **High** in S1 | **High** in S4 | **High** in S4 |
| Soil depth | **High** in deep soils (>1m) | **High** in shallow soils (<1m) | **High** in shallow soils (<1m) |
| Level of soil erosion | **High** with low soil erosion | **High** with high soil erosion | **High** with high soil erosion |

**Occurrence with different management practices**:
LSD – The incidence is high with regular application of inorganic fertilizer and mulching (***good management)***, and low with application of organic manure and husk pits (***source of micro nutrients***).
TD - The incidence has no correlation with the application of inorganic or organic fertilizer, but low with mulching and husk pits (***soil moisture conservation***).
Weak - The incidence is low with regular application of inorganic fertilizer and mulching (***good management***) and has no correlation with the application of organic fertilizer or husk pits.

**Source of planting material**: Similar to above observations, LSD is higher in planting material with high yield potential; LSD was high in CRI issued and TxT, DxT seedlings, TD was equally high in growers' estate seedlings and CRI seedlings and weak palms were high in CCB (TxT and Plus palm) seedlings. Based on the results of this survey new researchable areas will be identified for LSD, TD and weak palms separately, under long-term and short-term strategies.

*C S Ranasinghe, T S G Peiris, J Jayawardane, L Perera, M T N Fernando, I Wickramananda, R C M Wijeratne, A S Jayasundara, L R M C Liyanage, B M A P Balasooriya,*

**Training and Extension Activities**

Research and technical staff participated as resource personnel in many training programmes for Agriculture teachers and students, Agriculture extension officers and Coconut Development Officers.

**Acknowledgement**

The co-operation and assistance extended by staff of the Plant Physiology Division in conducting experiments, data collection and in compiling this report is gratefully acknowledged.

# REPORT OF THE TECHNOLOGY TRANSFER DIVISION

**Head- P A H Nimal Appuhamy**

## 1. GENERAL

The Division implemented number of programmes to transfer new technologies to coconut growers and the extension personnel. Several programmes were implemented in collaboration with the Coconut Cultivation Board with the emphasis of introducing new technologies and increasing the adoption rate in the field. In addition, several programmes were conducted for school teachers, students, undergraduates and officials of other institutions to increase awareness about scientific cultivation of coconut. With the aid of electronic media, steps were taken to uplift the technical knowledge of coconut growers and the general public on coconut cultivation and processing. A significant increase in the number of coconut growers who obtained the services under these programs was observed.

## 2. OTHER ACTIVITIES

2.1. Mr. A M A P G Gunawardene, Extension Officer, completed his MSc in Agricultural Extension at Maharana Pratap University of Agriculture and Technology, Rajasthan, India and assumed duties at the Institute on 16 August.

2.2. Mr. K J P Jayawardene, Assistant Extension Officer, commenced postgraduate studies with effect from 16 November at the Kerala Agricultural University, India under the ICAR/CARP training programme.

2.3. Mr. C S Herath, Extension Officer, participated at the Farmer Field School Curriculum Development Workshop held at Coconut Development Board, Kochin, India from 03 to 05 February.

## 3. ADVISORY AND FARM DEVELOPMENT SERVICES

The number of coconut growers who visited the division seeking advice for their field problems significantly increased during the year. Majority of them were new landowners who purchased coconut lands with inadequate knowledge and experience in coconut cultivation and management. Depending on their requirements different services were provided.

### 3.1 Advisory and Consultancy Activities

During the year under review, over 175 stakeholders visited the division seeking advisory assistance for their field problems. The staff of the division promptly attended their technical needs and also provided with relevant literature and audio-visual materials.

### 3.2 Advisory Field Visits

The division received a large number of requests from coconut growers to obtain advice on for rehabilitation and productivity improvement in their plantations. Requests of coconut growers for general advice and problems that can be addressed to the Coconut Development Officers were referred to the CCB Regional Managers of respective regions. During the year nearly 40 field inspections were made and reports were submitted with necessary recommendations.

### 3.3 Technical Advise Through Telephone

Coconut growers were provided with the facilities to obtain technical advice and information through a dedicated telephone line available in the division. A wide publicity has been given on this service available for the benefit of coconut growers. During the year, a considerable increase in the number of growers who received this service was observed.

### 3.4 Advisory Correspondence

The number of letters requesting technical information and advice on field problems increased significantly. Replies with relevant information and literature were provided promptly. The letters received regarding field problems, which need the attention of the Coconut Development Officers, were referred to the Regional Managers for necessary action.

## 4. EDUCATIONAL PROGRAMMES

The following educational programmes were conducted during the year.

### 4.1 Educational Programmes for Coconut Growers

- A group of 40 coconut growers from the Sanasa Organization at Wariyapola participated in a full day programme on 05 April.
- A group of 30 coconut growers form the Sanasa Organization at Kurunegala on 12 May.
- A full day programme was conducted for a group of 40 growers from the Kobeigane Cooperative on 17 May.
- A programme was conducted for a group of 125 farmers from "*Samagi Prajasanwardena Padanama*" at Dambadeniya, on 07 June.
- Educational programme was conducted for a group of 30 farmers from Sanasa Organization at Pannala on 01 August.
- A group of 25 coconut growers participated in a full day progrmame from Dambadeniy Development Foundation on 12 August.

### 4.2 Educational Programme for Officers from Other Organizations

- An educational programme was conducted for a group of ten Thailand scientists on 11 April.
- An educational programme was also conducted for a group of 30 members of the District Agricultural Committee of Matale on 13 June.
- A programme was conducted for a group of officials the Browns Beach Company on 22 June.
- A full day programme was conducted for a group of officers from the Air Force Base, Katunayake on 02 August.
- An educational programme was conducted for a group of Agricultural Instructors from Ampara on 27 September.
- A programme was conducted for the Agricultural Committee members of AGA Division at Ukuwela on 29 September.

### 4.3 Educational Programmes for School Children

- During the year educational programmes were conducted for 6400 school children from 53 schools from various parts of the country.
- Necessary guidance and information were provided for O/Level and A/Level projects for 48 students from different areas.

### 4.4 Educational Programmes for Students from Other Educational Institutions

- Educational programmes were conducted for two students from the Aquinas Collage, Colombo and Six undergraduates from the University of Kelaniya.
- Full day educational programme for two groups of undergraduates from the University of Jaffna on 04 and 25 August respectively.
- One week educational programme for students of the Technical Collage, Kuliyapitiya from 08 to 12 August.
- A full day educational programme for a group of students from the Technical Collage, Naiwala, Weyangoda on 15 September.

### 4.5 One Day Educational Programme Series for Coconut Growers

This was one of the most popular educational programmes of the Institute among coconut growers. This whole programme includes seven programmes on different subject areas in order to improve the knowledge and skills of coconut growers from planting to harvesting. The details of the seven programmes conducted during the year are as follows.

- The first programme of the series was conducted on 1st July 2005 at the Isolated Seed Garden, Ambakelle on *" Replanting and Underplanting of Coconut"*. Nearly 175 coconut growers participated.

- The second programme of the series was conducted at Ratmalagara Estate on 29 July 2005 on *"Soil and Moisture Conservation Measures and Irrigation for Coconut"*. Nearly 180 coconut growers participated.

- The third programme was conducted at the Bandirippuwa Estate on 26 August on *" Organic and Inorganic Fertilizer Application for Coconut"* Nearly 170 coconut growers attended the programme.

- The forth programme was conducted at the Walpita Reasarch Station on 23 September on *" Intercropping in Coconut Lands"*. Nearly 150 coconut growers participated.

- The fifth programme was conducted at the Bandirippuwa Estate on 28 October on *" Coconut Pests and Disease Management"*. Nearly 140 coconut growers attended the programme.

- The sixth programme was conducted Ratmalagara Estate on 25 November on *" Rehabilitation of Low Yielding Coconut"*. Nearly 145 coconut growers participated the programme.

- The seventh programme was conducted at the Bandirippuwa Estate on 16 December on *" Coconut Estate Management"*. Nearly 140 coconut growers attended.

At the end of this programme series a certificate was awarded to those who participated all seven programmes.

On the first day of the above programme a survey was conducted to assess the nature of participants and their level of field operations. 125 coconut growers participated in this study.

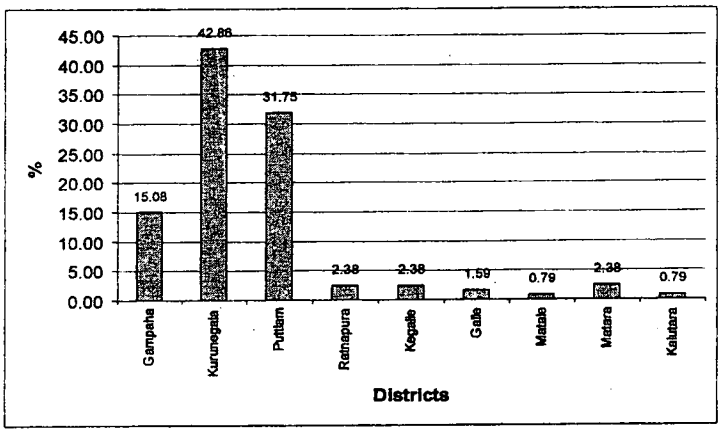



*Figure 1.:* ***Percentage of participants according to the districts.***

Out of total participants nearly 43% had come from Kurunegala, 32% from Puttalam and 15% from Gampaha districts. Land size categories of participants are shown in the Table 2.

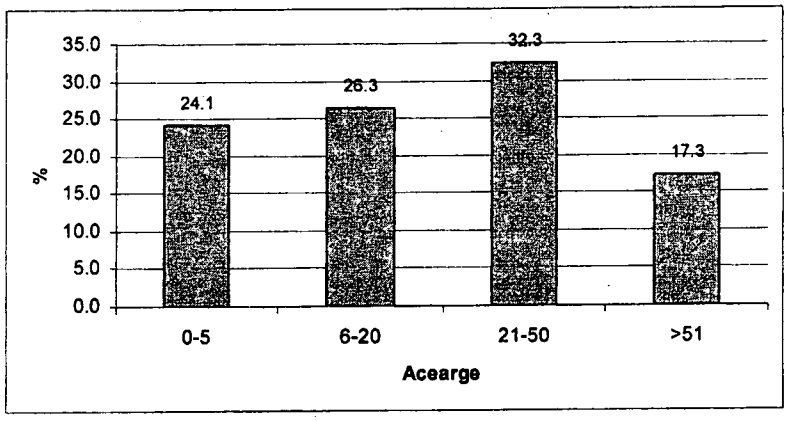



*Figure 2.* ***Land size categories of participants***

According to Table 3, out of total number of participants, nearly 50% were landowners and 16% were members of families who own coconut lands. Nearly 28% were estate superintendents or supervisors.

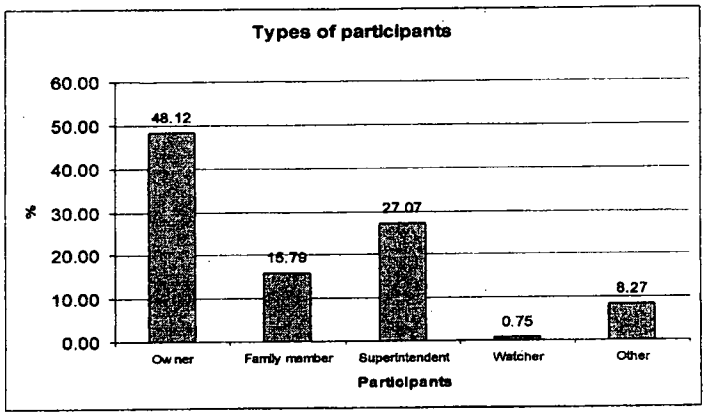



*Figure 3.* ***Types of participants***

## 5. SEMINARS AND FIELD DAYS

5.1 A seminar was conducted on coconut mite management for the Coconut Development Officers of CCB on 20 January.

5.2 A seminar was conducted on new technology in coconut cultivation including coconut mite management at Gannoruwa, for the Agricultural Officers of the Mahaweli Project on 22 February.

5.3 A field day on coconut mite management was conducted at Galewela in collaboration with CCB Regional Office, Matale on 17 February.

5.4 A seminar was conducted on coconut cultivation and management at the Paduwasnuwara Maha Vidyalaya, on 15 March.

5.5 A full day seminar was conducted for the Managers of the Chilaw Plantations Ltd on the management of coconut estates on 06 May.

5.6 A seminar on planting and management of coconut was conducted at Katuwana AGA's office for village level trainers 03 June.

5.7 A full day seminar was conducted for the managers and assistant managers of NLDB coconut estates on coconut mite management on 21 April.

5.8 A field function was conducted at the Isolated Seed Garden, Ambakelle to mark 50$^{th}$ Anniversary of the seed garden on 11 May.

## 6. COLLABORATIVE TECHNOLOGY TRANSFER PROGRAMMES

### 6.1 Research and Extension Dialogues

Research and extension dialogues were conducted between the field extension staff of CCB and the research staff of CRI on the current issues of the sector. These programmes provide opportunities to discuss current field problems and recommend suitable corrective measures. This also helps CRI research personnel to familiar with field problems and updates the knowledge of Coconut Development Officers on new findings. During the year the following research and extension dialogues were conducted.

6.1.1 The first research and extension dialogue was conducted at CRI on 15 May with the participation of field extension personnel of Marawila, Kuliyapitiya and Kurunegala regions.

6.1.2. Second research and extension dialogue was conducted on 18 August at CRI auditorium with the participation of 80 field extension workers of CCB from Gampaha, Kalutara, Kegalle and Ratnapura regions.

### 6.2 Island wide coconut mite management programme

This was a collaborative programme implemented in all coconut-growing areas through the regional staff of the Coconut Cultivation Board with the technical guidance of CRI. This division had the responsibility in coordinating and monitoring the activities implemented at the field level. The objectives of the programme were as follows.

a. To adopt integrated pest management measures to bring down the mite population in already affected coconut growing areas in order to reduce the economic crop loss until a sustainable biological control method is introduced.
b. Adopt recommended technologies to improve the palm vigor, which hinder the mite infestation.
c. Reduce the spread of coconut mite to new areas.

This programme was in progress in all CCB regions from January.

The following audio-visual materials were produced for the above programme and distributed to growers through CDOO.

a. Printing of a set of colour photographs (6 photos in 10" x 12") in 1000 copies in each to be used in field educational programmes by CDOO.
b. Printing of 50,000 copies of colour handouts on the promotion of technology package to improve the vigor of palms.
c. Printing of 100,000 copies of handouts in Sinhala and 15,000 copies in Tamil on the identification of coconut mite.
d. Broadcast three radio spots on SLBC channels, (Commercial Service, City FM, Rajarata FM and Ruhuna FM) for a period of one month.
e. Preparation of 500 banners in Sinhala and 100 in Tamil issued to regions.
f. Preparation of three TV spots to create awareness and encourage coconut growers to adopt control measures.

### 6.3. Crop Clinics in Coconut Growing Areas

Crop clinic was a new approach to build direct contacts between the research personnel and the stakeholders. Crop clinics were organized in a way that coconut growers and processors could discuss their field problems directly with the experts in the respective technical areas. With the participation of research divisions and the extension personnel of CCB the following crop clinics were conducted for the benefit of coconut growers in Dummalasuriya and Walpita areas on 20 October and 03,04 and 05 November respectively. These programmes were well attended by the growers and highly commended about the benefits they obtained.

### 6.4. Farmer Field Schools.

Farmer Field School (FFS) is a new technology transfer tool suitable for the smallholder sector. It was found to be beneficial to growers in many ways. When coconut growers come together in field schools, the environment facilitates them interaction, promotes the spirit of partnership and collective decision-making amongst growers. Secondly, the FFS helps to develop a valuable farmer-facilitator-researcher partnership, which improves self-discovery and farmer confidence. The division in collaboration with the Crop Protection Division implemented FFS in various coconut-growing areas with the financial assistance from APCC. As a pilot study, FFS programmes were conducted with a group of small coconut growers once in a month in Dambadeniya, Chilaw, Alawwa, Aunuradapura, and Galle areas.

## 7. PUBLICITY AND MASS MEDIA PROGRMMES

The division implemented several publicity and mass media programmes to create awareness and interest on new technologies among the stakeholders.

### 7.1. TV and Video Programmes

7.1.1 A documentary produced on the management of coconut mite was telecast on Rupavahini on 27 August for the benefit of coconut growers.

7.1.2. The video documentary produced by the division covering the activities and the progress of the Institute during the last 75 years was telecast over Rupavahini on 08 September.

7.1.3. The coconut mite management documentary was telecast over ITN on 28 November.

7.1.4 The same programme was again retelecast on Rupavahini on 08 December with few trailers.

### 7.2. Radio Progrmmes

7.2.1 "Gami Sarani" live radio programme was broadcast on 15 November from Kuliyapitiya Divisional Secretariate office with the participation of the Hon Minister of Plantation Industries and coconut growers in the area.

7.2.2 CRI sponsored another live radio programme of "Gami Sarani" which was broadcast from the Divisional Secretariate Office at Hambantota.

7.2.3 A weekly radio programme "Kapruka Pamula" was commenced in this year with the objectives of educating coconut growers, processors, students and the general public on coconut cultivation, processing, marketing and consumption. This programme was conducted in collaboration with CCB and CDA. During the year 24 programmes were broadcast over Commercial Service, SLBC.

### 7.3. Print Media

Newspaper advertisements on mite control activities, seminars and radio programmes were published. Eight newspaper articles on current issues of the sector were also published. Several news items were also issued to the press.

### 7.4 Improvement of CRI Museum

CRI museum was rearranged by introducing new posters and display boards. Ten colourfull light boxes were produced.

### 7.5 Exhibitions

The division participated a large number of exhibitions during the year to promote the coconut cultivation, management and processing technologies. Details of exhibitions are given below.

7.5.1 Mahapola exhibition from 07 to 15 March at Paduawasnuwara

7.5.2 Educational exhibition at the Sumana Vidyalaya, Niwithigala from 29 March to 04 April.

7.5.3 Educational exhibition at the TRI Ratnapura Substation on 08 May

7.5.4. Science exhibition at the St Thomas Collage, Matale from 18 to 20 May.

7.5.5. Educational exhibition at Madamulana CCB nursery from 08 to 10 June.

7.5.6. Educational exhibition at Allawwa on 15 June.

7.5.7. School exhibition at the Maris Stella College, Negombo from 05 to 06 July.

7.5.8. Rajarata Aruna Agricultural exhibition from 21 to 23 July.

7.5.9. School exhibition at the Holy Family Convent, Marawila on 14 September.

7.5.10. Educational exhibition at the Veyangoda Maddya Maha Vidyalaya from 19 to 22 September.

7.5.11. School exhibition at the St Xavier Collage, Marawila on 03 and 04 October.

7.5.12. Educational exhibition at the Prince of Wales Collage, Moratuwa from 18 to 20 October.

7.5.13. Agricultural exhibition at the Walpita Estate from 03 to 04 November.

7.5.14 Industrial and agricultural exhibition in Colombo from 05 to 10 November.

7.5.15 Agricultural exhibition at Labuduwa from 16 to 18 December.

## 8. PRINTING OF PUBLICATIONS

The printing unit was shifted to the main building due to roof renovation works. During the year the Printing Unit of the division achieved a progress in respect of the number of printing job completed. During the over 146 printing jobs were undertaken. This includes scheduled publications, letters, survey forms, questionnaires and handoutets.

### 8.1 Printing of Annual Report

Six hundred and fifty copies of the Annual Report for 2004 were printed in three languages for the submission to the parliament.

### 8.2. Printing and issue of booklets

The following booklets were issued

- Booklet to mark 50th Anniversary of Isolated Seed Garden, Ambakele – 300 copies
- Booklet to mark the opening of the Middeniya Research Station

### 8.3 Printing and Issue of Advisory Bulletin

The following advisory bulletins were published and sold at the rate of Rs. 30/=

- Coconut pests and diseases – 1000 copies
- Under planting, production of high quality planting materials and planting of seedlings. – 500 copies.
- Soil and moisture conservation -500 copies
- Fertilizer application – 200 copies.

### 8.4 Printing of Handouts for one day Educational Programme Series

The following handouts were issued

- Replanting, planting of seedlings and management of young plantation. – 300 copies
- Soil moisture conservation in coconut lands – 300. copies
- Use of organic and inorganic fertilizers – 300 copies
- Intercropping in coconut lands – 350 copies
- Pests and disease control in coconut lands – 300. copies
- Rehabilitation of low yielding coconut lands – 325 copies
- Principals in coconut estate management – 200 copies.

### 8.5 Printing and issue of Coconut Technology Update.

Three issues of Coconut Technology Update were published in three languages (Sinhala, Tamil & English) in 1000 copies each. Coconut growers have subscribed for this journal.

### 8.6 Reprinting of Advisory Circulars.

Fifteen advisory circulars were re- printed during the year covering 50000 copies. Advisory circulars were issued to growers on their needs.

## 9. PRODUCTION OF AUDIO VISUAL MATERIALS

### 9.1 Production of video documentaries

The production of six video documentaries was completed. The documentaries were available for sale in CDs at the subsidized rate of Rs. 100/= each are available on the following subjects

- Red Weevil control
- Coconut mite management
- Irrigation of coconut
- Intercropping under coconut
- Animal husbandry in coconut lands
- Coconut Caterpillar control

### 9.2 Production of digital posters

The following large digital posters were designed and printed for exhibitions and field days.

1. Planting of CRIC 65 in home gardens
2. Isolated Seed Garden
3. Correct planting of coconut seedlings
4. Red weevil pest control
5. Black beetle control

6. Control of Plessipa Beetle
7. Land suitability in coconut growing areas
8. Coconut mite management
9. Cultural practices in mite management
10. Intercropping in coconut lands
11. Animal husbandry in coconut lands
12. Moisture conservation in coconut lands
13. Plant nutrients for coconut

## 10. RESEARCH AND SURVEYS

10.1 The staff of the division was heavily involved in designing and data collection in two surveys conducted during the year. One survey was conducted in the coconut triangle to assess the level of damage and related conditions in respect of Leaf Scorch Decline, Tapering Disease, Coconut Rapid Decline and Weak Palms. The other one was a Diagnostic Survey covering the main coconut growing areas. Mr. C S Herath and two graduate trainees conducted field studies to assess the level of adoption of fertilizer application by coconut small holders in Chilaw area and to assess the distribution and probable causes of leaf scorch disorder and tapering disorder of coconut palm of small holders in Welpalla Coconut Development Office range.

## 11 STAFF PUBLICATIONS

11.1 **P A H Nimal Appuhamy,** Rainwater harvesting and moisture conservation in coconut lands, Sustainable ways to improve the productivity. *Coconut Technology Update*, Issue 1 April 2005,

11.2 **P A H Nimal Appuhamy,** Gliricidia foliage as a green manure for coconut, *Coconut Technology Update*, Issue 2, August 2005.

11.3 **P A H Nimal Appuhamy**, New method of injecting Monocrotophos to control Red Weevil post of coconut. *Coconut Technology Update,* Issue 3, December 2005.

11.4 **C H Herath,** Farmer Field School an innovative approach for coconut extension. . *Coconut Technology Update,* Issue 3, December 2005.

11.5 **B S P S S Perera, M N D Fernandopulle and C S Herath.** Assessment of the level of adoption of fertilizer application by coconut small holders in Chilaw area, Proceedings of fifth Agricultural Research Sympsium, part ii, Faculty of Agruculture and Plantation Management, Wayamba Uinversity of Sri Lanka, September,2005.

11.6 **N D C R Karunaratne, M N D Fernandopulle and C S Herath.** Assessment of distribution and probable causes of leaf schorch disorder and tapering disorder of coconut palm of small holders in Welpalla Coconut Development Office range Proceedings of fifth Agricultural Research Sympsium, part ii, Faculty of Agruculture and Plantation Management, Wayamba Uinversity of Sri Lanka, September, 2005.

# REPORT OF THE LIBRARY

**P.D.U.C Darmapala, Assistant Librarian**

## GENERAL

The library continued its routine services satisfactorily throughout the year. Information needs of both the internal staff and outsiders were satisfactorily met using both internal and external resources. The journal subscription of the library was strengthened with eight electronic journals. The library continued to be an active member of the agricultural information network (AGRINET) with a view to sharing of resources.

## ACQUISITIONS

During the year the library subscribed 08 e-journal titles and continued to receive journal titles including 09 Annual Reports on exchange.

## SERVICES

While routine library services were carried out, literature searches were made on the coconut database to cater to the information needs of staff as well as outsiders.

The library continued its support to the Sri Lanka Scientific & Technical Information Centre (SLSTIC) and AGRINET with a view to sharing resources.

## STAFF

Two graduates were trained under the graduate training scheme. Created two posts of Documentation Assistant in the Library carder. The graduate trainees resigned with effect from August and October respectively.

The staff position as at 31 December 2005 was Asst. Librarian -01, Clerk/Typist -01 and Office Attendant -01.

Many students attached to various training programmes at the institutes as well as students from various universities visited the library and used the resources.

## Report of the Estate Management Division – 2004/10 –2005/09

Manager (estates) – N.P.K. Liyanage (B.Sc. Agric)

1. Summary

The three Genetic Resource Centres and seven research sub stations that comes under the Estates Management Division were maintained satisfactorily with the implementation of several new research and development projects. Highlight of the year was the opening of the new sub station at Middeniya to serve coconut growers in the southern province. Among other significant events are; establishment of drip irrigation facilities in 70 acres at Ambakelle Genetic Resources Centre (AGRC) and divestment of approximately 15 acres to a mixed plantation of dwarf green and tall to increase the production of CRIC65 especially to cater the extensive home garden development programme of the CCB, continuation of the development of Pallama Genetic Resources Centre for mass production of CRISL98, conversion of Makandura Research Sub Station to provide facilities to multidisciplinary research programmes on improving soil fertility and coconut palm decline syndromes, production of over 0.8 million seed nuts, excavation of two ponds at the Bandirippuwa Main Research Centre and expansion of live stock activities in all estates. Overall income from the estates was approximately Rs. 49 million despite the increase in COP due to escalation of prices in inputs and 22% decline in yield due to non conducive weather conditions in the previous year. The average cost of production (COP) and net sales average (NSA) of all centres were 10.05 and 11.40 respectively.

Among other development programmes, initiation of demonstration plots at Pallma, Ratmalagara, Makandura and Maduruoya estates to exhibit recommended field practices in coconut, removal of weak and dud palms, planting of high valued timber trees at Bandirippuwa, Ratmalagara and Pallma on areas unsuitable for coconut and along fences at Makandura estate, resumption of curd production with newly procured eight buffaloes and the establishment of a nursery for producing various coconut dwarf colour forms along with high yielding coconut cultivars, redistribution of cattle among estates to produce hybrid calves through Artificial Insemination, expansion of pasture are other noteworthy events of the year. Arrangements and facilities provided to conduct one day training programmes at ISG, PRS, BRS and WRS are also noteworthy contributions of the Estate Management Division during the year.

2. Performance of Individual Units

2.1 Ambekelle Genetic Resources Centre (AGRC) : Pallama

| | | |
|---|---|---|
| Superintendent | : | Mr. W.M.Upali Rathayake |
| District | : | Puttlam |
| Agro Climatic Zone | : | Intermediate Dry Zone |
| Extent | : | 456.20 ha |

Genetics and Plant Breeding Division and Estates Management Division launched a programme to increase the production of CRIC65 with the assistance of CESS funds by establishing drip irrigation facilities for all mixed fields, 9 and 10 and part of 11A which was to be divested to a mix field. Total area covered was approximately 70 acres. The cost of the project was around Rs. 3 million. The expected increase in yield of CRIC65 due to irrigation is 0.1 million (30%). The project was in now in near completion and irrigation is due to commence before the onset of drought in 2006. A total of 430 dwarf green seedlings were planted in Field 11A after removing 27 alternate rows of tall coconut.

The total production of nuts during the period from October 2004 to September 2005 was 1.05 million, which is a 32% drop comparing to previous year. The total number of seed nuts issued

was 576,065 indicating a poor selection percentage of 54.6%. The drop in yield was mainly attributed to poor weather in the previous year. Infestation of mite has resulted in low percentage of selection of seed nuts. Rainfall during the year was 1017.3 mm with 65 wet days up to the end of October, which excluded the high rainfall months. Therefore, the rainfall figures are not comparable.

General maintenance was satisfactory during the year. Annual application of fertilizer was attended by covering all palms of the estate making advantage of both yala and maha rains. Over 2000 dwarf palms were fertilized with organic manure. Weeding, mulching and other cultural practices were duly attended however; the mite infestation was widespread with 12-13% of nuts being affected. Selected dud and weak palms were removed in the plantation after careful selection with the assistance of the Genetic and Plant Breeding Division.

A buffalo herd of 38 were maintained as an extensive system for grazing and thereby controlling weeds with low cost. Production of curd and born buffalo calves gave an additional income. The income generated by sale of coconut (seed nut and selected nuts), coconut seedlings and other sundries were Rs 14,073,973.02, 579,510.00 and 757,367.25 respectively. Total income of the AGRC was Rs 18,438,472.55. Cost of Production (COP): for 000 nut was Rs. 9,857.41 and the Net Sales Average (NSA ):for 1000 nut was Rs. 13,952.95

2.2 Bandirippuwa Main Research Centre (BMRC): Lunuwila

| | | |
|---|---|---|
| Superintendent | : | Mr. G.B.A.Wijesekara |
| District | : | Puttlam |
| Agro -ecological Zone | : | Wet Intermediate |
| Extent | : | 148.1 ha |

The total yield of coconut during the year was 372,562 which is a reduction of 44% comparing to year 2004. The main reason for the yield drop was the low rainfall received in the year, 2004. Also the rainfall and wet days received up to the end of October indicated a decrease (1282.5 and 86 respectively) of 0.5 % and 2.3% respectively when compared to the corresponding period of the previous year.

Application of fertilizer was completed with 800 palms being fertilized with organic manure. Weeding, mulching and other cultural practices were duly attended. Approximately 500 fathoms of drains were cut to facilitate drainage and moisture conservation. Two ponds were excavated to harvest rain water as a measure of conserving moisture and for wallowing Buffaloes. The selected 1,255 weak palms were removed. The road system stretching various fields was renovated.

Live stock consisting 100 cattle and 10 buffaloes including new purchases were maintained successfully to initiate production of curd. Management of dairy unit was scrutinized by adopting new scientific systems. Milk production was increased by milking cows twice per day. Cattle shed were renovated and planting of fodder commenced. Ground planning and arrangements were made for establishment of the proposed Technology Park in field no 7 adjoining the Kuliyapitiya road.

The incomes received by sale of coconut, copra and other estate produces are as follows,

| | | |
|---|---|---|
| Coconuts | = | Rs. 3,906,369.00 |
| Copra | = | Rs 131,735.77 |
| Seedlings | = | Rs 22,920.00 |
| Sundries | = | Rs 1,090,215.37 |
| Animal Products & Animals | = | Rs 194,376.75 |
| Total | | Rs. 5,345,616.89 |

Cost of Production (COP) for 1000 nuts was Rs. 14,130.00 and the Net Sale Average (NSA) ):for 1000 nut was Rs. 10,410. This showed a negative trend in income with a loss of Rs 3.72 per nut. The reduction in yield and increase of wages and cost of inputs attributed to the above increase in COP.

2.3 Dunkannawa Research Centre (DRC) : Thabbowa, Nattandiya

| | | |
|---|---|---|
| Officer In Charge | : | Mr. Newton Gamage |
| District | : | Puttlam |
| Agro – Ecological Zone | : | Intermediate Dry Zone |
| Extent | : | 10.4 ha |

This research centre is still on development stage with the establishment of the new variety, T×SR (SLR 98) and TxT (CRIC60). The estate has 840 four-year old seedlings and 320 old palms of the tall variety. The production of nuts during the year was 12,413.

The rainfall was 1206.3 mm with 80 wet days up to the end of October, which is a decrease by 19.6% & 30.5% respectively comparing to the corresponding in the previous year. The income from coconut and sundries (sale of seedlings) were Rs.147,103.04 and Rs 414,081.00 respectively. Cost of Production (COP) for 1000 nuts was Rs.7,730.00 and the Net Sales Average (NSA) for 1000 nut was Rs. 11,080.00. The cinnamon established as an intercrop was continued with filling of vacancies. A part of the land was allocated to CDA for starting a coir retting research station.

2.4 Maduruoya Genetic Resources Centre (AGRC) : Bogaswewa

| | | |
|---|---|---|
| Acting Superintendent | : | Mr. W.A.Harald Upali |
| District | : | Polonnaruwa |
| Agro ecological Zone | : | Dry Zone |
| Extent | : | 85 ha |

This seed garden was maintained to supply seed nuts to neighbouring CCB nurseries. The total yield of coconut during the year was 488,085 nuts, which is a 24.4% increase in the yield comparing to previous year. Among the crop 287,930 were issued as seed nuts, which is a 34.5% increase than the year, 2004. The performance of this seed garden was not affected by drought because of the successful implementation of the flood irrigation system.

Total rainfall received during the year was 635.4 mm and 50 wet days up to the end of October. This is 38.8 % and 16.3% reduction respectively than corresponding period of the previous year.

Income :

| | | | |
|---|---|---|---|
| Seed nuts | = | Rs. | 5,008,481.66 |
| Coconuts | = | Rs | 164,727.09 |
| Copra | = | Rs. | 87,364.00 |
| Seedlings | = | Rs. | 559,260.00 |
| Sundries | = | Rs. | 26,978.90 |
| Total | = | Rs | 7,329,359.20 |

Cost of Production (COP) for 1000 nut was Rs.7,093.00 and the Net Sales Average (NSA) ) for 1000 nuts was Rs. 11,828.38. This estate has recorded a profit margin of Rs 4.73 per nut.

## 2.5 Makandura Genetic Resource Centre (MGRC): Gonawila, Makandura

| | | |
|---|---|---|
| Superintendent | : | Mr. A.N.Eknaligoda |
| District | : | Kurunegala |
| Agro ecological Zone | : | Wet Intermediate |
| Extent | : | 58.20 ha |

The total yield of this estate was 181,634 nuts, which is a 43% reduction than the previous year. This station was taken over for a Board of Investment project in the year, 2004 and hence was not being maintained as a coconut estate. No records of rain fall in the year, 2004. This year the rainfall of 935.4 mm and 70 wet days up to the end of October 2005 were recorded.

Due to the long standing problem of palm tapering a complete soil survey and a palm survey were conducted to identify causes of the high percentage of weak, dud and senile palms in the estate, which resulted in low production. These were carried out collaboratively with Soil and Plant Nutrition Division and Plant Physiology Division. After the decision taken to rebuilt the station as a research centre for studying palm decline and soil fertility decline a total of 2,200 palms were uprooted for establishing new research plots. A decision was also taken to convert Field no. 03 for non coconut purposes such as cinnamon, cashew and pasture.

A remarkable improvement was observed in livestock production with eight buffaloes being introduced from other estates and new purchases for curd production. The cattle herd was increased to 120 from 60 during the year. All breedable cows were artificially inseminated. Grasses and fodder were established for feeding of animals. The aim of increasing the herd was to utilize the vacant land created by uprooted palms and tap the marketing potential for milk products in the area.

A commercial nursery was started to produce seedlings of dwarf colour forms because of the demand for ornamental requirements. Seed coconuts comprising 160 yellow, 305 red, 51 green. 89 Brazilian green, 40 and Cameroon red and 2000 DxT nuts and 400 king coconuts were laid in the nursery to increase the income of the centre.

The incomes received by various means during the year are as follows:

| | | | |
|---|---|---|---|
| Coconuts | = | Rs. | 2,405,758.00 |
| Copra | = | Rs. | 146,049.00 |
| Sundries | = | Rs | 301,495.66 |
| Animal Products & Animals | = | Rs | 210,191.00 |
| Total | = | Rs. | 3,063,493.99 |

## 2.6 Pallama Genetic Resource Centre (PGRC) Pallama

| | | |
|---|---|---|
| Officer in charge | : | Mr. A.Sugathadasa |
| District | : | Kurunagala |
| Agro-ecological Zone | : | Dry Zone |
| Extent | : | 260 ha |

A part of the estate is still in the developing stage as a seed garden for the mass production of seed nuts of the cultivar, CRISL98. Extent of mature and immature plantations are 188 ha and 176 ha respectively. The old mature plantation has produced 484,984 nuts including 20,280 plus palm seed nuts. Maintenance of the under plantation was successfully attended with infilling the available vacancies.

The total rainfall was 742.5 mm and 50 wet days up to the end of September, which was a decrease of rainfall by 45.7 % and increase of wet days by 56.25% comparing to corresponding period of the previous year. Livestock maintenance was not possible in this estate due to high percentage of the seedling population. The cattle herd of 48 was transferred to Makandura and Poththukulama centers.

Incomes of Rs 5,023,518.39 and Rs 663,276.81 were received from sale of coconut and sundries respectively. Cost of Production (COP) for 1000 nut was Rs.10,350.00 and the Net Sales Average (NSA) ) for 1,000 nuts was Rs.8,670 00. This was a decrease of Rs 1,780 for 1,000 nuts.

## 2.7 Poththukulama Research Centre (PRC) : Pallama

| | | |
|---|---|---|
| Officer in charge: | | Mr. D.L.I.Nethasinghe |
| District | : | Puttlam |
| Agro-ecological zone: | | Intermediate Dry Zone |
| Extent | : | 74.28 ha |

The production of coconut during the year was 602,445, which is a reduction of 23% nuts comparing to previous year. This estate is mostly used for research activities. A collection of dwarf varieties occupy a considerable portion of the estate.

Routine agronomic activities were continued in this centre successfully. Approximately 339 dud and senile palms were removed. Timber trees (500 teak plants) were planted in field no 4 since it is not suitable for Coconut. The estate staff aptly assisted the goat project of the Agronomy division. PRC was also conducting a cattle fattening program by collecting male animals from CRI estates. Animal comprising 107 goats, 66 cattle and 6 buffaloes were maintained successfully during the year.

Total rainfall received during the year was 1,049 mm and 57 wet days up to the end of October, which was a decrease by 25 % and 15.8% respectively when compared to the corresponding period of the previous year. Total income, Rs 7,080,131.33 constituted Rs 6,610,361.33 from coconut and Rs 469,770.00 from sundries.

Cost of Production (COP) for 1000 nuts was Rs.8, 266.13 and the Net Sale Average (NSA) ) for 1000 nuts was Rs.10,972.00. The estate has recorded a profit of Rs 2,706.42 for 1000 nuts.

## 2.8 Ratmalagara Research Centre (RRC) : Panirendawa

| | | |
|---|---|---|
| Officer in charge | : | Mr. T.M.Keerthiratna |
| District | : | Puttlam |
| Agro-ecological zone | : | Intermediate Dry Zone |
| Extent | : | 110.48 ha |

RRC has produced 602,445 nuts during the period under review in the year, 2005. This is a 37% reduction in yield comparing the previous year. The reasons for decline are low rainfall and inadequate application of fertilizer in previous years.

Total rainfall received was 1,419.1 mm and 80 wet days up to the end of October, which is a decrease by 26.3 % and similar number of wet days compared to the corresponding period of the previous year. The cattle project was maintained successfully with 57 animals contributing an income of Rs. 253,101.30. The nursery has also generated an income of Rs 593,490.00.
Total incomes are as follows

| | | | |
|---|---|---|---|
| Coconuts | = | Rs. | 4,568,507.10 |
| Copra | = | Rs. | 267,719.50 |
| Seedling | = | Rs. | 604,464.00 |
| Sundries | = | Rs | 1,558,266.13 |
| Animal Products & Animals | = | Rs | 245,756.64 |
| Total | = | Rs | 7,244,713.37 |

Cost of Production (COP) for 1000 nuts is Rs. 9,500.00 and Net Sales Average (NSA) for 1,000 nuts is Rs.11,560 00. This has recorded a profit of Rs 2,060.00 for 1000 nuts. An extent of five acres was uprooted for providing space for the GPBD to establish a new hybrid trial.

2.9 Walpita Research Centre (WRC) :

| | | |
|---|---|---|
| Superintendent | : | Mr. Nimal Hemasiri |
| District | : | Gampaha |
| Agro-ecological Zone | : | Wet Intermediate |
| Extent | : | 17.8 ha |

This research station is maintained specifically for demonstration of intercrops in coconut lands. All the intercrops suitable for intermediate conditions have been grown in this centre. A two-day field program was organized by the Coconut Cultivation Board with the assistance of Estate Management Division in this centre is a noteworthy event during the year.

The existing coconut plantation is 57 years old and the yield is now declining. The yield recorded in 2005 was 101,124 nuts, which is a 20% decline than the previous year,

Total rainfall was 1,666.6 mm and 75 wet days up to the end of October, which indicated a decrease by 13 % and 13% respectively when compared to the corresponding period of last year.

Livestock (9 cows) were introduced to collect dung organic manure and weed control purposes initially and later as a source of income from milking. A remarkable income was generated by sale of excess seedlings and Intercrops despite the drop of pepper prices.

The incomes generated during the year are as follows:

| | | | |
|---|---|---|---|
| Coconut | = | Rs. | 1,150,721.60 |
| Copra | = | Rs | 33,345.00 |
| Seedlings | = | Rs | 169,380.0 |
| Fruits and spices | = | Rs | 159,848.42 |
| Total | = | Rs | 1,514,295.02 |

Cost of Production (COP) for 1000 nuts was Rs.1, 0980.00 and the Net Sales Average (NSA) for 1000 nut was Rs.1,2150.00 This has recorded a profit of Rs1,170.00 per 1000 nuts.

**Middeniya Research Station**

A seventy five acre property was acquired from the Dept. of Agriculture in November 2004 to establish a coconut research centre to enhance the coconut industry in the southern province. Development of this research centre was being planned and commenced with the assistance of CESS funds. A technical officer was placed as the OIC and the work commenced by clearing of the land by using manual labour. Fence and the office building was constructed at the outset of 2005. The centre was declared open by the Honourable Minster of Plantation, Mr. Anura Priyadarshana Yapa on 9th July 2005.

## REPORT OF THE ADMINISTRATION DIVISION

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

### 1. ESTABLISHMENT UNIT

The unit continued to assist Research Divisions in routine administrative & financial matters and related affairs including maintenance work.

### 2. CADRE

The staff position of the Coconut Research Institute at the end of December 2005, is given in table 1.

**TABLE 1 : *Staff position as at 31/12/2005***

| Grade | Ungraded | Sp Cl | Cl I | Cl II | Cl III | Cl IV | Total |
|---|---|---|---|---|---|---|---|
| Executive | 02 | 00 | 11 | 11 | 28 | 41 | 93 |
| Technical | 00 | 34 | 10 | 11 | - | - | 55 |
| Intermediate | 00 | 05 | 01 | 00 | - | - | 06 |
| Clerical & Allied | 00 | 25 | 05 | 04 | - | - | 34 |
| Operative | 00 | 26 | 09 | 07 | - | - | 42 |
| Driver | 00 | 19 | 04 | 06 | - | - | 29 |
| Minor | 00 | 41 | 17 | 14 | - | - | 72 |
| Watcher | 11 | 00 | 00 | 00 | - | - | 11 |
| Grand Total | 13 | 150 | 57 | 53 | 28 | 41 | 342 |

### 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 64 employees, amounting to | Rs.15,934,000.00 |
| **Distress Loans:** | Granted for 40 employees amounting to | Rs. 3,007,277.00 |
| **Transport Loans:** | Granted for 25 employees amounting to | Rs. 1,213,875.00 |
| **Refrigerator Loans:** | Granted for 01 employee amounting to | Rs. 12,000.00 |
| **Loan Relief to Indebtedness Loans:** | Granted for 05 employees amounting to | Rs. 37,500.00 |

**Medical Aid:** Rs.2,741,170.00 was reimbursed by the Medical Aid Scheme during the year 2005, and an amount of Rs.555,087.00 was distributed to 331 Savings Accounts of Members.

The following medical clinics were conducted during the year 2005

- Eye Clinic
- Blood Donation Programme
- Medical Check up for members & their family conducted by Asiri Hospitals (Pvt.) Ltd and Sri Lanka Diabetic Centre.
- Held several seminars on various aspects related to health

3.2 **Other facilities to employees**

(a) Financial assistance was also granted to the Multi-purpose Co-operative Society, Art Circle, Day Care Centre, Seva Vanitha Movement, Death Donation Society and the Recreation Club during the year 2005.

# REPORT OF THE ACCOUNTS UNIT
# FINANCIAL PERFORMANCE REPORT

Accountant
R M U Chandranath, BSc Mgt. FCBA

The Coconut Research Institute's prime income comes from Treasury funds and other incomes generated from four Genetic Resource Centers, five Research Centers, CESS grant and Donor Funded Project Grants etc.. Table 1 shows the funds received from the treasury, income generated through self-financing units, CESS grants and donor funded projects grant for the last four years.

Due to financial limitations, allocation and utilization of available resources were made more effectively and efficiently to achieve organizational objectives. Planning and organizing the institute so as to maintain the financial strength and stability, investment plan was established to generate additional funds and to monitor the institute's resources.

**Table 1 :** *Grants from Treasury, income from self-finance units, CESS and donor projects*

| Sources | Rs. Million | | | |
|---|---|---|---|---|
| | 2002 | 2003 | 2004 | 2005 |
| Treasury Grant – Recurrent | 57.00 | 52.77 | 60.27 | 77.00 |
| Treasury Grant – Capital | 7.25 | 27.50 | 22.26 | 24.60 |
| Income Self-finance Units | 35.18 | 46.98 | 55.00 | 58.62 |
| CRI Own Income | 3.43 | 5.75 | 4.98 | 5.76 |
| CESS Grant | 14.88 | 12.50 | 20.67 | 57.48 |
| Donor Funded Projects | 7.15 | 7.72 | 8.45 | 7.29 |
| Total | 124.89 | 153.22 | 171.63 | 230.75 |

As shown in Table 1, the recurrent grant has increased by 28% in the year 2005 compared to year 2004. The grant had increased by 178% when compared to previous year.

**Table 2 :** *Financial progress of recurrent and capital expenditure*

| Description | Rs. Million | | (Decrease) % |
|---|---|---|---|
| | 2004 | 2005 | Increase |
| Personnel Emoluments | 63.59 | 78.05 | 22.7% |
| Travelling Expenses | 1.90 | 1.38 | (27%) |
| Supplies and Requisites | 6.06 | 9.39 | 55% |
| Maintenance Expenses | 12.41 | 12.68 | 2% |
| Contractual Expenses | 4.95 | 4.07 | (17%) |
| Other Recurrent Expenses | 1.84 | 5.47 | 197% |
| **Total Recurrent Expenses** | **90.75** | **111.04** | **22%** |
| **Total Capital Expenses** | **18.70** | **21.61** | |

The staff position of the CRI was 708 employees during the year 2005. Out of them 342 were permanent employees and 366 were daily paid workers. As indicated in Table 2, 70% of the total recurrent expenditure was on personnel emoluments and the next highest

expenditure was on maintenance such as buildings, vehicles, electricity, infrastructure development etc. Fuel and lubricant were included under supply expenditure and telephone, Internet, insurance, security charges, legal fees etc. included under contractual services.

**Table 3 :** *Financial Progress of Self-financing Units*

| Seed Gardens/ Research Centers | Year 2005 | | Surplus/ (Deficit) |
|---|---|---|---|
| | Income Rs. Million | Expenditure Rs. Million | |
| Ambekela Genetic Resources Center | 18.44 | 11.32 | 7.2 |
| Pallama Genetic Resources Center | 6.05 | 5.46 | 0.6 |
| Makandura Genetic Resources Center | 4.55 | 3.08 | 1.5 |
| Maduruoya Genetic Resources Center | 6.57 | 3.47 | 3.1 |
| Bandirippwa Research Station | 5.24 | 6.66 | -1.4 |
| Rathmalagara Research Center | 7.47 | 7.91 | -0.4 |
| Walpita Research Center | 1.73 | 1.88 | -0.2 |
| Pottukulama Research Center | 8.13 | 5.93 | 2.2 |
| Dunkannawa Research Center | 0.44 | 1.13 | -0.7 |
| Estates Management Division | | 3.71 | |
| **Total** | **58.62** | **50.55** | **8.1** |

Pallama Genetic Resource Center and Dunkannawa Research Center had been vested recently and therefore these two estates are in an improvement stage.

## STAFF MATTERS

### 4. APPOINTMENTS

47 appointments were given during the year 2005, and the details are given in Table 2:

Table 2 *Appointments made during the year 2005*

| Name | Designation | Division/Unit | Date |
|---|---|---|---|
| Mr. N P K Liyanage | Manager(Estates) | Estates Managements Division | 17.01.05 |
| Mr. A A Fernando | Technical Assistant | Genetics & Plant Breeding Division | 01.02.05 |
| Mr. J M D T Everard | Deputy Director(Research) | Establishment Unit | 02.02.05 |
| Dr.(Mrs) W C Fernando | Senior Research Officer | Soils & Plant Nutrition Division | 01.03.05 |
| Mrs. S M Mallawarachchi | Research Officer | Coconut Processing Research Div. | 01.04.05 |
| Mrs. K V N N Jayalath | Research Officer | Agronomy Division | 01.04.05 |
| Miss. E Pathiraja | Research Officer | Agronomy Division | 01.04.05 |
| Mr. K W L K Weerasinghe | Research Officer | Crop Protection Division | 01.04.05 |
| Miss. H D Mangalika | Administrative Officer | Establishment Unit | 01.04.05 |
| Mr. A S Nanayakkara | Administrative Assistant | Establishment Unit | 01.04.05 |
| Mr. E M Gnanaratne | Internal Auditor | Establishment Unit | 02.05.05 |
| Mr. A D N T Kumara | Assistant Research Officer | Crop Protection Division | 22.08.05 |
| Miss. D Paramasiwam | Assistant Research Officer | Soils & Plant Nutrition Division | 22.08.05 |
| Mr. A W A D R Abhayasekara | Assistant Research Officer | Agronomy Division | 22.08.05 |
| Miss N I Suawandaratne | Assistant Research Officer | Crop Protection Division | 22.08.05 |
| Mr. B A S Manjula | Assistant Research Officer | Agronomy Division | 22.08.05 |
| Mr. A R U Ratnesekara | Assistant Extension Officer | Technology Transfer Division | 22.08.05 |
| Mr. L M S R Jayathilaka | Seed & Seedling Production & Certification Officer | Genetics & Plant Breeding Division | 22.08.05 |
| Mr. H W A S Senaratne | Assistant Livestock Officer | Estates Management Division | 22.08.05 |
| Miss. H M Nadeeja | Assistant Manager (Information Systems) | Establishment Unit | 22.08.05 |
| Mr. B M A P Balasooriya | Documentation Assistant | Library | 22.08.05 |
| Mr. J A R Kelum Asanka | Assistant Chemical Engineer | Coconut Processing Research Div. | 22.08.05 |
| Mr. P G R S Premathilaka | Seed Production & Certification Assistant | Genetics & Plant Breeding Division | 22.08.05 |
| Mr. R I B C T Herath | Seed Production & Certification Assistant | Genetics & Plant Breeding Division | 22.08.05 |
| Mr. M N Nadeeranga | Seed Production & Certification Assistant | Genetics & Plant Breeding Division | 22.08.05 |
| Mr. R C M Wijayartne | Seed Production & Certification Assistant | Genetics & Plant Breeding Division | 22.08.05 |
| Mr. L J Saman | Seed Production & Certification Assistant | Genetics & Plant Breeding Division | 22.08.05 |
| Mr. A S Jayasundara | Seed Production & Certification Assistant | Genetics & Plant Breeding Division | 22.08.05 |
| Mr. D M A Leelananda | Seed Production & Certification Assistant | Genetics & Plant Breeding Division | 22.08.05 |

| | | | |
|---|---|---|---|
| Mr. S A D W Priyankara | Seed Production & Certification Assistant | Genetics & Plant Breeding Division | 22.08.05 |
| Mr. K Liyanaarachchi | Assistant Estates Superintendent | Estates Management Division | 22.08.05 |
| Mr. V H S Somasiri | Assistant Estates Superintendent | Estates Management Division | 22.08.05 |
| Mr. H B S Herath | Assistant Estates Superintendent | Estates Management Division | 22.08.05 |
| Mr. H W A N Kumara | Assistant Estates Superintendent | Estates Management Division | 22.08.05 |
| Mr. T M P A K Thilakaratne | Assistant Estates Superintendent | Estates Management Division | 22.08.05 |
| Mr. D M I S K Dewametta | Assistant Estates Superintendent | Estates Management Division | 22.08.05 |
| Mr. L R M C Liyanage | Assistant Research Officer | Soils & Plant Nutrition Division | 22.08.05 |
| Mr. M K F Nadeesha | Assistant Research Officer | Soils & Plant Nutrition Division | 22.08.05 |
| Mr. E M T Bandaranayake | Assistant Extension Officer | Technology Transfer Division | 22.08.05 |
| Mrs. J A K M Fernando | Assistant Mechanical Engineer | Coconut Processing Research Div. | 18.10.05 |
| Mr. B H C Mendis | Research Officer | Plant Physiology Division | 26.10.05 |
| Mr. M G M K Meegahakumbura | Research Officer | Genetics & Plant Breeding Division | 26.10.05 |
| Miss. H D M A C Dissanayaka | Research Officer | Genetics & Plant Breeding Division | 26.10.05 |
| Miss. K P Waidyaratne | Research Officer | Biometry Division | 26.10.05 |
| Miss. S C Somasiri | Research Officer | Agronomy Division | 26.10.05 |
| Mrs. H M I K Herath | Research Officer | Soils & Plant Nutrition Division | 26.10.05 |
| Miss. M K F Nadeesha | Research Officer | Soils & Plant Nutrition Division | 26.10.05 |

## 5. RESIGNATIONS, RETIREMENTS, VACATION OF POSTS & TERMINATIONS OF SERVICES & DEATHS

The details are given in Table 3:

**Table 3.**

| Name | Designation | Division/Unit | Date |
|---|---|---|---|
| **Resignations:** | | | |
| Mrs. S R Samarajeewa | Senior Research Officer | Agronomy Division | 15.04.05 |
| Mr. A D Samarajeewa | Senior Research Officer | Agronomy Division | 15.04.05 |
| Mr. W A C Fernando | Book Keeper | Establishment Unit | 14.03.05 |
| Mr. I H Nelson | Senior Telephone Operator | Establishment Unit | 31.10.05 |
| Mrs. P S A de Seram | Senior Technical Officer | Plant Physiology Division | 10.11.05 |
| Mr. Y M W S Bandara | Technical Assistant | Crop Protection Division | 30.11.05 |
| **Retirements:** | | | |
| Mr. N M D Chandrasoma | Senior Lab/Field Assistant | Soils & Plant Nutrition Division | 27.01.05 |
| Mr. D W Jayasena | Senior Office Attendant | Engineering Unit | 11.05.05 |
| Mr. Y H Wimalasena | Senior Electrician/Power House Operator/Plumber Fitter | Engineering Unit | 28.08.05 |
| Mr. D W J Jayakody | Foreman(Electrical) | Engineering Unit | 17.09.05 |
| Mr. G D George | Senior Technical Officer | Soils & Plant Nutrition Division | 07.11.05 |
| Mr. M H Dhanasena | Senior Lab/Field Assistant | Soils & Plant Nutrition Division | 14.12.05 |

## 6. PROMOTIONS

### 6.1 PROMOTIONS IN NON-EXECUTIVE GRADES

Following Internal Promotions in Non-Executive Grades were implemented during the year 2005, as shown in Table 4. The effective date of these promotions was 01/01/2005.

**Table 4.** ***Promotions in Non-Executive Grades during the year 2005***

| Name | Designation | Division/Unit |
|---|---|---|
| **CLASS I TO SPECIAL CLASS** | | |
| **Technical Grade** | | |
| Mr. G R A Dharmasena | Senior Technical Officer | Coconut Processing Research Division |
| **Clerical & Allied Grade** | | |
| Mrs. M G Karunawathi | Senior Clerk/Typist | Establishment Unit |
| **Operative Grade** | | |
| Mr. H P Ashoka Kumara | Senior Lab/Field Assistant | Technology Transfer Division |
| Mr. W W A P R Fernando | Senior Supervisor | Estates Management |
| Mr. A Sugathadasa | Senior Supervisor | Estates Management |
| Mr. F H A J Rail Silva | Senior Lab/Field Assistant | Soils & Plant Nutrition Division |
| Mr. S Alahakoon | Senior Supervisor | Estates Management |
| **Minor Grade** | | |
| Mr. W A S S Weerasinghe | Senior Electrician | Engineering Unit |
| **CLASS II TO CLASS I** | | |
| **Technical Grade** | | |
| Mr. M R D Perera | Technical Officer | Soils & Plant Nutrition Division |
| **Clerical Grade** | | |
| Mr. S A D Richard | Accounts Clerk | Accounts Unit |
| **Operative Grade** | | |
| Mr. K D D Appuhamy | Lab/Field Assistant | Agronomy Division |
| Mr. W R O Fernando | Lab/Field Assistant | Agronomy Division |
| Mr. K J S Perera | Lab/Field Assistant | Soils & Plant Nutrition Division |
| Mr. M A S Fernando | Supervisor | Estates Management |
| Mr. W P Fernando | Lab/Field Assistant | Agronomy Division |
| **Minor Grade** | | |
| Mr. J K Jensus Perera | Office Attendant | Establishment |

## 6.2 PROMOTIONS IN EXECUTIVE GRADES

Following Promotions in Executive Grades were implemented during the year 2005, as shown in Table 5 & 6.

**Table 5.** ***Promotions in Executive Grades during the year 2005***

**Executive Grade Class II to Class I**

| Name | Designation | Division | Effective Date |
|---|---|---|---|
| Dr. M T N Fernando | Principal Research Officer | Agronomy Division | 14.12.2004 |

**Table 6.**

**Executive Grade Class III to Class II**

| Name | Designation | Division | Effective Date |
|---|---|---|---|
| Dr.(Mrs.) V R M Vidhanaarachchi | Senior Research Officer | Tissue Culture Division | 22.03.2005 |

## 7. TRANSFERS

Mr. W M D R Wijesinghe, Supervisor – From Genetics Resource Centre, Ambakelle to Ratmalagara Research Centre on 15 January

Mr. J A Hendry Nevil , Tractor Driver – From Bandirippuwa Research Station to Transport Unit on 15 January

Miss. E Pathiraja, Research Officer – From Soils & Plant Nutrition Division to Agronomy Division 08 August

Miss. H M Nadeeja, Assistant Manager (Information Systems) – From Biometry Division to Establishment Unit on 26 August

Mr. D P S K Hettiarachchi, Estates Superintendent – From Dunkannawa Research Centre to Estates Management Division on 19 September

Mr. K G Dhanapala, Field Attendant – From Genetics Resource Centre, Makandura to Walpita Research Centre on 16 Novermber

## 8. SABBATICAL LEAVE

**Table 7.**

| Name | Designation | Period | Purpose | Institute |
|---|---|---|---|---|
| Dr. M T N Fernando | Principal Research Officer | 09.08.2005 08.08.2006 | Sabbatical Leave | United Nations Office for Project service Colombo |

## 9. LOCAL TRAININGS (More than 5 days)

Mr. K N A S Perera/Resident Engineer and Mr. A L D K Amarasinghe/Works Superintendent followed a certificate Course on Maintenance Management at the Institute of Techno Management (Pvt.) Ltd., from 12 February – 2 April (Every Saturdays)

Mr. G K Ekanayaka/Senior Technical Officer and Mr. A R A N Kumara/Technical Assistant followed a Diploma in Information Technology at Sri Lanka Institute of Development Administration From 12 March – 20 August (Every Saturdays)

Mr. E P Gunapala/Deputy Director (Adm. & Fin.) followed a Advanced English Course at Aquinas College of Higher Studies, from 12 February

Miss. H D Mangalika/Administrative Officer followed Diploma in English at Sri Lanka Institute of Development Administration one year from September (Every Sundays).

Mr. H M I K Herath/Lab/Field Assistant followed a Computer Training Programme for Office Staff at IDM Computer Studies (Pvt) Ltd., Negombo from September.

Mrs. W S Madurapperuma/Research Officer followed a Postgraduate certificate course on Advanced Biochemistry – Part I in Postgraduate Institute of Science from 23 October – December (Every Sundays).

## 10. OVERSEAS VISITS

Mr. I R Wickramananda/Senior Research Officer attended the workshop on Farmer Field School and visited Central Plantation Crop Research Institute Kayangulam , India from 01 to 06 February.

Mr. Mr. R P B H S Senaratne/Research Officer attended the IFAD funded project training workshop and Project Inception meeting in Hat Yai, Vietnam from 09-13 may

Dr.(Mrs.) C Jayasekara/Director, Coconut Research Institute participated in the Coconut Asia 2005 conference in Kochin, India from 14 – 18 June.

Dr. A A F L K Perera/Senior Research Officer participated in the proposal writing workshop and visited United Plantation where Commercial Coconut Hybrid Seed Production is carried out in Kuala Lampur , Malaysia from 19 – 25 June.

Dr.(Mrs.) C K Bandaranayaka/Senior Research Officer participated a workshop on Molecular Makers for Allele Mining Chennai, India from 21 – 27 August.

Dr.(Mrs.) L C P Fernando/Head, Crop Protection Division visited CABI, BIOSCIENCE UK to develop "Integrated Pest Management of Coconut Mite with special emphasis on "Hirsutella thampsonil" between Coconut Research Institute and CABI, BIOSCIENCE, UK from 31 August – 15 September.

Miss. S A C N Perera/ Resarch Officer visited Canberra, Australia to undertake in research project titled "Profiling of Coconut genome by diversity array technology" Canbrra, Australia from 01 June – 01 December

Mr. N A K de Silva/Research Officer, participated in the Seminar on Nuclear Safety – Radiation Application in Japan from 07 – 18 November.

Dr.(Mrs.) C Jayasekara/Director, participated in the 14$^{th}$ Steering Committee Meeting of the Coconut Genetic Resources Network (COGENT) in CPCRI, Kasaragod, India from 27 November – 02 December

## 11. OVERSEAS TRAININGS

Mrs. H D D Bandupriya/Research Officer followed a short-term training in Cryo- preservation of Coconut Plumules at the Institute for Research and Development (IRD), France from 02 February – 30 March.

Dr.(Mrs.) C K Bandaranayaka/Senior Research Officer followed a three months short-term training under the Generation Challenge Programme in the field of Association mapping at the IRD, Montpellier, France from 01 September – 30 November.

Mr. K D P P Gunathilaka/Research Officer followed a training on Food Industry & Agribusiness, Wagangen University, Netherlands from 15 September – 20 November.

## 12. TRANSPORT UNIT

Administration of the staff of the unit including drivers and maintenance of the following fleet of vehicles were done by the Transport Unit during the year 2005.

| | | |
|---|---|---|
| Buses | - | 03 |
| Lorries | - | 02 |
| Vans | - | 08 |
| Cars | - | 01 |
| Cabs | - | 13 |
| Jeeps | - | 05 |
| Motor bicycles | - | 52 |
| Three Wheelers | - | 02 |

## 13. FINANCE UNIT

Total budgetary allocation for this year is 123 million and out of which 96.8 million under recurrent and 26.1 million under capital expenditure. Income forecast for this year was 12.238 million. Therefore the government grant was 103.1 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.

## 14. 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 2005.

- Supply, Installation and commissioning of Drip Irrigation System for Ambakelle Genetic Resource Centre
- Construction of Pump House (02 Nos.) at Genetic Resource Centre at Ambakelle.
- Rehabilitation to Existing Roads at Bandirippuwa Research Centre
- Renovation of Coconut Processing Research Division Office
- Construction of Proposed Agriculture Economics Division at Bandirippuwa Research Centre
- Renovation of staff quarters BE/GR/III/34 at Bandirippuwa Research Centre
- Renovation of staff quarters BE/GR/III/23 at Bandirippuwa Research Centre
- Renovation of staff quarters BE/GR/I/16 at Bandirippuwa Research Centre
- Renovation of staff quarters BE/GR/I/22 at Bandirippuwa Research Centre
- Dug well at Demonstration Farm in Thabbowa.
- Boundary wall & Gate at Middeniya Research Station
- Proposed office & Training Building at Middeniya Research Centre

## STAFF PUBLICATIONS AND COMMUNICATIONS AT SCIENTIFIC MEETING

## JOURNLS, PRESENTATIONS AT SEMINAR/WORKSHOPS AND SCIENTIFIC SESSIONS

### Staff Publications/Communication

**Balasuriya, B. K. A., Bandupriya, H. D. D. and Fernando, S. C. (2005).** Effect of Abscisic acid as a cryoprotectant on the survival of cryopreserved plumules and mature zygotic embryos of coconut *(Cocos nucifera L.)*. In Proceedings of 5th Agricultural Research Symposium Part 1:24. Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka, Makandura.

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**Fernando, M. T. N., Jayalath, K. V. N. N. and Dissanayake, A. M. U. (2005).** Trends in land extent under coconuts within two decades (1982-2002): Evidence from fifteen districts in Sri Lanka, *Economic Review*, 10pp.

**Fernando, M. T. N., Samarajeewa, S. J. N. and Jayalath K. V. N. N. R., Dassanayake, K. B., Subasinghe S. D. (2005).** *Coir Fibre Pith Industry in Sri Lanka.* Coconut Research Institute of Sri Lanka.

**Fernando, M. T. N. and Jayalath, K. V. N. N. (2005).** Establishment and Maintenance Cost and Returns of A Typical Coconut Plantation. *Technology Update* (2). Coconut Research Institute of Sri Lanka.

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**Madurapperuma, W.S. (2005).** Root exudation of two different rice varieties grown at different nutrient concentration levels. Proc. Sri Lanka Association for the Advancement of Science, 61, 47.

**Marikkar, J. M. N., Ghazalia, H. M., Che Man, Y. B., Peiris, T. S. G. and Lai, O. M. (2005).** Use of gas liquid chromatography in combination with pancreatic lipolysis and multivariate data analysis techniques for identification of lard contamination in some vegetable oils. *Food Chem*istry, 90, 23-30.

**Marikkar, J. M. N., Ghazali, H. M., Che Man, Y. B., Peiris, T. S. G. and Lai, O. M. (2005).** Distinguishing lard from other animal fats in admixtures of some vegetable oils using liquid chromatographic data coupled with multivariate data analysis. *Food Chemistry,* 90, 30-35.

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**Tennakoon, N. A. (2005).** Fertilizer recommendation for coconut. Paper presented at the Seminar on Efficient Land Utilization in the Estate Sector on Research Priorities in Coconut Cultivation held in Sri Lanka Association for the Advancement of Science Auditorium, Colombo, Sri Lanka, 6th July, 2005.

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**Tennakoon, N. A. (2005).** Soil fertility status and fertilizer recommendation for coconut in Sri Lanka. Paper presented at the Seminar on Intermation Potassium held in Sri Lanka Foundation Institute, Colombo, Sri Lanka, and 3rd December 2005.

**Wickramananda, I. R., De Silva P. H. P. R., Sarathchandra, S. R., Kumara, A. D. N. T. and Rajapakse, R. H. S. (2005).** A method for *in vitro* culture of coconut mite (*Aceria guerreronis).* In Proceedings of International Conference of the Coconut Research Institute of Sri Lanka. Part II (Contributed papers) pp 229-236. (Eds: T.S.G. Peiris and C.S. Ranasinghe) Coconut Research Institute of Sri Lanka, Lunuwila 61150, Sri Lanka.

**Academic and professional Activities**

**Miss S.A.C.N. Perera was awarded PhD degree by the University of Birmingham, UK.**

Dr. L Perera, Dr. (Mrs.) C K Bandaranayake and Dr. (Miss) S A C N Perera served as visiting lecturers at the Faculty of Livestock, Fisheries and Nutrition, Wayamba University of Sri Lanka.

Dr. L Perera served as a judge for the biotechnology session of the 5th Agricultural Research Symposium of Wayamba University of Sri Lanka, 27-28 September 20045

Dr. L Perera served as a judge for the biotechnology session of the 17th Annual Congress of Postgraduate Institute of Agriculture, PGRC, Peradeniya from 27 to 28 November 2005.

Dr. L Perera served as referee of research papers (biotechnology) to Tea Science Journal of the Tea Research Institute, Sri Lanka, Journal of the National Science Foundation of Sri Lanka and an International "New Zealand Journal of Crop and Horticultural Science"

Dr. (Mrs.) C K Bandaranayake served as a referee for research papers submitted to PGIA Annual Congress, 2005 and ASDA, 2005.

Dr. (Mrs.) C K Bandaranayake supervised the research project of Mr. Kelum Jayasignha, Undergraduate, Wayamba University of Sri Lanka

Dr. N.A. Tennakoon supervised B.Sc (Agric) final year project of Miss. J.A.D.S.S. Jayakody in University of Wayamba. The title of the project was "Assessment of the available phosphorus in two soil series under different fertilizer used for coconut in Gampaha District".

Dr. N.A. Tennakoon supervised B.Sc (Agric) final year project of Mr. M.H.M. Anezh in University of Wayamba. The title of the project was "Amount of the exchangeable potassium and magnesium in two soil series under different fertilizers used for coconut in Gampaha District".

Dr.(Mrs). W.C. Fernando and Dr. N.A. Tennakoon supervised final year Botany special course project of Mr. K.Karunanayake in University of Kelaniya. The title of the project was "Soil physicochemical status and the occurrence of Arbuscular Mycorrhizal fungi in the rhizosphere of coconut palms affected by Rapid Decline and Leaf Scorch Decline in Makandura Research Station".

**Extension activities**

Dr. N.A. Tennakoon participated as a resource person in 5 programmes on Usage of Eppawela Rock Phosphate for coconut held in Pannala, Kegalle, Rathnapura, Gampola and Polgahawela organized by Phosphate Lanka Pvt. Ltd., Colombo.

Dr. N.A. Tennakoon participated as a resource person in training programme conducted by Coconut

Development Training Centre and NIPM.

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

The division staff involved in organizing and conducting the first programme of the One day training programme series of year 2005 of the CRI on "Replanting of coconut" at the Isolated Seed garden, Ambakelle.

The division staff participated in many exhibitions and field days organized by CRI, CCB and other various organizers and conducted field demonstrations.
The division staff delivered lectures to many groups of students, farmers, and growers who visited CRI.

The number of clients who visited the division in search of technical knowledge during the year exceeded three hundred. In addition a substantial number of school children, students of technical colleges, undergraduates and graduates visited the division, molecular biology laboratory and the Isolated Seed Garden at Ambakelle.

Division staff engaged in selection of seed palm estates and selection and reselection of seed palms for CCB in several estates.

**Visitors**

Dr. Patricia Lebrun, Molecular biologist and Miss. Angelique Burger, Technician of CIRAD France visited the division from 2 to 8 December 2005

**Meetings, workshops and seminar participation**

Dr. L Perera participated as a resource person and delivered a lecture on "Global status of GMO/GMF" at the regional training programme on "Detection of Genetically Modified Organisms, Food, Feed and Processed products", Biotech Centre, Peradeniya from 17-18 February 2005.

Dr. L Perera participated and delivered a talk on "Recommended coconut cultivars in Sri Lanka" to the applicants of private coconut seedlings dealers, CCB Auditorium, Colombo, 23 March 2005

Dr. L Perera served as a resource person for the workshop on "Future directions in crop improvement research" and delivered a lecture on "Current status and future directions in breeding coconut". In-Service Institute of Department of Agriculture, Gannoruwa, 04 April 2005, organized by the Sri Lanka Council for Agricultural Research Policy (CARP), Sri Lanka.

Dr. L Perera served as a resource person for the symposium on "Application of biotechnology in Agriculture" and delivered a lecture on "Molecular markers in coconut breeding: Current status and future possibilities". Hector Kobbakaduwa Agrarian Research and Training Institute, Colombo, 12 October 2005.

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