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HIGH LEVEL ADVICE ON THE DEVELOPMENT OF A HERBAL BASED
R & D PROGRAMME FOR INDUSTRY

SI/SRL/96/802/11-53/0730AO

SRI LANKA

Technical report *

Prepared for the Government of Sri Lanka
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of C.L. Tikoo
Pilot Plant Technologist

Project Manager: Tuley De Silva
Chemical Industries Branch

United Nations Industrial Development Organization
Vienna, Austria

* This document has not been edited

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ABBREVIATIONS

ANMAP	-	Asian Network on Medicinal and Aromatic Plants
BMARI	-	Bandaranaike Memorial Ayurvedic Research Institute, Ministry of Indigenous Medicine
CARP	-	Council for Agricultural and Research Policy
CISIR	-	Ceylon Institute of Industrial and Scientific Research
IUCN	-	International Union for the Conservation of Nature
NARESA	-	Natural Resources, Energy and Science Authority of Sri Lanka

ABSTRACT

Title of the Project : High level advice in setting up of a goal oriented research and development programme in CISIR to promote phytopharmaceutical and essential oil industry in Sri Lanka.

No. of the Project : SI/SRL/96/802

Objective and duration of activity : The activity started in Sri Lanka from 29 August to 11 September 1996. The objective of the mission was to assist in preparing a goal oriented research and development programme to promote the phytopharmaceutical industry in Sri Lanka by developing expertise in process technology on pilot scale for the production of value added herbal preparations and essential oils.

Sri Lanka is in an enviable position by virtue of its biodiversity and ranges of habitat and climate to develop a significant global phytopharmaceutical industry and essential oil industry. She has a widespread Ayurvedic medicinal industry but significant technological input is required for this not only to become a player on the world scene but to improve its products for internal consumption.

There is a considerable scope for the development of other (non-Ayurvedic) value-added herbal products which can significantly contribute to the economy of Sri Lanka. CISIR is well placed to lead these initiatives but current constraints and operating difficulties need to be urgently redressed to fulfill its potential. One way in which this may be achieved is through the creation of a commercial arm.

Increased emphasis should be placed on the undertaking of suitably directed research projects at CISIR. The consultants feel that much of this could be market-led and financed. Quality control must be improved. CISIR should play the leading role in this activity both for Ayurvedic preparations and other plant-based products.

Non-Ayurvedic plant products could be developed such as value added herbal extracts, isolates and processed oils.

The consultant carried out the duties as given in the job description in Annexure 1, successfully.

This comprehensive report prepared by the consultant gives an account of the activities carried out by him during his mission.

1. INTRODUCTION

During the mission, visits to various industries, institutions and field trips to various agronomical farms and gardens in the field of herbal drugs and essential oils were undertaken. The list of industries and institutions visited is given in Annexure 8. Discussions with the representatives of various industries and staff of CISIR were held to assess the present status of technological development in the field of herbal drugs and essential oils. The list of people met is given in Annexure 7.

The consultant observed the constraints and difficulties faced by the industries visited and also shortcomings of CISIR in transferring the technologies to the user industry and has come out with remedial measures and recommendations to be followed by CISIR so that the present technologies of user industries could be updated and new technologies could be developed and transferred to industries by CISIR in the field of *phytopharmaceutical and essential oil industry*.

The objective of the mission was to assess the status of pilot scale production of herbal drugs presently carried out at CISIR, discuss the problems and constraints faced by CISIR in the pilot plant scale production and recommend remedial measures, advise counterpart staff on methodology to be used in developing process and quality parameters, demonstrate the use of pilot plant extraction methods and prepare an action oriented R&D programme in pilot production needed for the development of the phytopharmaceutical industry in Sri Lanka.

The objectives of the mission have been fulfilled except that demonstrations to the counterpart staff on the use of pilot plant extraction methods could not be carried out by the consultant as no work was ongoing in the pilot plant due to equipment being non functional for the pilot plant extraction methods.

2. ACTIVITIES

The consultant during his mission visited a number of phytopharmaceutical and essential oil industries including pine oleoresin unit which are in the process of producing herbal extracts, Ayurvedic preparations essential oils, oleoresins, and pine oleoresin and discussed at length about the constraints and difficulties they are facing at the production level due to lack of proper technology.

Two field trips were undertaken, the first was to the hill country to visit the Botanical Garden at Peradeniya, the Research Station of the Department of Export Agriculture at Matale, the field station of CISIR (part of the Mahaweli Development Programme) at Girandurukotte, the Ayurvedic Herbal Gardens at Haldumulla and the pine oleoresin production unit of Conifer Products Processing (Pvt) Ltd., at Nugathalawa. The second visit was 'down south' to visit the small scale field production facilities (e.g. at Moratuwa) of companies producing a number of essential oils, mostly from cinnamon bark, cinnamon leaf, clove and nutmeg.

The consultant visited the CISIR, which is the premier Institute of its kind in whole of Sri Lanka. It is expected to have capabilities to carry out R&D work for the generation of viable technologies in various fields including essential oil and phytopharmaceuticals through process development, process optimization and scale up and technology transfer to the user industry. Since the consultant perceived a big gap in technology transfer from CISIR to the user industry in the field of essential oils and phytopharmaceuticals, it became necessary for the consultant to have discussions with the management of CISIR regarding the seriousness of the problem.

Discussions were held with Dr. R.O.B. Wijesekera, Chairman of the Institute, Dr. P.M. Jayatissa, Director of the Institute and Ms. N.T. Amarasinghe, Manager, Pilot Plant. Various issues were taken up and

discussed and it was felt that the consultant should visit the pilot plant and assess the present status, deficiencies and constraints so that the gap in technology transfer between CISIR and user industry could be bridged by taking remedial measures.

The consultant visited the process and plant division of CISIR which has the pilot plant, Design Engineering Section, a Workshop responsible for process optimization and scale up, design of chemical plants and its fabrication and development of technologies on turn-key basis. The pilot plant is equipped with various equipment and machinery to carry out different unit operations and unit processes. These were inspected by the consultant. The list of equipment and machinery in the pilot plant is given in Annexure 3. The members of the pilot plant group are given in Annexure 4.

3. FINDINGS

It has been observed that the industries in the field of essential oils and phytopharmaceuticals are carrying out the production of their products in a most disorganized and inefficient manner by using primitive and outdated process technologies with the result their products are of poor quality and the cost of production is very much on the higher level.

These industries have no R & D facilities to update their existing technologies to improve the quality of their products and also determine the cost effectiveness and no capacity to absorb new technologies.

Use of direct fire through firewood or gas stoves while making decoctions/extracts and other Herbal and Ayurvedic preparations is in practice.

Extracts are being prepared in open pans without any insulation leading to tremendous heat loss.

The operations are carried out manually which has made it labour oriented.

No strict process parameters and process controls are adhered, to control the quality of the product.

Distillation of essential oil bearing plant materials is also being carried out by using fire wood.

The Distillation Stills used are of primitive design and coil type condensers dipped in water tanks are most inefficient resulting in low recovery and oil of inferior quality.

The oil separators to trap the oil are defective resulting in the loss of oil.

The pine oleoresin plant recently set up at Upali Organization Pvt. Ltd., Uvathanna, Kalupahana, is a classical example of primitive design and outdated technology. The melting of the resin and its distillation to produce rosin and turpentine oil is being carried out by using direct fire which deteriorates the quality of rosin. The condenser of the unit is under capacity which gives rise to very hot condensate leading to loss of turpentine oil. No proper conditions and controls are adhered, to control the quality of the product.

At present, no pilot scale production is being carried out on process development and scale up in the field of herbal drugs and essential oils at the CISIR. In the past, little work has been done in essential oil field but no proven technology has been generated by CISIR which could have been transferred to the industry.

Discussions were held with pilot plant and workshop group to find out constraints and problems faced by pilot plant for pilot scale, production, design of chemical equipment and its fabrication in the field of herbal drugs and essential oils and why technologies in this field were not developed for the user industry.

4. CONSTRAINTS AND PROBLEMS IN PILOT PLANT AND WORKSHOP

It was observed that some equipment and machinery in the pilot plant unit were non functional and required to be either modified or repaired to make these functional. The list of equipment which needs to be either modified or rectified is given in Annexure 3.

Lack of additional inputs to pilot plant by way of procuring new equipment and machinery to update the pilot plant facilities.

No facility is available in pilot plant to develop distillation technology on materials of leafy or grassy nature.

Although a glass fractionating column of 10 liter capacity is available, it is not in a working condition and also the capacity of this unit is so small that no pilot scale technology can be developed in the field of essential oil fractionation.

Lack of methodology to be adopted in process scale up and quality parameters.

Lack of competent and trained staff to carry out pilot scale production in the field of essential oils and herbal drugs.

There are no processes at present in hand which could be taken up for scale up.

Lack of direction in identifying the projects.

Lack of coordination between the pilot plant staff and the management.

No link and liaison between the user industry and CISIR in general and pilot plant staff in particular.

Lack of leadership and coordination within the discipline.

Financial crunch to carry out process development work.

Workshop facilities are very good. The staff is quite adequate. However, training to welders in the art of stainless steel welding is very much needed. The list of machines available and the staff working in workshop is given in Annexure 6.

5. RECOMMENDATIONS

Necessary steps should be taken to update pilot plant facilities, by way of modifying/rectifying some of the existing equipment. The necessary recommendations for modifying and rectifying some of the existing equipment are given in Annexure 3.

Steps should be taken to procure some additional equipment and machinery very much needed for updating pilot plant facilities. (Details of additional input of plant machinery is given in Annexure 2).

Some projects in the field of herbal drugs, essential oils and oleoresins and development of technologies on pilot scale should be identified.

A qualified Chemical Engineer (Chief Co-ordinator) at senior level who can guide and organize pilot plant process development work and design of chemical equipment (Job description given in Annexure 5) should be recruited.

At least 2 qualified chemical engineers at junior level to carry out pilot production and process scale up (Job description given in Annexure 6) should be recruited.

Training should be imparted on existing staff in process development and process scale up methodology.

Link and liaison to be created between CISIR and user industry to know their problems and up date their technologies. For this a liaison cell has to be setup within CISIR to create contacts and gain confidence of the user industry which are at present very much apprehensive about the competence of CISIR capabilities.

On the spot demonstrations should be carried out by pilot plant staff to convince user industry about the proven technologies developed by CISIR in the field of herbal drugs and essential oils.

Steps should be taken to seek financial assistance through the Government of Sri Lanka from international agencies or funding organizations to meet the financial inputs for updating pilot plant equipment and machinery.

The consultant is of the firm opinion that if the pilot plant equipment and machinery required for the process development of herbal drugs and essential oils are not updated and the qualified staff not recruited, new technologies can neither be developed nor existing technologies in the user industry can be improved by CISIR with the result, a very important export oriented industry in the field of herbal drugs and essential oil may face a crisis in the near future resulting in a great loss to this country in general and the concerned industries in particular.

6. ACTION ORIENTED R & D PROGRAMME

Immediate steps should be taken by CISIR management to look into the problems faced by phytopharmaceutical and essential oil industry and come out with solutions to update their existing technologies and provide proven technologies developed by the Institute to bring cost effectiveness on production level and improvement on quality of the products they produce.

To approach industries to sponsor the projects where they need help to adopt new technologies or want improvisations in the technologies under use.

To develop appropriate pilot production facilities in the Institute and prepare an action oriented R & D programme related to herbal extraction, Ayurvedic drug preparation, distillation of cinnamon bark, cinnamon leaves, nutmeg and cloves which are priorities of the industry.

To approach the Government of Sri Lanka and other international agencies through collaborative or bilateral programmes to seek financial assistance to implement the action oriented R & D programme in this area.

To set up a liaison cell in the Institute to bridge the missing link between the Institute and the user industry.

To build up a sense of confidence among industrialists in the working culture of CISIR by way of giving on the spot demonstrations on the technologies developed.

To create a work culture among pilot plant and workshop staff by providing top leadership who can organize, coordinate and guide pilot plant and workshop activities to achieve success in time bound projects.

JOB DESCRIPTION
SI/SRL/96/802/11-53/0730AO

- Post title : Consultant in Pilot Plant Technology
- Duration : 0.5 m/m
- Date required : ASAP
- Duty station : Colombo, Sri Lanka
- Purpose of Project : To assist in setting up of a goal oriented research and development programme to promote the phytopharmaceutical industry in Sri Lanka by developing expertise in quality control, agrotechnology and process technology for the production of value added herbal preparations.
- Duties
- Assess the status of pilot scale production of herbal drugs presently carried out at the Ceylon Institute of Scientific and Industrial Research (CISIR) and other institutes.
 - Discuss the problems and constraints faced by CISIR in the pilot plant scale production and recommend remedial measures.
 - Advise counterpart staff on methodology to be used in developing process and quality parameters during pilot plant production.
 - Demonstrate the use of pilot plant extraction methods.
 - Prepare an action oriented R&D programme in pilot production needed for the development of the phytopharmaceutical industry in Sri Lanka.
 - Recommend measures to be undertaken in order to develop the pilot plant unit.
 - Submit a comprehensive report (in a hard copy and on a diskette using word perfect 5.1/5.2) on his findings and recommendations for a goal oriented R and D programme to promote and service the phtopharmaceutical industry in Sri Lanka.

ADDITIONAL INPUTS TO PILOT PLANT

1. Modern Steam Distillation Unit

Distillation Vessel	:	250 liter total volume
Vapour pipe line	:	62 mm dia
Condenser	:	shell and tube
Condenser shell	:	175 mm dia
Condenser bonnets	:	150 mm dia x 150 mm
Tube length	:	1500 mm
Tube dia	:	20 mm ID x 14 G.
No. of tubes	:	16 nos.
M.O.C.	:	Shell M.S.
Tubes	:	S.s. 304
Shell thickness	:	3 mm

The S.S. Shell to be provided with 3 mm thick M.S. Jacket. Condenser to be connected with vapour line horizontally at a slope of 75mm. Primary and secondary oil separators each separator of 300 mm dia x 450 mm long to be provided with a inside partition. The vapour line to be provided with 62 mm ball valve.

The configuration of piping should be such that the unit should work under:

- a. steam distillation under atmospheric pressure
- b. steam distillation under pressure
- c. hydrodistillation under cohabitation

2. Fractional distillation unit specifications

- a. Reboiler cap. 100 liters total
- b. Working cap. 75 liters
 - Column dia 100 mm
 - Column height 6000 mm
 - Packing material schulzer or hyflux
 - Boil up rate 50 liters/hr
 - Shell and tube condenser - 2 sqmt
 - Product cooler 1 sqmt.
 - Receivers 2 nos. of 10 lit cap each.

The Reboiler to be provided with a M.S. jacket and internal cooling coil of 2 sqmt heating area. A oil sealed vacuum pump with displacement capacity of 3000 lit/min at 1 mm Hg vacuum to be connected to the top condenser through a vapor trap (chiller) which is connected to existing chilling plant.

The fractionating column to be provided with A solenoid valve operating on a timer to control the reflux. The unit to be provided with all inter-connecting pipe lines and mounted on a steel structure. M.O.C. of the contact parts to be S.S. 304.

The modern distillation unit and fractionating column can be fabricated in CISIR workshop who have the competence and facilities to take up fabricational work.

3. All glass Rotavac of 10 liter capacity provided with high vacuum pump of the order of 0.5 mm Hg Vacuum with cryogenic trap for removal of lost traces of solvent in oleoresins.
4. A sparkler filter press having of six disc plates of 300 mm dia with a built in high pressure feed pump for removing fine particles from a fermented broth.
M.O.C. all contact parts S.S. 304
5. Wood cutting and chipping machine to have 50 kg/hr cap to cut and chip hardy/woody material to make it suitable for disintegration in a hammer mill.
6. Tablet making machine.
7. Tablet coating machine.
8. Bottling and sealing machine.
9. Homogenizer of 50 liter capacity.
10. Granulating machine and mixer.

**LIST OF EQUIPMENT AVAILABLE IN THE PROCESS AND PLANT ENGINEERING DIVISION
WITH MODIFICATIONS/RECTIFICATIONS REQUIRED ON SOME OF THE EQUIPMENT.**

	<u>Equipment</u>	<u>Features</u>	<u>Remarks</u>
1.	Vacuum still	capacity:45L/batch maxm.	working order
2.	High speed centrifuge	capacity:liquid feed rate of 30-40 l per hr	working order
3.	Tray drier (oil fired)	capacity:100 - 200 kg per batch 30°C - 100°C	working order
4.	Oil Expeller	Capacity: feed rate 20 - 50 kg/hr	working order
5.	Ribbon mixer	Capacity: 50 kg of material/batch	working order
6.	Universal Grinder	Capacity: Feed rate 40 - 60 kg/hr of cereals and grains	working order
7.	Vibratory screen	Capacity:Feed rate 10 - 20 kg/hr	working order
8.	Plate Heat Exchanger	Capacity:25 kcal/hr	working order
9.	Toothed colloid Mill (wet grinder)	Capacity:20 kg/hr	working order
10.	Colloid Mill	Capacity:20 l/hr	working order
11.	Plate and Frame Filter Press	Capacity:2-4 l/min	working order
12.	Cross Beater Mill	Capacity:5-10 kg/hr	working order
13.	Hammer mill	Capacity:1-2 kg/hr	working order
14.	Jaw Crusher	Capacity:1 kg/hr	working order
15.	Disc Grinder	Capacity:2-3 kg/hr	working order

16.	Roll Mill (Adjustable)	Capacity:2-3 kg/hr	working order
17.	End Runner Mill	Capacity:1 kg/hr	working order
18.	Twin blade Universal Mixer	Capacity:25 liters	working order
19.	Multi Purpose Extraction unit	Capacity:15 kg/batch	working order *
20.	Fruit Pulper	5 - 10 kg/hr	working order
21.	Snow Maker	3 kg/large cylinder	working order
22.	Mincer	10-20 kg/hr	working order
23.	Liquid/Liquid Extractor		working order

* This multipurpose unit needs following modifications to make it properly functional. The unit is being used without any insulation. Proper insulation to extractor body, vapour line, reboiler and its vapour line is to be provided with glass wool. Provision to be made to provide cohabitation system by connecting the drain of the separator to the bottom of the still with a S.S. pipe through a U tube seal. The condenser of the reboiler should be followed by a chiller to avoid solvent losses during solvent recovery under vacuum. This chiller should be fixed between the condenser and the receiver and to be connected with existing chilling plant for brine circulation. The chiller could be made out of a S.S. 304 coil having 1 sqmt. cooling surface housed in closed M.S. cylindrical vessel with provision to circulate brine solution outside the coil.

	<u>Equipment</u>	<u>Features</u>	<u>Remarks</u>
1.	Wiped Film Evaporator	capacity:for tea extract 10l/hr	product pump and distillate pump need replacement.
2.	Continuous Extractor	Capacity:10kg raw material/hr	Hot water circulation system of the feed rate: 8-10kg/hr trough,feed water heating element and trough inclination system need replacement.
3.	Twin screw extruder	Capacity:feed rate 10 -25 kg/hr	Needs replacement of armature of the dc drive motor.
4.	Belt Drier	Capacity: 3-5 kg/hr	Not in use
5.	Fractionating column	10 l. capacity	Needs replacement of high vacuum pump.

6. Spray Drier

Capacity:Product
rate 3-5 kg/hr

Pre-setting and controlling of temperature of hot air is not possible due to non availability of the controlling system. Non availability of nozzle type atomizer. **

** This should be provided by procuring a thermostatic control range 0-200°C with a sensor fitted to the unit. A nozzle type atomizer or a nozzle of a oil burner to be incorporated in the system so that this unit can be put into operation.

PILOT PLANT GROUP

- | | | | |
|-----|--|---|---|
| 1. | Mr. P. Gunawardena
C.Eng., MI Mech.Eng.(London)
F.I.E. (S.L.), H.N.D. (Mech.) | - | Head, Process & Plant
Engineering Division |
| 2. | Ms.N.T. Amarasinghe
Dip., M.Sc. (Chem.Eng.) Bradford
C.Eng., M.I. Chem. Eng., F.I.E.D. | - | Manager, Pilot Plant |
| 3. | Mr. N.A.T.D. Gunasekera
B.Sc. (Chem.Eng.) | - | Research Officer
(On contract basis) |
| 4. | Ms. P.L.C. Dias
N.D.T. (Chem.Eng.)
M.I.E.D. | - | Senior Technical Officer |
| 5. | Mr. P. Jeyachandran
N.D.T. (Mech.Eng.) | - | Senior Technical Officer |
| 6. | Mr. M.S.N. Perera
N.D.T. (Chem.Eng.) | - | Technical Assistant |
| 7. | Mr. J.A.P.V. Jayasinghe
N.D.T. (Chem. Eng.) | - | Technical Assistant |
| 8. | Mr. A.A.V. Amarasinghe
N.D.T. (Chem.Eng.) | - | Technical Assistant |
| 9. | Mr. M.S. Mannapperuma | - | Technical Assistant |
| 10. | Ms. Y. Athukorala | - | Draughtsman |
| 11. | Ms. K.P.R.T. Perera | - | Clerk/Typist |
| 12. | Mr. G. Sirisena | - | Glass Blower |
| 13. | Mr. D.M. Weerawardena | - | Boiler Operator |
| 14. | Mr. M. Dayananda | - | Electrician |
| 15. | Mr. B.W. Prematileka | - | Lab Attendant |

**LIST OF ADDITIONAL STAFF IN THE PILOT PLANT
WITH QUALIFICATION AND JOB DESCRIPTION**

Post: Chief Coordinator (Chemical Engineering)

Qualifications: A Ph.D. in Chemical Engineering with 10 years of experience in R & D and production of herbal drugs in the field of phytopharmaceuticals.

The incumbent should have leadership and organizing abilities to organize, guide and coordinate R & D activities in Pilot Production, Design Engineering and Plant fabrication.

Post : Process Engineer - 02 posts

A masters degree in Chemical Engineering with 5 years experience in process development and pilot production in the field of phytopharmaceuticals and essential oils. The incumbent should have adequate knowledge of process optimization and scale up in producing herbal drugs and essential oils.

MACHINERY AVAILABLE AT WORKSHOP

3 nos.	Center lathes (mid size)
1 no.	Universal Milling Machine
1 no.	Shaping Machine
1 no.	Surface Grinder
3 nos.	Upright drilling machines
1 no.	Manual guillotine shear
1 no.	Light duty plate rolling machine
1 no.	Welding machine
1 no.	Plasma Cutter
1 no.	Tig welding machine
1 no.	Power hammer
1 no.	Bending machine
1 no.	Fly Press
1 no.	Spray painting machine
1 no.	Multi Purpose wood working machine
1 no.	Cross cutting machine
1 no.	Band saw
1 no.	Power Hacksaw
1 no.	Gas welding/cutter set.

LIST OF WORKERS AT WORKSHOP AND THEIR SKILLS

1.	G.V.D. Ranjithsena	Lathe Machinist
2.	L.N.P. Fernando	Lathe Machinist
3.	W.P. Weerawardena	Machinist - Contract
4.	V.D. Ganegoda	Fitter
5.	C.G. Fonseka	Welder/Fitter
6.	M.K. Piyalal	Welder
7.	W. Rozairo	Carpenter
8.	S. Solaman	Carpenter
9.	W. Coonghe	Carpenter
10.	M.U. Nimalsiri	Carpenter
11.	N.L. Perera	Carpenter
12.	G. Sarath Kumara	Carpenter
13.	N. Weerasinghe	Electrician
14.	D. Wijeratne	Electrician
15.	J. Sujeewa	Electrician
16.	U. Amarajeewa	Motor Mechanic
17.	B. Jayawardena	Motor Mechanic
18.	S. R. Rodrigo	Labour
19.	U.A. Kannangara	Labour
20.	C. Witharana	Labour

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21.	E. Premadasa	Fitter
22.	H.K. Somasiri	Painter
23.	D.L. Amarasinghe	Painter
24.	L.D. Thilakeratne	Tool Issuer
25.	S.P. Dharmaratne	Clerk/Typist
26.	R. Chandana	Casual

CHARGE HAND

1.	W.T. Fernando	(Garage)
2.	D.W. Wijesuriya	(Carpentry)
3.	D. Dantanarayana	(Electrical)
4.	P.A. Robinson	(Fitting & Welding)

List of people met

N T Amarasinghe	Manager, Pilot Plant, Process and Plant Engineering Division, CISIR, PO Box 787, Bauddaloka Mawatha, Colombo 7
L S R Arambewela	Senior Research Officer, CISIR, P O Box 787, Bauddhaloka Mawatha, Colombo 7
R Bahardeen	General Manager, Bio Extracts (Pvt) Ltd., Orugodawatte and 10 Mile Post Road, Colombo 3
K R Dayananda	Senior Research Officer, Natural Products Development Group/AFTD, CISIR, 363 Bauddhaloka Mawatha, Colombo 7
N D Ediriweera	Head, Agro and Food Technology Division, CISIR, PO Box 787, 363 Bauddhaloka Road, Colombo 7
H P M Gunasena	Chairman, Faculty of Agriculture, University of Peradeniya
S Jayakody	Factory Manager, Link Natural Products (Private) Ltd., Malinda, Kapugoda
P Jayanetti	Senior Scientist, Department of Ayurveda, Bandaranaike Memorial Ayurvedic Research Institute, Navinna, Maharagama
S Jayasinghe	Manager, Services, Agro and Food Technology Division, CISIR, PO Box 787, 363 Baudhaloka Mawatha, Colombo 7
P M Jayatissa	Director, CISIR, 363 Bauddhaloka Mawatha, Colombo 7
W Jayawardena	Chairman, Link Natural Products (Pvt) Ltd., 97A Galle Road, Colombo 3
N Karunatilake	Chief Quality Controller, Bio Extracts (Pvt) Ltd., 10 Mile Post Avenue, Colombo 3
P M Kavikara	Managing Director, D Peiris & Co Ltd., 31 St. John's Road, Colombo 11
D Nuguwela	Managing Director, Link Natural Products (Private) Ltd., 97A Galle Road, Colombo 3
D A Perera	Managing Partner, Eoas International, 34/3 Lumbini Avenue, Ratmalana
J Ranatunga	Senior Research Officer, Agro Food Technology Division, CISIR, 363 Bauddhaloka Mawatha, Colombo 7
C K Samaraweera	Managing Director, Conifer Products Processing (Pvt) Ltd., Green Gables, Nugathalawa

L Senaratne	Acting Assistant Director, Bandaranaike Memorial Ayurvedic Research Institute, Nawinna, Maharagama
J Weerasinghe	Superintendent, Ayurveda Drugs, Hettigoda Industries (Pvt) Ltd., 33/3 Sri Dharamarama Road, Ratmalana
P J Wickremasinghe	Deputy Director, Research Field Station, Ministry of Export Agriculture, Matale
L M Wijesundra	Chief Pharmaceutist, Sri Lanka Ayurvedic Herbal Products Company, PO Box 20, Navinna, Maharagama
R O B Wijsekera	Chairman, CISIR, 363 Bauddhaloka Mawatha, Colombo 7

List of Institutions and Organizations visited

Bandaranaike Memorial Ayurvedic Research Institute, Navinna, Maharagama.

Bio Extracts (Pvt) Ltd., 10 Mile Post Road, Colombo 3.

Botanic Garden, University of Peradeniya.

CISIR.

Conifer Products Processing (Pvt) Ltd., Green Gables, Nugathalawa.

Department of Export Agriculture, Research Station, Matale.

EOAS International, 34/3 Lumbini Avenue, Ratmalana.

Hettigoda Industries (Pvt) Ltd., 33/3 Sri Dharamarama Road, Ratmalana.

IUCN Sri Lanka Country Office, 7 Vajira Lane, Colombo 7.

Link Natural Products (Private) Ltd., Malinda, Kapugoda.

Ministry of Indigenous Medicine, Herbal and Medicinal Plant Garden, Haldummulla.

Natural Resources, Energy and Science Authority of Sri Lanka, 47/5 Maitland Place, Colombo 7.

Sri Lanka Ayurvedic Herbal Products Corporation, Ministry of Indigenous Medicine, 94 Old Kottawa Road, Nawinna, Maharagama.

Sri Lanka Export Development Board, 115 Sir Chittampalam A Gardiner Mawatha, Colombo 2.

State Pharmaceuticals Manufacturing Corporation of Sri Lanka, 11 Sir John Kotalawala Mawatha, Kandalwala Estate, Ratmalana.