Ministry of Environment and Forests, Government of India

**Centre of Excellence for**
**Medicinal Plants & Traditional Knowledge**

# Annual Report

## 2009-10


**Foundation for Revitalisation of Local Health Traditions**
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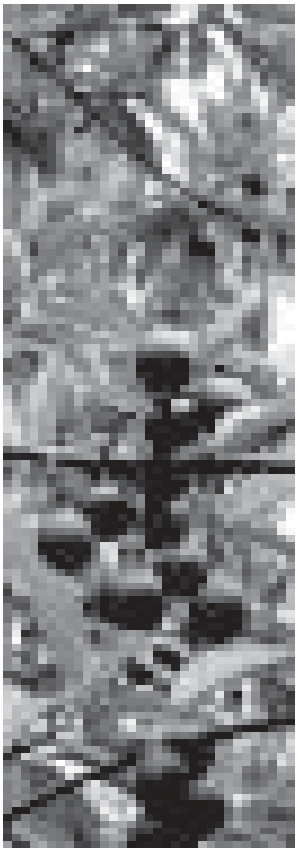

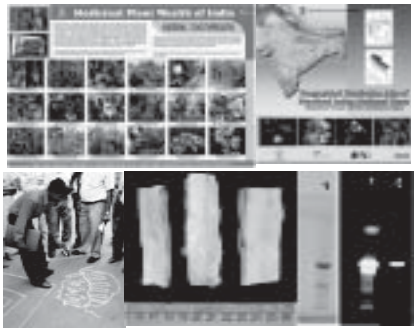

IMAGES ON THE COVER

1. Fruits of Rudraksh in EMG
2. Poster on Herbal Toothbrush
3. Jacket of Georaphical Distribution Atlas of Prioritised Medicinal plants
4. Learning session during the capacity building programme for FD Staff, Gujarat.
5. HPTLC profile of Daruharidra

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## CONTENTS

# 1 INTRODUCTION

The Foundation for Revitalisation of Local Health Traditions (FRLHT), a Bangalore based organisation is the Center of Excellence (CoE) for 'Medicinal Plants and Traditional Knowledge', established by the Ministry of Environment and Forests (MoEF), Government of India under the 10th Five year Plan during the year 2002-03.

Its six major goals are focused on:

- Establishment and strengthening of a bio-cultural herbarium of the medicinal plants of India
- Establishing and strengthening of an ethno-medicinal garden
- Developing educational materials on the Indian medicinal plants used in Indian Systems of Medicine
- Undertaking pharmacognostic studies of controversial botanical raw drug group
- Generation of distribution maps for prioritised medicinal plants
- Training for the master trainers of village botanists and the Working Plan Officers of the State Forest Department

## 1 The Project Components:

The project comprises of the following six components. The details of these components alongside their central purposes are presented below:

| Project Component Code | Project Component Title | Central Purpose of the Components |
|---|---|---|
| CE-P1 | Project Coordination | The Centre of Excellence involves activities spread across different groups within and outside the organisation. The project coordination cell provides the common string to all the planned activities. It also forms an interface between the MoEF and FRLHT, liaison with other organisations and coordinates project formulation to strengthen the CoE. |

| | | |
|---|---|---|
| CE-P2 | Herbarium of Medicinal Plants used in ISM | According to the Planning Commission Task Force on medicinal plants (2002), India's herbal industry has a huge economic potential in the global market. A National Repository of the medicinal plants of India is an essential requirement to support this potential. The FRLHT Herbarium is the only medicinal plants herbarium in the country. It has been designed as a bio-cultural herbarium which offers the vernacular names and the currently accepted botanical names of particular species including the specific location (latitude, longitude, altitude) on Indian Territory. This project requires expertise both in taxonomy as well as in traditional knowledge of plants. |
| CE-P3 | Establishment of Ethno-medicinal Plants Demonstration Garden | Ethno-medicinal gardens are different from the conventional botanical gardens and arboreta in that they raise the plants which are prominently associated with different ethnic groups, besides being arranged according to the botanical families, genus, species, sub-species etc. Such gardens, therefore, represent the cultural dimensions of the botanical wealth of a region. India has one of the world's richest ethno-botanical traditions. Therefore, it is important to create regional ethno-botanical gardens in every district of the country as they can serve not only to conserve plants but also to conserve the cultural history related to natural products of the country. |
| CE-P4 | Pharmacognosy Studies on Medicinal Plants | India needs a large number of Pharmacognosy labs because internationally acceptable standards have to be developed for almost 2000 species of medicinal plants that are used by different traditional systems of medicine. In the last 50 years the pharmacopoeial standards have been developed for only about 400 species. The FRLHT lab activities supported under CoE are of a unique nature because they are focused on creating what may be termed as *traditional knowledge guided* standards. This is an innovative inter-cultural strategy in the field of Pharmacognosy. |

| | | |
|---|---|---|
| CE-P5 | Distribution mapping of Medicinal Plants using GIS | The GIS technology is well known for its application in the field of conservation of natural resources. Under the CoE project GIS applications are being made focusing on medicinal plants resources. |
| CE-P6 | Outreach (Training & Educational Material on Plants of ISM) | It is envisaged to identify and train the master trainers of village botanists who in turn can facilitate develop a cadre of village botanists to help monitor populations of prioritised medicinal plant species. It is also envisaged to train the forest managers and working plan officers in incorporating the strategies for medicinal plants conservation into the forest working plans.<br><br>In order to make the rich traditional knowledge of the medicinal plants of India accessible to students, teachers, researchers and industry in the country, it is necessary to use IT tools to interpret and present this knowledge. This task of translation of the traditional knowledge about plants requires inter-disciplinary expertise of ISM scholars and experienced plant taxonomists. |

## The Implementation Mechanism:

FRLHT prepares the annual action plans in respect of the above project components within overall five-year project objectives and submits the same to the MoEF for approval. Within MoEF, a special Project Steering Committee under the Chairpersonship of the Addl. Secretary, MoEF, GoI appraises the annual proposals, recommends release of funds and monitors the project performance on a six monthly basis.

At the implementation level at FRLHT, each project component is steered and monitored on a monthly basis by the respective Joint and Assistant Directors designated as Principal Investigator for that component.

During the year 2009-10, the project has moved further in the direction of achieving the goals of this centre of excellence. Whereas the project has made credible contribution in strengthening FRLHT's resource and knowledge base to develop it as Center of Excellence in the field of Medicinal Plants and Traditional Knowledge, the outcomes from this project have been making significant contribution towards adding value to the Indian Medicinal Plants sector.

This report provides glimpses of the highlights of the project activities pertaining to the year 2009-10 (section 2) and a matrix of detailed annual progress report (section 3).

# 2 PROJECT HIGHLIGHTS DURING 2009-10

During the year, the approved annual plan for the year 2009-10 was implemented as scheduled. The detailed physical progress vis-à-vis targets in relation to various activities are given in a matrix format in section 3 of this report while the highlights of the project activities during the year are given below:

## CE-P2: BIO-GEO CULTURAL REPOSITORY OF NATURAL RESOURCES USED BY INDIAN SYSTEMS OF MEDICINE

A "Herbarium" may be referred to as a repository of certain kind of "plant specimens" or vegetative parts of plants collected from far and wide, processed, dried, mounted, labeled and housed as per a known botanical classification.

The FRLH herbarium[1] established in 1993 is a specialized herbarium with a focus on medicinal plants used in Indian Systems of Medicine (ISM). The objective is to highlight the morphological variations of the plants as well as to represent plant species across different ecosystems by engaging in botanical surveys to collect plant specimens across different bio-geographic zones, ecosystems and habitats of the country. These botanical surveys will result in the additions to the existing collection of medicinal plants used in ISM as well as the plants traded in the country.

The botanical surveys conducted during the year have resulted in raising the total number of medicinal plant species in the herbarium to 3027. About 1900 species are known to be in use in ISM and of which, FRLH currently houses 77.4 % of the species. Similarly in India, 960 medicinal plants are reported to be in trade, of which FRLH houses 81% of the species.

During the year botanical surveys were carried out in different regions of India in order to add more species to the existing collection. The state wise collection of the specimens is tabulated below:

| State | No. of collections |
|---|---|
| Andaman and Nicobar Islands | 193 |
| Andhra Pradesh | 6 |
| Goa | 5 |
| Gujarat | 6 |
| Meghalaya | 98 |
| Nagaland | 40 |
| Karnataka | 26 |
| Kerala | 26 |
| Rajasthan | 95 |
| Tamil Nadu | 153 |

[1]. FRLH" is the internationally accepted Acronym accredited by the New york Botanical gardens, New York, USA and the Herbarium of medicinal plants maintained at FRLHT is recognized by this accredited name.

Besides, the herbarium team also took up special focused collections from different Botanical gardens with the following additions: Indian Botanical Garden, Kolkata-78, Botanical Garden, Calicut University, Calicut, Kerala-86, and A Balasubramaniam Garden, Salem, Tamil Nadu-47. All such collections from the wild as well as from the gardens, have resulted in addition of 921 specimens during the year pertaining to 155 species not available in collections earlier.

## Habit analysis of 155 species (new additions)

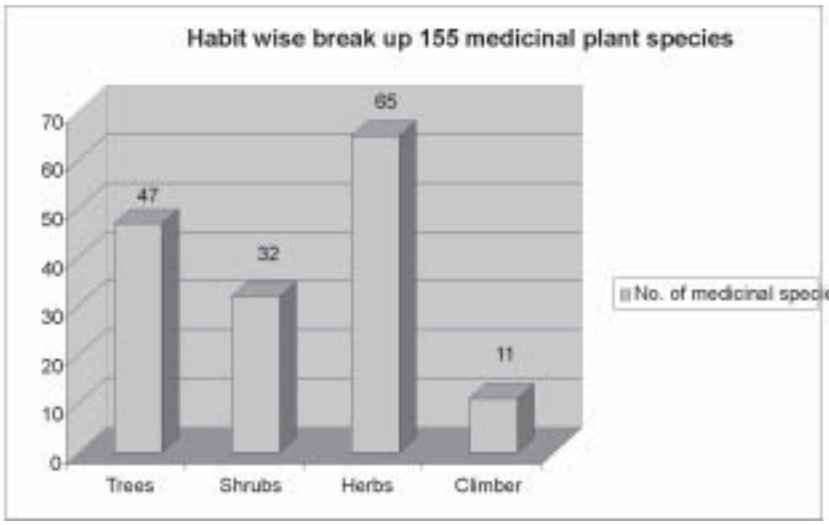
Of the 155 additions, the Herbs took the major share (65 species), followed by Trees (47 species), Shrubs (32 species), Climbers (10 species) and Liana (1 species).

These collections were found to capture some important traded species also such as *Tribulus rajasthanensis*, *Trichosanthes cordata* as well as *Coptis teeta* which is endemic to Arunachal Pradesh and *Panax sikkimensis*, which is endemic to Sikkim Himalayas.

The special focused collections from the Botanical gardens were found to capture many species of interest, such as: *Alpinia mutica* Roxb., *Amomum hypoleucum* Thw., *Aponogeton monostachyon* L.f., *Brunfelsia uniflora* (Pohl.) D. Don, *Caryota mitis* Lour., *Clusia rosea* Jacq., *Dracaena fragrans* Ker.-Gawl., *Ficus lyrata* Warb., *Livistona chinensis* (Jacq.) R. Br. ex Mart, *Podocarpus angustifolius* Griseb. , *Ptychosperma elegans* (R.Br.) Bl., *Roupellia grata* Wallich & Hooker, *Syzygium grande* (Wight) Walp, *Tristellateia australasiae* A. Rich.

## Herbarium Exchange Program

The FRLH herbarium encouraged an active exchange of herbarium specimens during the year. As a result of the exchange, 6 specimens were received from Rajasthan, 8 from Sadar Patel University, Kutch, Gujarat and 67 specimens from Dibang valley, Central National Herbarium, Kolkata. Such exchanges resulted in adding 67 species to the FRLH herbarium.




Under the Herbarium Exchange Program, the FRLH herbarium donated 17 medicinal plant specimens to KLE Society's Nijalingappa College, Bangalore. The FRLH team also visited the Botanical Survey of India, Shillong circle for getting the herbarium specimens of its North East collections identified. This exercise resulted in ascertaining the identity of 72 specimens.

## EDUCATIONAL MATERIALS

### *Educational Posters*

Continuing to add different elements to the broad theme, "Medicinal Plant Wealth of India", the Herbarium team produced 4 more posters titled *Aromatic medicinal plants*, *Herbal Toothbrushes*, *Medicinal Flowers* and *Goksura*.

- The poster on *Aromatic Medicinal Plants* is quite illustrative and throws light on select indigenous and exotic medicinal plants containing essential oils. The poster also offers interesting information about different plants and their parts used for the extraction of essential oils.
- The poster on *Herbal Tooth brushes* is a novel piece of educational material that provides information on use of several medicinal plant species for dental care. The poster also brings to light several interesting pieces of information pertaining to some very popular species such as Neem as well as some less known species such as *Glycosmis pentaphylla*.


- The Poster on *Medicinal Flowers* brings to light significant therapeutic values of many attractive and colorful flowers.
- The Poster on *Goksura*, offers interesting information on the medicinal, cultural and commercial importance of the plant, *goksura* which is an important *Rasayana* drug (an Ayurvedic term to denote a rejuvenative drug). It illustrates certain simple thumb rules, to establish the identity of 3 different species correlated to *goksura* (*Tribulus terrestris*, *Tribulus subramanyamii* and *Tribulus lanuginosus*), based on their exo-morphological, microscopic and molecular features.

### Outreach Activity

The Herbarium team also engaged in different Outreach activities during the year.

Different 2-day training programs on "Herbarium Techniques and Plant Identification" were conducted to the researchers, graduates and post graduate students from different Institutions. National Institute of Unani Medicine, Al-Ameen College, Mount Carmel College and Bishop

Cotton's women's college in Bangalore were benefited from these training programs. Besides, 1-day Orientation program "Herbarium Techniques" was organized for the Botany students from Womens Christian College, Chennai and Shri Shri Ayurveda College, Bangalore.

Learning sessions during these training programs included hands on orientation in the field and demonstrations about different steps of Herbarium preparation.

## Raw Drug Repository

The Raw Drug Repository at IIAM specializes in the collection of plant raw drugs used in the Indian Systems of Medicine. In order to meet its objectives, the team at the Repository engages in different field and market collections of raw drugs.

During the year, 235 market collections and 255 authentic field collections were added to the repository. With these additions the raw drug repository now houses 2171 samples of raw drugs, of which 1548 are from the market collections while 623 are authentic field collections. Of the 960 plant species found to be in the trade, 365 species are represented in the Repository. This collection also includes 84 species reported in high volume trade in the country. Besides the plant raw drugs, the repository also has in its collection 45 minerals and 2 metals used as raw drugs in ISM.

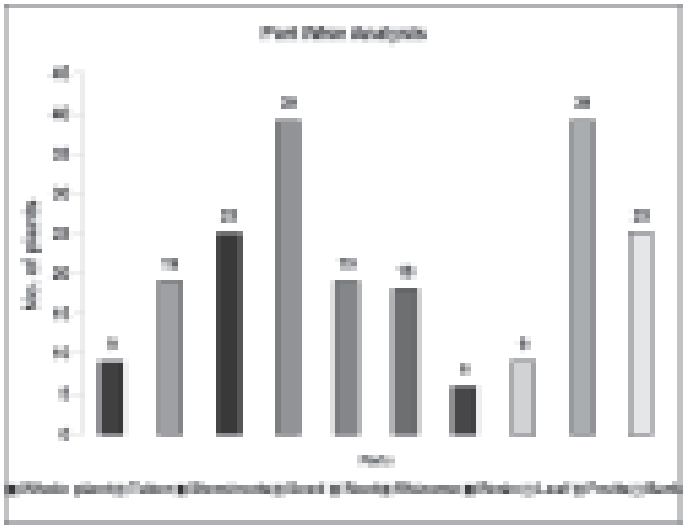
## Market Collections

The breakup of market collections of plant raw drug samples during the year are as below.

| Raw drug Markets | No. of samples |
|---|---|
| Katni and Amarkantak, Madhya Pradesh | 75 |
| Udaipur and Ajmer, Rajasthan | 96 |
| Rajpipla, Gujarat | 53 |
| Goa | 11 |

Highlights of the market collections are as below:

These 235 market collections correspond to 149 plant species which represent 133 genera and 75 botanical families. These collections were found to have captured many important species of



medicinal plants such as: *Anacyclus pyrethrum* (Root), *Dactylorhiza hatagirea* (Tubers), *Luffa echinata* (Fruit), *Oroxylum indicum* (Bark), *Aquilaria agallocha* (Wood) and *Cyperus scariosus* (Tuber).

It was found that the collections include 20 different types of plant parts collected as raw drugs. The bar chart presents the frequency (No. of plant species) corresponding to the top 10 plant parts in the market collections during 2009-10.

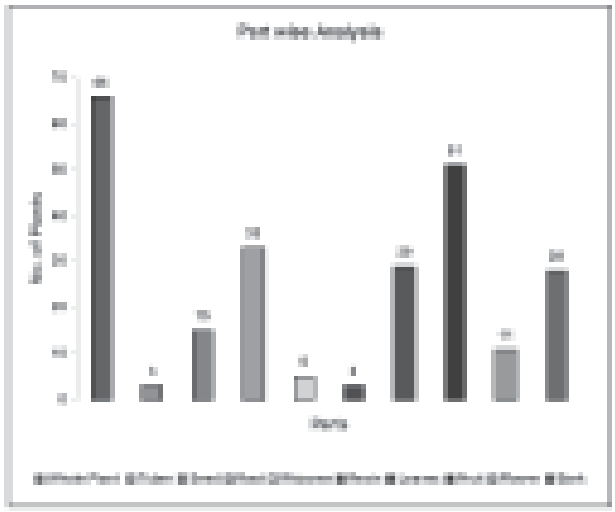
Of the 235 samples, the Herbs take the major proportion of the collections with 103 samples (43%), followed by Trees with 84 samples (36%), Climbers with 32 samples (14%) and Shrubs with 16 samples (7%).

## Authentic Field Collections

Authentic field collections were sourced from different states as below:

| | | | |
|---|---|---|---|
| Karnataka | 115 | Kerala | 6 |
| Tamil Nadu | 110 | Rajasthan | 3 |
| Madhya Pradesh | 8 | Himachal Pradesh | 3 |
| Gujarat | 7 | Goa | 3 |

A detailed analysis of the collections is presented below.



The 255 authentic field collections correspond to 195 plant species which represent 170 genera and 73 families. These include several important species such as *Aconitum heterophyllum* (Tuber), *Adenia hondala* (Tuber), *Cucumis prophetarum* (Fruit), *Stereospermum colais* (Root), *Uraria lagopodioides* (Root), *Uraria picta* (Root).

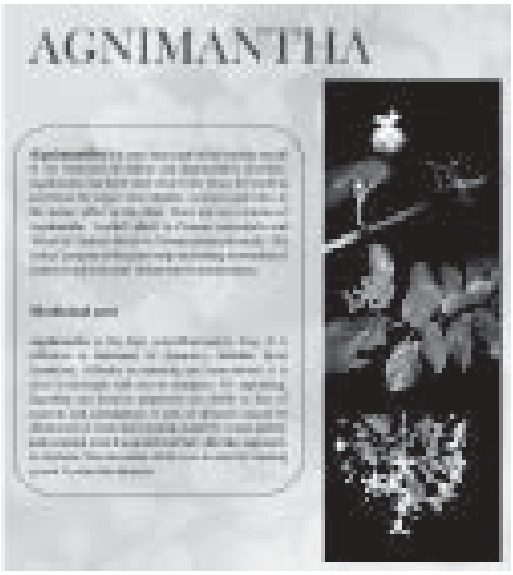
Of the 255 collections 98 (39%) are herbs, followed by Trees with 76 samples (30%), Shrubs with 42 samples (16%) and Climbers with 39 samples (15%).

View of Raw drug market in Amarkantak

## Arrangement and Display of the collections in the Repository

During the current year, the collections at the repository were grouped and arranged in a user-friendly fashion, following different themes. Accordingly, appropriate display cabinets were brought in to showcase the collections. The collections were also grouped based on interesting themes such as “One species-multiple raw drugs”, “Different plant parts as raw drugs” etc.

It was observed during the year that, this systematic grouping and displays of the collections in the repository began to attract quite many visitors and student groups. Considering the educational significance of these collections, initiatives were taken up during the year to enhance the collections and accordingly, different illustrated posters were designed on the following important drugs: 1) Agnimantha, 2) Daruharidra, 3) Goksura, 4) Isabgol, 5) Pashanabheda, 6) Punarnava, 7) Trikatu, 8) Trimada, 9) Triphala, 10) Vidanga, and 11) Vidari.




These posters placed next to the respective collections provide additional relevant information about the collection thereby making it more educative. One such poster brought out during the year is shown along side.

## Catalogue

A draft version of the Raw Drug Repository catalogue was developed during the year. This catalogue enlists 1682 collections (1313 market collections and 368 field collections) housed in the repository, which correspond to 365 plant species. The catalogue also brings together information pertaining to the botanical family to which a species belongs, the medical systems in which the plant finds a use, and its trade status. The catalogue also highlights the need, significance and different features of the repository.

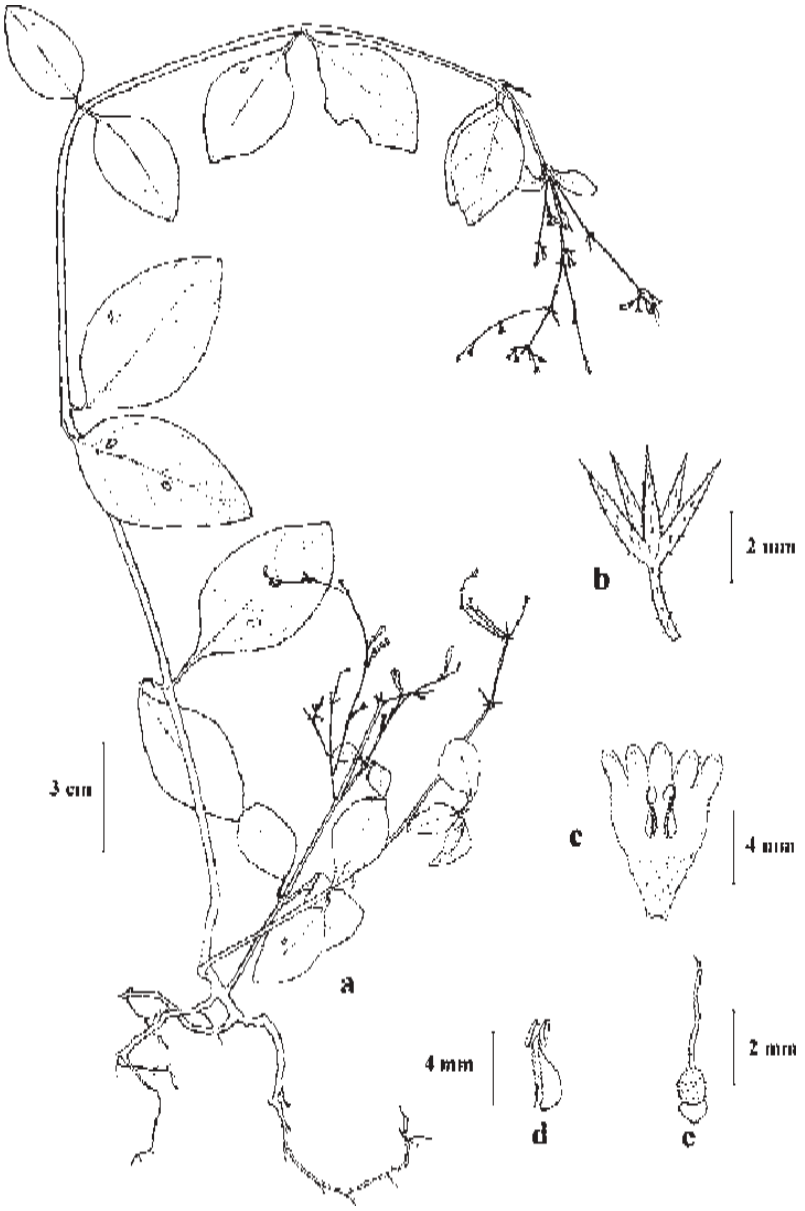



Figure 1. Codonacanthus sanjappae Karthig., Sumathi, Jayanthi & D. Naras sp. nov. (a) habit, (b) calyx, (c) corolla (split open), (d) stamen, (e) ovary with style.

## Database

Different kinds of information has been generated alongside the raw drug samples that are housed in the repository. Information recorded in the field note books used during the market and field collections, offers interesting data on various aspects of the raw drugs. This data is quite helpful in generating profiles of the raw drugs, identification labels, and data on the markets and field sites. This kind of information in respect of 1682 samples has been systematically documented in the computerized database. The database is used to store and retrieve information related to raw drug specimens. This information in the database has covered 74% of the total collections in the repository.

## CE-P3: ETHNO MEDICINAL GARDEN

The Ethno Medicinal Garden (EMG) on FRLHT campus houses different thematic subsections which are created by planting specific groups of medicinal plants used in the traditional systems of medicine. So far, 31 such thematic plantings have been established in the EMG. Every year, newer themes are being added to strengthen the collection at the EMG and eventually to transform it into an education centre on sustainable utilization and conservation of medicinal plants.

During the year 2009-10, three new thematic plantings were taken up in the EMG.

- Narcotic and poisonous plants
- Plants used in enhancing water quality and
- Plants used in traditional bone setting

Besides, 68 unique species were added during the year to the existing theme plantings thereby increasing the species holding of EMG to 1008 unique species. Appropriate sign boards for the additional 3 thematic plantings and 100 individual species have been erected to make the garden more user-friendly. Eight EMG-based awareness-cum-educational programs for the target groups from different disciplines such as Botany, Environmental Science, Pharmacy and other Indian Systems of Medicine, were conducted. Students from about 50 schools visited the EMG as a part of their curriculum, during this year.

### Outreach Nursery

A Semi-Permanent Type (SPT) nursery with a capacity of around 75,000 seedlings was established in *c.* 50,000 sq ft. area. The nursery boasts different features such as Green packages, Hardening beds, Medicinal bonsais, Aquatic plants, Potted plants, etc. This nursery is spread over 78 beds and determined walk ways. The beds are serially numbered and the corresponding species are labeled. During the year, the nursery produced 60,000 seedlings of 210 species. The seedlings housed in the nursery are watered with over-head mistifiers.

### Nursery Database

The garden team during the year also engaged in developing a Database for the Nursery. The database developed, provides the user, information on the seedlings of different medicinal plants species available in the nursery, their physical location in the nursery beds, and the type of packages they are included in. The database also provides options to computerize different

datasets in respect of the functions of the nursery, and thereby facilitates its management by way of computerizing and helping to organize the physical stocks for daily transactions.

## Garden management Software

A Garden Management Software called *'Garden Accession Information System'* was developed during the year, as a supportive tool for efficient management of the EMG. The software offers options to manage different kinds of information of a species in the garden, which includes date of entry of a plant species into the garden, its accession no., collection locality, collector's name and date and location of planting on the campus. This software has helped in monitoring the growth and development of every plant species brought into the campus, besides facilitating their maintenance. The software also contains different information retrieval modules which are quite user-friendly.

## Seed Herbarium

A Seed herbarium is an essential part of any garden and nursery engaged in the activities related to conservation education. Such a Seed herbarium uses different seeds as the tools for identification of plants and helps a visitor in familiarizing himself with the identity of different plant species. The seed herbarium also helps a nursery manager to select appropriate propagation protocols. During the year, the seed herbarium consisting of the seeds of around 130 species of medicinal plants was established in the EMG. All the collections were given appropriate labels (depicting scientific name of the species, family, accession number, collection locality, date of collection and name of the collector).

## The Rudraksh tree: An attraction in the EMG

The EMG has 4 trees of Rudraaksh, (***Elaeocarpus sphaericus)*** which is native to the North East Himalays and Nepal. Rudraaksh whose unique beads, as is known, are highly revered as an object of pooja and used in different cultural observances by several orthodox communities in the country.

These trees introduced from the North east have now started flowering and fruiting regularly. The flowering is so profuse that it attracts swarms of honeybees and many other insects. Each tree was laden with copious, marble sized fruits with attractive bluish purple colour. The ripe fruits were seen eaten by different birds which flock the trees. The trees became the star attraction of the garden, for their cultural importance. The fruits obtained are used for further regeneration.

## EMG supports other Research projects of the Institution

The EMG has been used by many visitors who are deeply interested in medicinal plants. It has also been found to be a convenient place for serious research by the scholars and research students. This significance of the EMG was conspicuous in the case of the project on Species recovery studies of ***Janakia arayalpathra*** taken up by the Herbarium team of the Institution. The individual plants of *Janakia arayalapthra* on the Garden, served as the study material for the floral biology experiments of this project. Similarly the garden collections offer very convenient study materials for the different research studies related to propagation, pharmacology, pharmacognosy of Medicinal Plants.

## Tie up with BDA for developing herbal parks in Bangalore

BDA (Bangalore Development Authority) entrusted the EMG team during the year, the task of developing a medicinal plants garden close to the children's park at Visweswarayya lay out in Bangalore city. Accordingly, the EMG team established a thematic herbal garden which now attracts hundreds of visitors. Several plants in this thematic garden attract several butterflies which are indeed a feast to the eyes of the onlookers.

The EMG during the year extended the necessary technical support to the Christ University, Bangalore to supplement their plant replication strategy, on its campus. Similarly the EMG also extended its expertise support to different Land developers and builders and many other prominent citizens of Bangalore, in their attempts to landscape the area.

## EMG Manual

The EMG team completed the preparation of EMG manual during the year. This manual, titled 'Secrets of Ethno Medicinal Gardens', is a comprehensive, step-by-step guide to develop a medicinal plants garden on similar lines of the EMG established at FRLHT Campus. This manual covers all aspects of developing an Ethno Medicinal Garden, beginning from the guidelines for conducting botanical surveys for collection of plants for the garden; choice of planting themes and appropriate species for thematic plantings; topography and landscape related elements of the area chosen for developing a garden, and intricacies of garden management. The manual is quite illustrative and includes images of around 200 herbs, 130 shrubs, 100 climbers, over 200 trees, around 100 species of orchids and about 50 species of ferns that are appropriate for establishing a garden. The information alongside is quite user-friendly, as it offers the plant names in 6 regional languages and English, the botanical details and their medicinal properties. The manual contains a section on the Nursery, which includes the guidelines for setting-up a nursery and its management, and details on propagation methods for select medicinal plants.


Authors: Ganesh Babu, N M, Geetha Suresh and K Haridasan, 2010.

## Exhibitions in which the EMG team participated:

- Independence Day celebration exhibition and Flower Show, Lalbagh, Bangalore. 5-15th August 2009.
- Republic Day celebration exhibition and Flower Show, Lalbagh, Bangalore. 16-26th January 2010.
- Apart from taking part in these major events, the Garden team also conducted different Exhibition cum- Medicinal Plants sales at the following locations during the year.

Poorna Pragna school, NITTE international School, Akshara School, Vyasa School and RBMS School, all in Bangalore and INFOSYS, Bangalore.

## Eminent personalities and Expert groups visited the EMG during the year include the following:

1. Dr. R.P. Warrier, Vice-Chancellor, Manipal University, Manipal
2. Dr. (Fr.). Thomas C., Vice Chancellor, Christ University, Bangalore.
3. Prof. Thangaraj, Vice Chancellor, Tamil Nadu Veterinary University & Animal Sciences, Tamil Nadu.
4. Prof. B.V. Sreekantan, Emeritus Professor, NIAS, Former Director, TIFR, Mumbai.
5. Prof. H.Y.Mohanram, Prof. of Botany, Delhi University, New Delhi
6. Prof. V.N. Rajasekaran Pillai, Vice Chancellor, IGNOU.
7. Dr. Ray, Managing Director, TISCO hospitals, Jamshedpur, Chattisghar

8. Dr. R.A. Mashelkar, Bhatnagar Fellow & President, Global Research Alliance, National Chemical Laboratory, Pune.
9. Prof. R.H. Singh, Professor Emeritus, Faculty of Ayurveda, Banaras Hindu University, Varanasi

## CE-P4 : PHARMACOGNOSY STUDIES

Authentic identity of the medicinal plant raw drugs is an important determinant of quality, safety and efficacy of herbal medicines. Increasing demand for herbal drugs coupled with non-availability of genuine raw materials results in substitution of the raw material with alternative materials. The legitimacy of substitution if systematically analysed, can provide scientifically validated substitutes that are bio-equivalent to the original drug.

### VIDANGA

The fruit of Vidanga is a high volume (> 500 MT/year), top-traded botanical drug used in Indian Medicine such as Ayurveda, Siddha and Unani The raw drug is the dried fruits of Vidanga plant.Vidanga is a well known Ayurvedic herbal drug for helminthiasis, indigestion, and tumours. The official pharmacopoeia has correlated the authentic botanical entity of Vidanga to be *Embelia ribes* Burm.f (Myrsinaceae). Its sporadic distribution in Western Ghats, Eastern Himalayas and North East India however indicates that the volumes traded cannot be contributed by this species alone. Three other species namely *Embelia tsjeriam-cottam* A.D.C., *Myrsine africana* L. and *Maesa indica* (Roxb.) A.D.C., all belonging to Myrsinaceae family, are also used as Vidanga.

Embelin, the main constituent of the fruits *of Embelia ribes* is also present in *Embelia tsjeriam-cottam* and *Myrsine africana* but is absent in *Maesa indica.* Thin Layer Chromatography was carried out on ethyl acetate extract of *Maesa indica.* The ethyl acetate extracts of *Maesa indica* afforded two compounds that appeared to closely run with Embelin on a TLC plate suggesting similarity in polarity. One of these compounds (Rf, 0.50) was isolated and the results of its structural studies are presented here. The compound at Rf 0.50 was isolated from *Maesa indica* and characterized. It is a new compound, which we have named as Kiritiquinone because “Kiriti” is the Malayalam name for *Maesa indica*, and ‘quinone’ is the nature of the isolated compound.

In 2009-10, the structure of Kiritiquinone, including position of the double bond in the side chain was characterized and confirmed.

### Confirmatory studies on the structure of Kiritiquinone

- Confirmation of presence of -OH groups was carried out by preparation of the dimethyl ether, diacetate and tetra acetate of the extract.
- In the diazomethane reaction, the expected reaction was that the -OH group will be converted to an -OMe and in acetylation reaction, the -OH group will be converted to -OAc.
- Confirmation of OH, C=O using done by carrying out reductive acetylation of the extract. The expected reaction was that the –OH and -C=O groups, will be converted to -OAc.

- Hydrogenation reaction carried out on the dimethyl derivative confirmed presence of double bond in the side chain.
- Confirmation of position of double bond C=C using ozonolysis. The double bond was expected to be broken giving rise to an aldehyde.

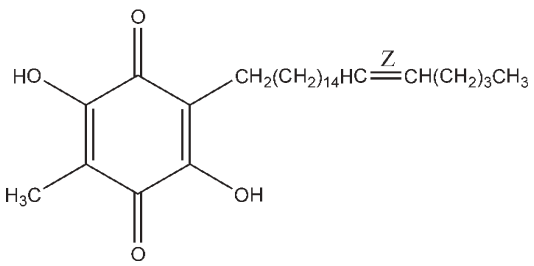
## Findings:

- It was confirmed through literature search that Kiritiquinone, isolated from the fruits of *Maesa indica* was a new compound.
- Characterization by NMR, IR and Mass spectral data showed that it is a 1, 4-benzoquinone derivative.
- Confirmation of presence of the -OH groups was carried out by diazomethane and acetylation reactions wherein the –OH groups converted to -OMe and –OAc respectively as expected.
- Reductive acetylation of kiritiquinone afforded a tetraacetate. The reaction was as expected and the -OH and -C=O groups were converted to -OAc thereby confirming the presence of two hydroxyl groups and two carbonyl groups.
- Hydrogenation reaction carried out on the dimethyl derivative confirmed the presence of a double bond in the side chain as the mass spectral data showed increase in the molecular weight of the hydrogenation product equivalent to the addition of two hydrogen atoms.
- Ozonolysis of the tetraacetate afforded an aldehyde which was reduced to the corresponding alcohol. Mass spectral analysis of the alcohol confirmed that the double bond is present at $C_{16}$ position of the $C_{21}$ side chain. Further the stereochemistry of the double bond appeared to be Z from the $^{1}$H NMR spectral analysis of kiritiquinone and its derivatives.
- Hence, the chemical structure of Kiritiquinone is 2,5-dihydroxy-3-methyl-6-henicos-16-enyl-1,4-benzoquinone from chemical and spectral studies of its derivatives

A manuscript titled “A new quinone from *Maesa indica* (roxb.)A.dc, (myrsinaceae)” has been accepted by Indian Journal of Chemistry.

**Structure of Kiritiquinone**

2,5-dihydroxy-3-methyl-6-(*Z*-16-henecosenyl)-1,4-benzoquinone




Mol wt: 446  melting point: 129-30°C

## Microscopy

The anatomy work was carried out on the four Vidanga species. To reconfirm our previous years' observations, the samples were sent to Plant Anatomy Research Centre, Chennai for microscopic study. The major anatomical difference among the four candidates is as below:

- The secretory canals are distributed in a row in Embelia ribes and Embelia tsjeriumcottam, in Maesa indica it is throughout the pericarp, and in Myrsine africana they are absent.
- The testa and tegmen of Myrsine africana are crushed, but in Embelia ribes and Embelia tsjeriamcottam, only the tegmen is crushed.
- *Maesa indica* is many seeded, while the other three are single seeded at maturity. *M. indica* shows the presence of fertile and sterile seeds which is not seen in the other three species.
- In addition to this *Maesa* indica has some peculiar features like, the enlarged sclerotic epidermal cells of testa and sterile seeds oozing out contents.

### Anthelmentic studies

Vidanga, as mentioned in the traditional medicine texts is prescribed for its Anthelmintic properties. *Caenorhabditis elegans* is a Nemathelminth worm and is generally used for the Anthelmintic assays. Anthelmintic assay using *C. elegans* was established at FRLHT, with a culture obtained from National Centre for Biological Sciences, Bangalore and extracts of Vidanga spp. and embelin were tested on *C. elegans* model. Ethyl acetate extract of the dry fruits of *Embelia ribes*, showed a good kill at around 10 mg/ml after a 7 day period. Isolated Embelin compound also showed good activity. Testing the anthelmintic activity of the other Vidanga spp. and kiritiquinone is ongoing.

### Monograph on Vidanga

Bio-equivalence testing of the original and substitute species of Vidanga is ongoing. Once the bioequivalence of these species has been demonstrated for their prime activity including antihelmintic and anticancer properties, profile of these candidate species of Vidanga would be published as a monograph.

## VIDARI

### Development of RAPD based SCAR marker for Identification of Ipomoea mauritiana

During 2007-8, a putative 600-bp polymorphic DNA sequence, specific to Ipomoea *mauritiana* was identified using randomly amplified polymorphic DNA (RAPD) technique. In 2009-10 sequence characterized amplified region (SCAR) primers (IM1F and IM1R) were designed from the unique RAPD amplicon of *I. mauritiana.* The SCAR primers produced a specific 323-bp amplicon in authentic *I. mauritiana* and not in the allied species, thus distinguishing *I. mauritiana* from the other Vidari candidates (Devaiah et al., 2010).

## Microscopy

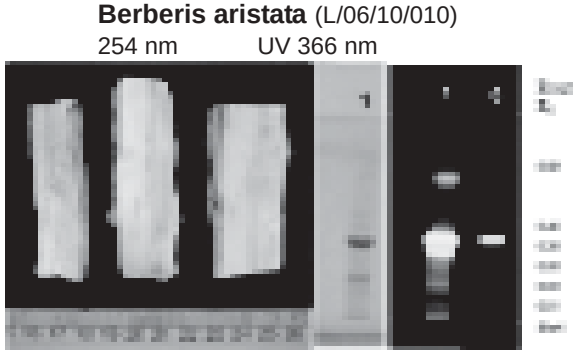
The anatomy work on all the four Vidari candidates was carried out to re-validate the observations made in the previous years. The observations made were similar to those observed in the previous years work.

## Monograph on Vidari

Similar to the monograph on Vidanga, the profile of the different candidate species of Vidari would be compiled as a monograph.

## Intercultural studies on the Daruharidra candidates

Confirmation of results of 2008-9 work and testing of new accessions on Daruharidra candidates was carried out. The alkaloid berberine was used as the reference marker to compare the five species. Berberine was found in all the *Berberis* species and *Coscinum fenestartum*. *Berberis aristata* had the maximum content (3.67%) followed by *Berberis lycium* (2.82%), *Coscinium fenetsratum* (1.43%), and *Berberis asiatica* (0.74%). HPLC/HPTLC profile of *Berberis* species showed a unique e.g a yellow green band at $R_f$ 0.01 was found in the HPTLC of *B. aristata.*




TLC track 1 - Berberis aristata (L/06/10/0.10) methanol extract
Track 6- Standard berberine

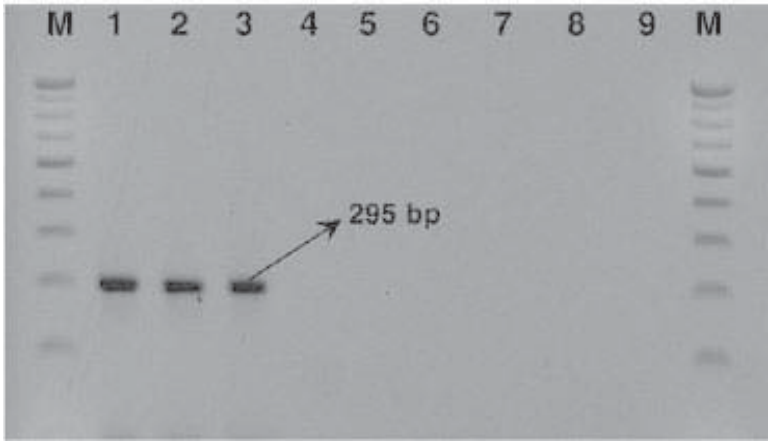
An observation was made that the new accessions analysed this year were not as brightly coloured as the previous ones (yellow) and the girth of the stems were less (1-1.5 cm) than earlier ones (2.5 – 3.0) The Berberine content was also low (0.11%) when compared to previous ones (3.4%) even though the fingerprints were matching.

*Morinda umbellata* is another candidate for the ayurvedic entity Daruharidra. HPTLC and HPLC work on the new accessions of *M. umbellata* was carried out to compare with that of *Berberis aristata.* The reference marker berberine could not be detected in the new accessions of *M. umbellata.* This confirms our previous year's observation with a single accession of *M. umbellata.*

## Studies on Goksura

Ayurvedic Pharmacopoeia of India recognizes *Tribulus terrestris* as Goksura, *Tribulus lanuginosus* and *Tribulus subramanyamii* are also traded by the same name raising issues of quality control. The nuclear ribosomal RNA genes and ITS (internal transcribed spacer) sequence were used to develop species-specific DNA markers. The species-specific markers efficiently amplified 295 bp for *T. terrestris* (TT1F and TT1R), 300 bp for *T. lanuginosus* (TL1F

and TL1R) and 214 bp for *T. subramanyamii* (TS1F and TS1R). These DNA markers can be used to distinguish *T. terrestris* from its adulterants (Balasubramani et al., 2010).




RAPD-SCAR Marker sequencing of Goksura

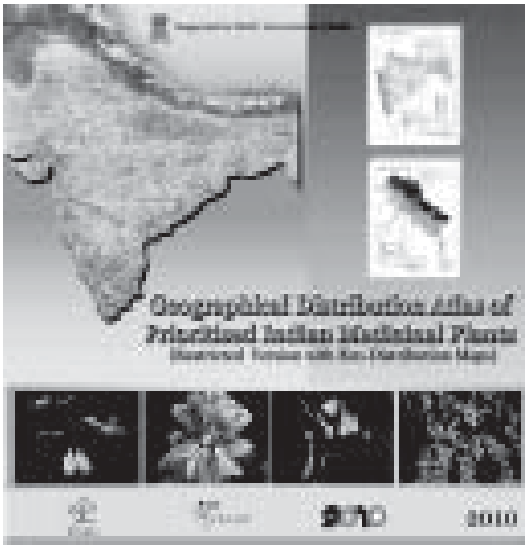
## Abhava Prathinidhi Dravya

Six accessions of *Cyperus rotundus* and one accession of *Aconitum heterophyllum* was collected. An article titled *"Cyperus rotundus*, a substitute for *Aconitum heterophyllum*: Studies on the Ayurvedic concept of Abhava prathinidhi dravya (drug substitution)'' has been published in JAIM, vol 1, 2010.

Literature review on *A.heterophyllum* and *C. rotundus* has been carried out.

## CE-P5: DISTRIBUTION MAPPING USING GIS & IDENTIFICATION ISSUES OF TRADED MEDICINAL PLANTS

### 1. Digital Geographical Distribution Atlas of Prioritised Indian Medicinal Plants




Preparation of geographical distribution database, and maps for 250 wild medicinal plant species of India was undertaken during the year. Detailed eco-distribution maps were prepared for 25 species using GIS (Map info). This digital data has been incorporated into a searchable database and provided on CD-ROMs. Two sets of such CD-ROMs have been developed. The first one is a public version containing data and geo-distribution maps while the second version is a restricted one which incorporates the same geo-distribution data and also eco-distribution maps for prioritized species.

The digital atlas, now available on the CD-ROMs, is aimed at providing the forest managers and researchers a reliable source of information on the natural distribution of medicinal plants within India. This updated version of Geographical Distribution Atlas incorporates Geographical distribution maps for 1670 species (2243 botanical names) and Eco-distribution maps for 180 prioritized species.

## Œ - P6: OUTREACH

### Development of a CD-ROM on Plants in Susruta Samhita

The prototype of the CD-ROM on plants of *Susruta Samhita* which was developed during the previous year has been modified and the same has been reviewed by the experts during this year. As it is known, *Susruta Samhita* is the work of Acharya *Susruta* (one of the Brihat-trayees of Ayurveda during 1500 BC-400 AD) which provides in-depth knowledge of the plants. Additional references to several plants are available in this text when compared to *Caraka Samhita.*


The prevailing versions of *Susruta Samhita* have experienced multiple transformations and redactions by different scholars from time to time over the last few centuries. The original founder of the tradition was *Divodasa Dhanvantari*. On ascertaining the date of *Divodasa & Susruta* from the available data, one may presume that they flourished during 1500-1000 BC. *Nagarjuna* (4$^{th}$ -5$^{th}$ century AD) is considered to be the redactor of *Susruta Samhita*.

This CD-ROM brings together comprehensive information of 775 plant drugs which are correlated to 1078 distinct botanical names including the synonyms. The information is supported by 9676 citations from the text, which correspond to 1856 distinct Sanskrita names, of which identity of 119 has not been established.

This CD-ROM also offers detailed clinical data including the descriptive plant information for 528 species along with about 1300 plant images and pharmacological information for select plants.

Detailed help file on *Susruta samhita* explaining various classifications of plants, and a commentary by *Dalhana* on plant identity is also provided in the CD-ROM.

The CD-ROM has a special feature in respect of the names of the plants under consideration. All the Sanskrita names of the Plants are classified under specific basonyms which are further

linked to their respective synonyms, with the help of different color tags for easy understanding. Wherever, the botanical identity of the plant names is either "Controversial" or "Doubtful", such names are further indicated as C or D, thereby denoting the clarity about their identity. The botanical correlation of the Sanskrit names has been supplemented with respective reference citations from the different source books.

### Development of Prototype of the CD-ROM on Plants in Ashtanga Samgraha (500-650 AD)

Charaka, Susruta and Vaghbhta are considered the "Brhattrayee" or 3 main Acharyas of Ayurveda. Of the three, *Vagbhata* is the author of Ashtanga samgraha (500-650 AD) who compiled information on 8 main branches of Ayurveda in a systematic manner. The information on dravyaguna or materia medica of plants is quite descriptive in *Ashtanga* samgraha (AS) and is presented in a comprehensive manner. Activities to prepare a CD on plants in AS has been completed for 9000 records out of 16,000 citations required for this database.

### Reorientation Training program (RoTP) on Indian medicinal plants in collaboration with Rashtreeya Ayurveda Vidyapeeth under AYUSH, Govt, of India

The centre organized a 6-day Reorientation Training Program (RoTP) for the faculty of Dravyaguna from Ayurveda colleges. The program was conducted at FRLHT, during 28th May – 2nd June 2009, with the support from the department of AYUSH, Govt of India. The focal subject of the program was "Indian Medicinal Plants" and accordingly, the program focused on subjects such as Nomenclature correlation of Medicinal plants, Botanical identity, Geographical distribution, Rare and endangeredness, Conservation and trade status, and Pharmocognosy of these plants, Sensory tools for evaluation of *Rasa* profile of the plants, Controversial identity, adulterants, substitutes and toxicity, Research on *abhava dravyas*, etc.

The Materia medica-Dravyaguna faculty from 13 Ayurveda colleges from different states participated in the workshop. A participatory approach was adopted in the learning sessions which were ably handled by the resource persons drawn from in-house and external agencies. All the sessions of any given day of the program, were structured around a select focal topic as mentioned above. All the groups of MOEF-CoE project took part in this program as the resource persons. The training sessions also included a field demonstration on plant identification skills, herbarium

techniques, Laboratory techniques, exposure to educational tools such as CD-ROMs on medicinal plants, produced under CoE.

### Village Botanists ToT Program

Towards furthering the cause of creating a cadre of Village Botanists (VB), the centre continued its novel initiatives of mentoring the VB Master Trainers through a 3-stage comprehensive TOT course. The program began during 2008-09, and was meant for NGO managers and Training Faculty from forestry Training institutes, who would be trained as VB Master Trainers. These select NGOs and Forestry Training Institutes were expected to carry on the cause of creating a cadre of VBs by way of conceiving independent courses and projects for VBs through their respective Institutes. Select NGOs and state Forest departments from across the country, who had demonstrated an interest in training the local communities in the field of natural resource management having a prior experience of doing the same, were selected for this course.

Accordingly, a TOT course for 26 to-be VB Master Trainers drawn from select NGOs and training and research faculty from forest training schools in Tamil Nadu, Karnataka, Andhra Pradesh, Himachal Pradesh, Kerala, Rajasthan, Maharashtra, Madhya Pradesh, Orissa, West Bengal and Uttara Khand was initiated during 2008-09. During the year 2009-10, the third phase of this course was completed during 26-28$^{th}$ August 2009 at Bangalore. This event was aiming at Submission of Assignments and Final Evaluation and Experience Sharing by the Course participants.

The participants showcased their VB skills in the form of an Exhibition of Seeds, Raw drugs and Herbarium sheets of Medicinal plants. The exhibition was quite an informative one and successful in bringing together different region specific highlights of Medicinal plants diversity, use by the local communities and the trade related dynamics. Subsequently the participants also shared their experience and expressed several concerns related to Village Botanists. The participants also underwent an evaluation in which practical and written tests were conducted to assess their learning. Finally the successful candidates were issued the Certificates.

### Brainstorming Workshop for developing the Strategy and Guidelines for Conservation and Management of Medicinal plants genetic resources in India

Medicinal plant conservation programs of various intensities are initiated across the country while the National Medicinal Plants Board is supporting different initiatives focused on conservation and sustainable use of medicinal plants. Such an enhanced interest about medicinal plants, seen across the different strata of the domain, strengthens the need for developing a national strategy and guidelines which could be followed by the State Forest Departments and others undertaking medicinal plants conservation.

Such a national strategy and guidelines is primarily intended for decision makers, managers,

administrators, planners and researches at national and state level, who are involved in planning and implementation of natural resource management programs and would provide a common framework for planning and implementation of the initiatives for conservation and management of medicinal plants genetic resources in India.

Trying to address this need, the National Medicinal Plants Board sponsored a 3-day Brain Storming Workshop for developing the Strategy and Guidelines for Conservation and Management of Medicinal plants genetic resources in India. The program was organised by FRLHT at Bangalore during 19- 23rd May' 09. About 35 participants comprising of many senior forest officers from different states, Conservationists and CoE team of FRLHT took part in this program. The brain storming sessions finally led to the synthesis of a draft of the strategy and guidelines.

## Capacity Building of the Front-line Staff of State Forest Departments in respect of Identification and Management of Wild Medicinal Plant Resources.

Medicinal plants have emerged as an important plant group having huge potential of enhancing incomes of those people living in the adjoining areas of the forests in the country. They have an equally huge role in the globalization of Indian Systems of Medicine. However, the wild populations of many of the medicinal plant species are fast declining due to habitat degradation, indiscriminate harvesting and general apathy of the forest managers towards the diversity and status of this invaluable resource. Lack of adequate sensitization of the forestry staff towards the value and conservation imperatives of this resource during induction training programs is viewed as one of the major reasons for this neglect of medicinal plants. Inadequate focus on management of this resource even in the Forest Working Plans further strengthens this apathy towards medicinal plants. So much so that the capacity of the staff to even identify the species remains limited to a few tree species only.

Trying to address this need, the CoE Training team conceived an innovative initiative for strengthening the capacities of the frontline forest staff in respect of identification and management of wild medicinal plants resources from 2008-09. The program continued during the current year and focused on the following:

- to develop appropriate state-specific training modules (in local vernacular) on the subject

- to sensitize and train the front-line staff in the medicinal plant identification and management methodologies.
- to train the trainers by effectively involving them in the module delivery sessions.

During the year 2009-10, four training courses (2 back-to-back courses in each state) were organized during 7-10 October 2009 and 12-15 October 2009 at Jaipur, Rajasthan and during 18-21 November 2009 and 23-26 November 2009, at Rajpipla, Gujarat.

Altogether 205 participants including the frontline staff, middle level officers and the faculty of the Forestry Training Institutes took part in these courses and got a re-exposure on various issues related to identification and management of medicinal plants. The Course pedagogy included multimedia presentations, hands on practical sessions, field exercises, games and group discussions.

# 3 COMPONENT-WISE PROGRESS REPORT FOR THE YEAR 2009-10

## CE-P1: PROJECT COORDINATION

| S. No. | Title of Activity | Targets for 2009-10 | Details of Activity | Achievements |
|---|---|---|---|---|
| 1. | Review of physical & financial project progress | Six-monthly Steering Committee meetings | - Timely preparation & circulation of Agenda items to members.<br>- Drafting, approval & circulation of minutes of these meetings. | First Steering Committee Meeting of the year was held during April 09 to approve the annual action plan and budget for the year 2009-10.<br>The second meeting to review the progress upto Janury 2010 was held at Bangalore 5th March 2010. |
| | | 6 bi-monthly project review meetings | - Follow up on the action points. | 6 bi-monthly project review meetings held at FRLHT, with the project staff, by the Project Director. |
| | | Timely audit of project accounts | - Compilation of accounts, preparation of utilization certificates and annual audit of accounts. | Project accounts for the year 2008-09 have been audited and the utilization certificate stands submitted to the MoEF. |
| 2. | Preparation of Progress Reports | Preparation of Annual Project Report (bi-lingual) for 2008-09 | - Compiling reports on the basis of information received from PIs.<br>- Finalization of reports. | Printed copies of the Annual CoE report (in English and Hindi versions) for the year 2008-09, duly vetted by the Steering Committee, submitted to the MoEF |
| | | | | Two progress reports have been prepared. |

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| 3 | Writing of new proposals to strengthen CoE | Follow up of proposal to NMPB for funds towards strengthening the raw drug repository | - Liaison with NMPB for the purpose. | NMPB is still in the process of finalizing the modalities for such funding. Pending sanction of the grant from NMPB, FRLHT had mobilized its internal resources to maintain the repository during 2009-10.<br><br>To add to the CoE resources, a project related to *Decalepis arayalpathra* (*Janakia arayalpathra*), an endemic and endangered medicinal plant species of Western Ghats has been sanctioned by the DST and the work is in progress. |
| 4 | Liaison with other organizations to further the objectives of CoE | With BSI and its regional centres for sharing of herbarium sheets | - Drafting agreements, writing letters, personal meetings with target organizations. | FRLH herbarium encouraged an active exchange of herbarium specimens among different Herbaria and Botanical gardens from Rajasthan, Sadar Patel University, Gujarat Central National Herbarium, Kolkata. The FRLH team also visited the Botanical Survey of India, Shillong Regional Centre. |

## Œ- P2: BIO-GEO CULTURAL REPOSITORY OF NATURAL RESOURCES USED BY INDIAN SYSTEMS OF MEDICINE

| S. No. | Title of Activity | Targets for 2009-10 | Details of Activity | Achievements |
|---|---|---|---|---|
| 1. | Strengthening of Herbarium | Addition of 150 medicinal plant species to herbarium (=500 voucher specimens) | - Planning field visits, making logistic arrangements & obtaining necessary permissions<br>- Field visits to various parts of the country for collection of specimens for herbarium.<br>- Processing, mounting, identification and labeling of specimens.<br>- Data entry, accession and physical placement of specimens in the herbarium cabinets. | Herbarium specimens collected from Andaman and Nicobar Islands, Andhra Pradesh, Goa, Gujarat, Meghalaya, Nagaland, Karnataka, Kerala, Rajasthan and Tamilnadu and special focused collections from Botanical gardens such as Indian botanical Garden, Kolkata; Calicut university, Kerala and Btoanical Garden in Salem, Tamilnadu resulted in addition of 921 field collection numbers.<br>In Addition to in-house collections, the collaboration with BSI (Kolkata) and 69 specimen from "Dibang Valley" were added to the herbarium.<br>Totally 155 plant species have been added to the herbarium. |
| | | Addition of voucher specimens to cover the range of distribution and morphological variations of medicinal plant species (=1000 voucher specimens). | | 1500 voucher specimens added to the repository. |

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| 2 | Development of virtual herbarium | Addition of 2000 images of medicinal plants, their officinale parts & habitats | - Recording images of medicinal plant species in the field.<br>- Scanning of selected herbarium sheets highlighting flowers/ fruits/ both/ morphological variations and systematic storage of scanned images. | 2200 plant images, edited and added to the image library |
| | | Addition of 500 digitized herbarium sheets | | 500 voucher specimens have been scanned at 600 dpi. |
| 3 | Design of educational and extension material | Finalize Draft-1 of 'Red listed medicinal plant species of India' | - Finalization of Draft-1 of manuscript, including the images, description, Threat status etc. | The species have been shortlisted and a format has been prepared for developing the write-up. Pooling of photographs is in progress. |
| | | Design and produce second set of 4 posters on medicinal plants | - Prepare concept notes for 4 themes, pool relevant data.<br>- Design and produce poster sets. | Four posters of the following themes were designed, compiled and printed.<br>1. Aromatic medicinal plants,<br>2 Herbal toothbrushes,<br>3 Medicinal Flowers,<br>4 Goksura, |
| 4 | Training programmes | Organize two training programmes in herbarium techniques | - Plan and organize the training programmes<br>- Prepare training reports. | Conducted 2 day training on herbarium techniques and plant identification to<br>1. Unani medical and Pharmacy colleges (30th-31st July for 30 participants),<br>2. Mount Carmel College 2nd-3rd July for 30 participants and 16th -17th July for 33 participants)<br>Additional training programes<br>Additional training programmes were conducted for the students of different colleges (Jain College, Bangalore, Women's Christian College, Chennai, Sri Sri Ayurveda College and Bishop Cotton Women's College). |

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| | | Thematic arrangement of the medicinal plants repository for educational purposes in the newly designated area | • Short-listing of 10 themes<br>• Selection of representative herbarium sheets for the short-listed themes.<br>• Developing the contents for educational material | The following 11 themes have been short listed and posters for the same have also been prepared. 1) Agnimantha, 2) Daruharidra, 3) Goksura, 4) Isabgol, 5) Pashanabheda, 6) Punarnava, 7) Trikatu, 8) Trimada, 9) Triphala, 10) Vidanga, 11) Vidari. |
| | | Addition of 250 authentic raw drug samples | • Collection of authentic samples from properly identified plants | 255 authentic raw drug samples from properly identified plants have been collected from Karnataka (115), Tamil Nadu (109), Madhya Pradesh (8), Gujarat (7), Kerala (6), Rajasthan (3), Himachal Pradesh (3) and Goa (3). They have been processed and bottled. |
| | | Addition of 150 market samples | • Raw drug samples procured from the raw drug markets | 235 raw drugs have been procured from raw drug markets across India: Madhya Pradesh (75), Rajasthan (96), Gujarat (53) and Goa (11) |

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| 5 | Status survey of Red-listed medicinal plant species | Status survey of wild populations of *Saraca asoca* across its range of distribution in India | - Plan and conduct survey in East Coast/ Ghats (West Bengal, Orissa) and north-east India (Khasi hills). | Final report has been prepared |
| 6 | Strengthening of Raw Drug Repository | Stock and status verification of Raw drug Samples in the Repository | • Verifying the collections and recording their status; preparing the status and stock report. | Completed the stock verification, repository houses 2171 samples which include 1548 market collections and 623 authentic field collections. |
| | | Bottling of samples into display bottles and labeling the bottles | • Bottling of the raw drug samples<br>• Preparing the labels and Labeling the raw drug sample bottles | The activity is ongoing and in progress. 1014 samples have been labeled. |
| | | Computerisation of Raw drug sample data into the data entry module. | • Entry of the Field data book information into the raw drug entry module. | 1682 records have been computerized into the raw drug entry module (entire repository). |
| | | Preparation of draft – raw drug catalogue of raw drug repository collections. | • Preparation of the draft of the catalogue based on the stock verification of raw drug samples | Draft catalogue has been prepared. |

## CE-P3: ESTABLISHMENT OF ETHNO-MEDICINAL PLANTS DEMO GARDEN

| S. No. | Title of Activity | Targets for 2009-10 | Details of Activity | Achievements |
|---|---|---|---|---|
| 1. | Strengthening of ethno-medicinal garden | Collection of propagules of 65 additional medicinal plant species | - Planning field visits, making logistic arrangements & obtaining necessary permissions<br>- field visits for collection of planned germplasm & maintaining of the same in nursery<br>- design of thematic layout plan<br>- planting of seedlings in the thematic layouts<br>- strengthening & maintaining the thematic layouts created during the previous years | 68 species collected and added to the garden. |
| | | Establishment of three new themes in the EMG | | The following 3 themes established:<br>1. Narcotic and poisonous plants.<br>2. Plants used for enhancing water quality<br>3. Plants used in traditional bone setting |
| | | Strengthening & maintenance of thematic layouts established during the previous years | | Ongoing |
| 2 | Design, preparation and affixing of educational signage | Preparation and fixing of educational signage (3 themes & 100 boards) | - Finalization of write up and photographs for the sign boards<br>- Production and affixing of sign boards | 100 boards have been prepared and installed. |

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| 3. | Educational & Extension programs | Organizing four EMG based awareness-cum-educational programs in medicinal plants | - Plan and organize the training programs<br>- Prepare training reports | 8 programs conducted for students and staff of :<br>● St. Joseph's College, Bangalore (21 participants)<br>● Seth Govindji Raoji Ayurved Mahavidyalaya, Solapur, Maharashtra (40 participants).<br>● Bannari Amman Institute of Technology, Bangalore (30 participants).<br>● Garden City College, Bangalore (30 participants).<br>● Srishti School of Art, design and technology, Bangalore (8 participants).<br>● Mount Carmel College, Bangalore (30 participants).<br>● Nirmala College for women, Coimbatore, (25 participants).<br>● Government Homeopathic medical college, Bangalore (38 participants). |
| | | Preparation of manuscript of EMG establishment manual | - Incorporating peer comments and print 500 copies. | Final draft ready. |

## CE-P4: PHARMACOGNOSY STUDIES

| S. No. | Title of Activity | Targets for 2009-10 | Details of Activity | Achievements |
|---|---|---|---|---|
| 1. | Studies on controversial botanical raw drug groups | Continuation of laboratory work to complete gaps in Daruharidra | - HPLC & HPTLC fingerprint of new accessions of *Morinda umbellata*<br>- Physicochemical analysis of *Morinda umbellata* (new accessions) and compilation of results.<br>- Phytochemical screening of Daruharidra candidates (3 samples each)<br>- DNA extraction standard-ization from stem samples.<br>- RAPD-PCR of the DNA using random primers.<br>- Development of species-specific SCAR markers for *Berberis aristata*. | - **Completed -** HPLC & HPTLC fingerprint of new accessions of *Morinda umbellata* samples received in March 2009.<br>- **Completed–**Physicochemical analysis of *Morinda umbellata* samples received in March 2009 and compiled the results.<br>- **Completed** - Phytochemical screening of all Daruharidra candidates (3 samples each).<br>- **Completed** - DNA extraction from the available accessions of Daruharidra spp.<br>- **Completed** – ITS and rRNA sequence based approach for molecular identification was done for Daruharidra DNA sequence submitted to NCBI.<br>- **Completed** – Species-specific markers for each Daruharidra species have been developed and validation of markers completed.<br>**Still to do (2010 –11)**<br>1) Obtain more Berberis accessions. 2) Experimentation with new accessions - Phytochemical screening, physicochemical analysis, HPTLC & HPLC & Molecular analysis. 3) Obtaining quality images of macro, micro, TLC, HPLC and molecular marker fingerprint 4) Report preparation |

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| 2. | | Bring out Vidanga monograph (50 nos). | - Improvement of draft monograph based on experts comments<br>- Getting quality images- Photographs and figures for the monograph<br>- Structure confirmation of the isolated compound from *Maesa indica* in collaboration with IISc. (Organic Chemistry Dept).<br>- Peer reviewing, updation, layout design and printing. | **Completed** - As per experts suggestions carried out the repeatability & reproducibility of results obtained and confirmed the previous findings.<br>**Completed -** Getting quality images- Photographs and figures for the monograph.<br>**Completed** – Structure confirmation of the New compound<br>**Still to do (2010 – 11)**<br>- Publishing work on kirtiquinone in Peer-reviewed journal.<br>- Screening for biological activity of kirtiquinone (anthelmintic & antitumour)<br>- Critical features of distinction between spp. using Microscopy<br>- Anthelmintic & anti-cancer activities of Vidanga spp<br>- Monograph finalisation and printing Peer reviewing and publishing on other work. |
| 3. | | Bring out monograph on 'Vidari' group of species. | Finalization of Vidari monograph and submission for peer review<br>- Completion of quantification of Puerarin and scopoletin by HPLC and HPTLC.<br>- Estimation of total carbohydrates and proteins in all four spp. used as vidari | **Completed** - quantification of puerarin and scopoletin in Vidari spp. using HPLC and HPTLC.<br>**Completed** – Estimation of total carbohydrates and proteins in all four spp. used as vidari and incorporated in the report.<br>**Still to do (2010-11)**<br>- Quality images- Photographs, Figures for the monograph.<br>- Draft Monograph on Vidari<br>- Publishing in Peer-reviewed journals. |

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| 4. | | Continuation of laboratory work to complete gaps in Goksura (*T. terrestris, T. subramnyamii* & *T. lanuginosus)* for differentiating the species. | - Physicochemical analysis, phytochemical screening, total saponins, total alkaloids, total carbohydrates and total proteins in Goksura speciesRAPD-SCAR Marker development and sequencing | **Completed -**physicochemical analysis, phytochemical screening, total saponins, total alkaloids, total carbohydrates and total proteins in Goksura species<br>- **Completed** - Identification of approx. 500 bp polymorphic band for *Pedalium murex* with OPA 08; Band isolated and sequenced. SCAR markers were designed and validated.<br>- **Completed**- Identification of approx. 600 bp polymorphic band for *Tribulus* spp. with GKVK 14; Band isolated and sequenced.<br>- **Completed** – ITS region and rRNA sequence based molecular identification of *Tribulus* spp. and species specific markers for *T. terrestris*, *T. lanuginosus* and *T. subramaniyamii* completed and validated.<br>- **Publication –** An article titled "Development of ITS sequence based marker to distinguish *Tribulus terrestris* (Zygophyllaceae) from its adulterants" has been published in Fitoterapia. DOI information: 10.1016/j.fitote.2010.01.002 (Impact Factor- 1.5)<br>**Still to do in 2010-11**<br>Quantification of diosgenin in Goksura candidates Validation of results reproducibility (Personnel).Quality photos of macro, micro, TLC, HPLC fingerprinting and RAPD-PCR for monograph Report preparation Publishing in Peer Reviewed Journal. |

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| 5. | | Abhava Dravya | - Collection of minimum three accessions of *Aconitum heterophyllum* and *Cyperus rotundus* Spp. (min. 3 samples each)<br>- Preliminary phytochemical studies on collected accessions. | Completed – Collection of 6 samples of *C. rotundus* Collected one accession of *A. heterophyllum* sample.<br><br>More needed<br><br>**Publication** - An article titled "*Cyperus rotundus*, a substitute for *Aconitum heterophyllum*: Studies on the Ayurvedic concept of Abhava Pratinidhi Dravya (drug substitution)" has been published in JAIM, Vol. 1, 2010<br><br>**Still to do in 2010-11**<br><br>● Collection of more samples of *Aconitum heterophyllum*<br>● Comparative phytochemical studies of *A. heterophyllum* and *C. rotundus.*<br>● Publishing in Peer reviewed journals |

## CE-P5: DISTRIBUTION MAPPING USING GIS & IDENTIFICATION ISSUES OF TRADED MEDICINAL PLANTS

| S. No. | Title of Activity | Targets for 2009-10 | Details of Activity | Achievements |
|---|---|---|---|---|
| 1. | Generation of distribution maps for traded medicinal plants | Generate geo-distribution maps for **250** prioritized species.<br><br>Generate eco-distribution maps for **25** prioritized species<br><br>Finalize the upgraded version of digital atlas of distribution maps prepared during the previous year | - Collate information from published sources & in-house survey results.<br>- Generate geo-distribution maps for **250** species, and eco-distribution maps for **25** species.<br>- generate multi-layered maps based on this information<br>- Finalize the upgraded version of digital atlas | Data for preparing geo-distribution maps in respect of **250** medicinal plant species compiled and corresponding maps have been generated.<br><br>Data compilation completed for **25** prioritised species and eco-distribution maps have been prepared for the same.<br><br>The newly generated geo-distribution maps as well as eco-distribution maps have been added to the digital atlas. It now incorporates geo-distribution maps for **1670** taxa and eco-distribution maps for **180** taxa. |
| 2 | Studies on identity of medicinal plants being exported/ imported | Discussions with BSI and the Customs department of GoI for developing a proposal for more rigorous system of HS codes with precise linkage with taxonomic identities of medicinal plants. | - Development of a draft for improvement of HS codes. | The report titled “Appraisal of data recording and reporting system relating to exports and imports of Indian Medicinal Plants” has been shared with BSI and the issues related to this, has been shared with IRS (customs) officer trainees. |

## CE-P6: OUTREACH (TRAINING & EDUCATIONAL MATERIAL ON PLANTS OF ISM)

| S. No. | Title of Activity | Targets for 2009-10 | Details of Activity | Achievements |
|---|---|---|---|---|
| 1 | Develop educational CDs | Development of CD-ROM on plants in *Susruta Samhita*: Peer review of the prototype of the CD-ROM on plants in ***Susruta Samhita*** and preparation of its finalized version after peer review. | • Peer review of the prototype prepared during 2008-09.<br>• Updating the CD in view of peer comments<br>• Application testing. | **Completed.**Internal review has been undertaken and application interface has been modified. Search facility has been improved and errors/ bugs rectified.<br>For the peer review, CD had been sent to three experts. Their comments/ suggestions have been incorporated in the CD. |
| | | Preparing prototype of the CD on plants in ***Ashtanga Sangraha*** (500-650 AD Ayurvedic text)<br>Other outreach activities | Grouping of information (Botanical correlation, Sanskrit synonyms, plant references with clinical data, commentary, formulations, etc) from classical text *Ashtanga Sangraha*<br>Interface development and testing for the draft version. | Incorporated clinical data for around **9000** records and identified around 16,000 citations for this database.<br>**Completed** botanical correlation exercise for Sanskrit synonyms.<br>**Completed** interface development in net environment.<br>Reorientation training program (RoTP) on medicinal plants, for teachers of Ayurveda Colleges, conducted during 28th May – 2nd June 2009 with financial support from AYUSH.<br>Participated and displayed educational CD-ROMs on medicinal plants at National food festival, Calicut, during 10-15th of February 2010. |

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| 2. | VB ToT Course | Organise the third level of VB ToT course for the VB master trainers | - Organise final (3rd) level VB ToT program for the master trainers who have undergone 2 levels of ToT during 2008-09 | Final evaluation course completed in August 2009. |
| 3. | Brain Storming workshop for finalizing guidelines for conservation of medicinal plants | Organise 3 day workshop on conservation of medicinal plants | • Seek funds from NMPB to organize the workshop.<br>• Identify the participants<br>• Organise the workshop<br>• Prepare the Draft Strategy guidelines for conservation of medicinal plants. | Workshop conducted during May 2009<br>Draft Strategy guidelines developed and circulated among eth participants |
| 4. | Capacity Building Courses for the front-line staff of State Forest Departments in respect of Identification and Management of Wild Medicinal Plant Resources | Organise state specific capacity building courses in 4 states for the frontline forest staff (2 back to back courses in 4 states) | - Seek permission from the PCCFs of respective states to organize the training courses<br>- Identify the participants with the help of respective State Forestry Training Institutes<br>- Prepare state specific curriculum and module<br>- Organise training | Four Capacity Building courses conducted in Rajasthan and Gujarat, during October-November 2009 (courses were conducted as planned).<br>The remaining will be taken up during 2010-11 |

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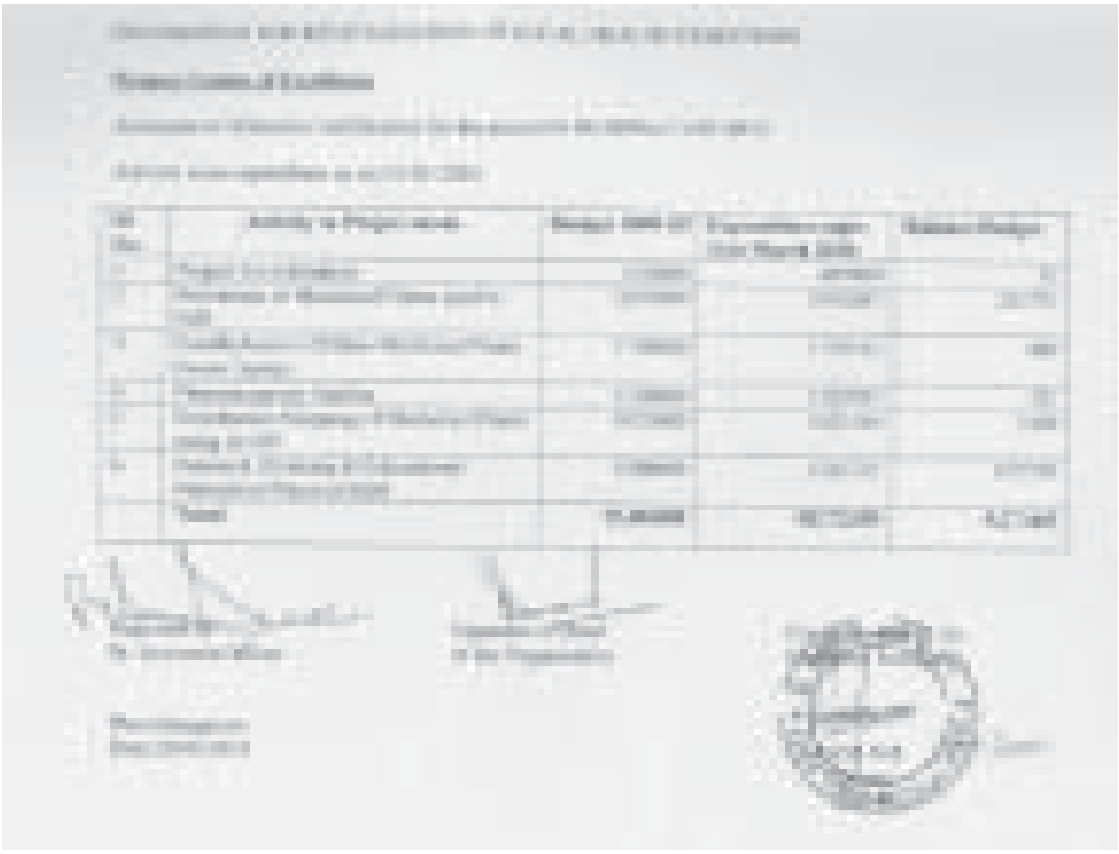
| 5. | Organisation of a National workshop to finalise the draft Strategy and guidelines for conservation and sustainable utilisation of wild medicinal plants resources | Planning and execution of a national workshop for finalizing the draft strategy and Guidelines for conservation and sustainable utilisation of medicinal plants of India | - Preparing the structure of workshop.<br>- Enlistment of participants and correspondence<br>- Logistic arrangements<br>- Conduct of the workshop<br>- Preparation of the report | The program could not be held owing to non availability of suitable dates from the PCCFs and senior forest officers of 26 states. The same will be taken up during early 2010-11. |

# 4 BUDGET & EXPENDITURE

Grant of Rs. 90 lakhs was released towards the action plan of the Centre of Excellence for the year 2008-09. Component-wise expenditure, Utilisation Certificate and other expenditure details are presented below:

| | Component-wise Annual Expenditure (in Rs.) | | | | | | Total |
|---|---|---|---|---|---|---|---|
| | CE-P1 | CE-P2 | CE-P3 | CE-P4 | CE-P5 | CE-P6 | |
| Salaries & Wages | 3.36 | 12.90 | 11.70 | 10.20 | 7.80 | 6.96 | 52.92 |
| Permanent Equipment | 0 | 3.50 | 0 | 0 | 0 | 0 | 3.50 |
| Expendable Items | 1.25 | 2.00 | 2.40 | 3.90 | 1.45 | 0.94 | 11.94 |
| Travel | 1.00 | 4.85 | 1.00 | 0.70 | 1.00 | 0.70 | 9.25 |
| Contingencies | 0.59 | 0 | 0 | 0 | 0 | 0 | 0.59 |
| Other Costs | 0.50 | 3.30 | 2.30 | 0.50 | 0 | 10.20 | 16.80 |
| Total | 6.70 | 26.55 | 17.40 | 15.30 | 10.25 | 18.80 | 95.00 |

** Note: Includes an amount of Rs. 5 Lakhs, out of the unspent balance for the year 2008-09, carried forward to 2009-10.



# 5 INDIVIDUALS AND AGENCIES INVOLVED

The achievements under the project would not have been possible without the active support of many agencies and individuals. We would like to gratefully acknowledge the support provided by the following:

State Forest Departments: State Forest Departments of Andhra Pradesh, Uttarakhand, Kerala, Karnataka, Madhya Pradesh and Tamil Nadu for participating and facilitating the Village Botanist Training programme. State Forest Departments of Andaman & Nicobar Islands, Meghalaya, Assam and Himachal Pradesh for granting necessary permission and providing logistic support during field floristic surveys. State Forest Departments of Karnataka, Tamil Nadu, Andhra Pradesh, Madhya Pradesh, Gujarat, Maharashtra, Uttarakhand and Kerala for granting necessary permission to the Forest Working Plan Officers to attend training.

Botanical Survey of India, Kolkatta and Shillong.

Non-Government Organisations & Industry: Sambandh (Orissa), Rural Communes (Maharashtra), Tagore Society for Rural Development (West Bengal), Society for Technology and Development (Himachal Pradesh), Jagaran Jan Vikas Samiti (Rajasthan), SAWARD and Wayanad Social Service Society (Kerala), BIRD(K) (Karnataka) and SDM Ayurveda Pharmacy, Udupi.

Botanical Gardens, Research Institutes, Universities Kerala Forestry Research Institute (Kerala), Sadar Patel University, Gujarat, Calicut University, Calicut, Central National Herbarium, Kolkata. Indian Botanical Garden, Kolkatta, and A Balasubramaniam Garden, Salem, Tamilnadu,

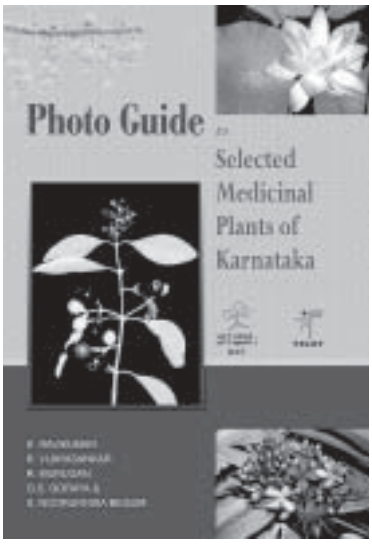
# 6 PROJECT TEAM

Implementation of this multifaceted project was steered by the Advisor FRLHT with separate Program Incharge for each of the project components. The list of staff members involved with the project is given below:

1. D K Ved, Director
2. Madhav Rao, Program Assistant
3. Dr. K Ravikumar, Assistant Director
4. S. Noorunnisa Begum, Program Officer
5. R. Vijaya Sankar, Research Officer
6. Dr. K Haridasan, Jt. Director
7. Ganesh Babu, Research Officer
8. T K Sriram, EMG Supervisor
9. B S Somashekhar, Assistant Director
10. Deepa G.B., Research Officer
11. Dr. Venugopal, Assistant Director
12. Dr. Shilpa, Research Fellow
13. Sugandhi, Data Entry Operator
14. Vijay Barve, Sr. Program Officer
15. Sangeetha, Research Officer
16. Dr. Padma Venkat, Jt. Director
17. Dr. Preethidan. D. S., Sr. Research Associate
18. C. Chandrakala, Research Officer
19. Padmashree, Research Associate
20. Balasubramani S.P. Research Associate
21. Neeraja, Research Fellow
22. P V Somashekhar, Assistant Director

# 7. PUBLICATIONS

## A. HERBARIUM GROUP




### Book

- Ravikumar, K., R. Vijaya Sankar, R. Murugan, G.S. Goraya and S. Noorunnisa Begum. 2010. *Photo Guide to Selected Medicinal Plants of Karnataka*. Foundation for Revitalisation of Local Health Traditions, Bangalore. Pages:111+iv, Price: Rs.170.00.

### Scientific Papers

- Karthigeyan K., R. Sumathi & J. Jayanthi. 2009. *Orophea narasimhanii* (Annonaceae) – A new discovery from Andaman Islands, India. *Nordic Journal of Botany*. 28: 56 – 57.
- Karthigeyan K., R. Sumathi, J. Jayanthi & P.G. Diwakar. 2009. New records of plants to the flora of India from South Andaman Island. *Indian Journal of Forestry*. 32 (2): 301–303.
- Karthigeyan K., R. Sumathi, J. Jayanthi & D. Narasimhan. 2010. *Codonacanthus sanjappae* (Acanthaceae) – A new species from Andaman & Nicobar Islands, India. *Nordic Journal of Botany*. 28: 501-502.
- Ravikumar, K. and R. Vijaya Sankar. 2009. *Antiaris toxicaria* (Moraceae) – a new distribution record to the Eastern Ghats. *Journal of Threatened Taxa*. 1(1):58-59.
- Sampath Kumar V., Vinod Maina & R.Sumathi. 2010. An Analysis of floral diversity in Volcanic Barren Island, Andamans, India. In: Ramakrishna, C. Raghunathan & C. Sivaperuman (Eds.) *Recent trends in Biodiversity of Andaman and Nicobar Islands.* Zoological Survey of India, Pp. 207 – 214.
- Sumathi R., K. Karthigeyan & J. Jayanthi. 2009. Additions to the genus *Bulbophyllum* in India from Andaman & Nicobar archipelago. *Taiwania* 55: 82 – 85.
- Sumathi R., J. Jayanthi, K. Karthigeyan & D. Narasimhan. 2009. New reports to the flora of India from Saddle Peak National Park, North Andaman. *Rheedea*.19: 69 – 71.
- Ved D.K., R. Sumathi & Darshan Shankar. 2010. Prioritisation of Medicinal Plants for cultivation. In: Gupta S.K and B.R. Mitra (Eds.) *Proceedings of the All India Seminar on Recent Trends in Utilization of Medicinal Plants in Human Welfare*. Ramakrishna Mission Ashrama, Narendrapur, Kolkata. Pp. 176 – 181.

## B. ETHNO MEDICINAL GARDEN GROUP

### Scientific Papers/ proceedings

- Haridasan K. 2009. A note on production and productivity of bamboo (nursery and plantation) in Orissa. In the proceedings of the *National level workshop on Productivity and Marketing of bamboo and its Products*, 12th February, 2009, Bhubaneswar, Pp. 111.

### Popular articles

- N. M. Ganesh Babu, 2009. Trivrit (*Operculina turpethum*)-a cheerful clambering! Live without whimpering! *Heritage Amruth*. Vol.5, Issue 2.
- N. M. Ganesh Babu, 2009. Palliative paarul mool! Keeping your garden cool! (*Stereospermum suaveolens & S. colais*). *Heritage Amruth*. Vol.5, Issue 3.
- N. M. Ganesh Babu, 2009. Wild Jack-food in the Kitchen! Good in Garden! (*Artocarpus hirsutus*). *Heritage Amruth*. Vol.5, Issue 4.
- N. M. Ganesh Babu, 2010. Murva-Endangered in wild, Enchanting in garden (*Chonemorpha fragrans*). *Heritage Amruth*. Vol.6, issue 1.

## C. LABORATORY GROUP

### Scientific Papers

- Balasubramani SP, Murugan R, Ravikumar K and Venkatasubramanian P. 2010. Development of ITS sequence based molecular marker to distinguish *Tribulus terrestris* L. (Zygophyllaceae) from its adulterants. *Fitoterapia*. 81: 503-508.
- Balasubramani SP and Venkatasubramanian P, 2010. Molecular Identification and Development of Nuclear DNA ITS Sequence based marker to Distinguish Coscinium fenestratum Gaertn. (Menispermaceae) from its Adulterants. *Provisionally accepted by Asian Journal of Pharmaceuticals and Clinical Research.*
- Devaiah K, Balasubramani SP and Venkatasubramanian P. 2010. Development of RAPD based SCAR marker for identification of Ipomea mauritiana Jacq. (Convolvulaceae). *eCAM* doi: 10.1093/ecam/neq023 (in press).
- Padma Venkatasubramanian, Subrahmanya Kumar K and Venugopalan S.N Nair. 2010. *Cyperus rotundus*, a substitute for *Aconitum heterophyllum*: Studies on the Ayurvedic concept of Abhava Pratinidhi Dravya (drug substitution). *Journal of Ayurveda and Integrative Medicine*.1 (1):33-39.

## D. TRAINING GROUP

### Invited Presentations

- Somashekhar B. S. *Overview of the Medicinal Plants Diversity of Tumkur District*. Workshop on Dry zone Biodiversity. Karnataka Forest Department & Western Ghats Task Force, Bangalore, 14th March 2010, Tumkur.
- Somashekhar B. S. *NTFPs: Harvesting Strategies and implications on sustainability of the resources.* State level Brainstorming Workshop on NTFPs. Sahyadri Parisara Vardhini & Western Ghats Task Force, Bangalore, 25th March 2010, Sirsi.