

**From Director's Desk**

The reporting period 'July 2017 to June 2018' was a crucial transition phase witnessing a change of guards in the Institute. The restructuring of the Institute as desired for its upgradation to a National level Institute in year 2016-17, was carried out; the 4-Thematic Groups and 10-Thematic Divisions mandated to take-up R&D activities in the specified thematic areas were reorganized into 4 -Thematic Centres named as - i) Centre for Land and water Resource Management (CLWRM), ii) Centre for Biodiversity Conservation and Management (CBCM), iii) Centre for Socio-Economic Development (CBCM), and iv) Centre for Environmental Assessment and Climate Change, and the 5-Regional Units were renamed as Regional Centres (CEA&CC), namely- Himachal Regional Centre (HRC), Garhwal Regional Centre (GRC), Sikkim Regional Centre (SRC), North-East Regional Centre

(NERC) and Mountain Division Regional Centre (MDRC), which were seen as independent units, to work on region specific R&D within the Institute's mandate.

The work domain, vision, and mission of the R&D programs of the Thematic Centers were redrafted and the research activities of the Thematic Centres and Regional Centres were accordingly aligned to cater to the developmental needs of the respective fields and the regions. Like previous years the Institute Annual Day remained the major event, the G B Pant Memorial Lecture was delivered by Prof S P Singh, the Former Vice-Chancellor HNB Garhwal University. The Global Environment Day-2018 was a long celebrations spanning over a period of 3 weeks; awareness meetings, community cleanliness drives, and inter school declamation/ skit/ painting/ poetry contests were organized by Institute HQs and Regional Centers, and the activities kept everyone busy during this period. The Institute as a nodal agency of National Mission on Himalayan Studies (NMHS) successfully discharged its duties relating to review, progress assessment, and implementation of projects. It further strengthened its ties with institutions like ICIMOD on trans-boundary collaborations and Earth-watch International India on Citizen Science Program.

This Newsletter provides a brief description of the events and activities of the Institute, I feel extremely delighted to forward this issue of HIMA-PARYAVARAN to our readers and would appreciate their comments for improvement.

**(Kireet Kumar)**  
**Director In-charge**



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(An Autonomous Institute of Ministry of Environment, Forest & Climate Change, Govt. of India)

**Kosi-Katarmal, Almora-263 643, Uttarakhand, India**

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## About the Institute

The G P Pant National Institute of Himalayan Environment and Sustainable Development (GBPNIHESD), previously known as 'G B Pant Institute of Himalayan Environment and Development (GBPIHED)', was established in 1988. It is mandated to devise suitable R&D strategies to maintain a balance of intricate linkages between socio-cultural, ecological, economic and physical systems that could lead to sustainability of the Indian Himalayan Region (IHR). The scope of Institute's R&D activities is broad and covers various facets of environment and development in the twelve Himalayan states of India. It executes its mandate through the Headquarters located at Kosi-Katarmal, Almora (Uttarakhand), and four Regional Centres known as Himachal Regional Centre (HRC) located at Kullu (Himachal Pradesh), Garhwal Regional Center (GRC) at Srinagar-Garhwal (Uttarakhand), Sikkim Regional Centre (SRC) at Pangthang-Gangtok (Sikkim), North-East Regional Centre (NERC) at Itanagar (Arunachal Pradesh), and a Mountain Division at MoEFCC, New Delhi. The R&D activities of the Institute at HQs are operated through four Thematic Centres, namely - i) Centre for Land and Water Resource Management (CLWRM), ii) Centre for Biodiversity Conservation and Management (CBCM), iii) Centre for Socio-Economic Development (CSED), and iv) Centre for Environmental Assessment and Climate Change (CEA&CC), whereas the R&D at Regional Centres focus on issues of regional relevance.

The Institute strives to achieve its mandate by following inter/multi-disciplinarity and integration as guiding principles, and a balanced approach with equal emphasis on research, demonstration, and dissemination activities. The emphasis on interlinking of natural and social sciences is the major thrust of all R&D programmes of the Institute. In this effort, special attention is placed on the intricate linkages between fragility of mountains, indigenous knowledge and sustainable use of natural resources, and trans-boundary collaborative studies on biodiversity conservation. Design and implementation of R&D activities on priority environmental problems, development and demonstration of best practices, technology packages and delivery systems for improved livelihood of the people are amongst the core issues covered under most of the Institutional projects/programmes.

In past Hima-Parayavaran have benefitted from the inputs of our readers, we solicit your suggestions & comments for improvement. Please do send your immensely inputs also on the contents and style of this newsletter.

## Events - (July 2017 to June 2018)

### Annual Day and G B Pant Memorial Lecture (GBPNIHESD, Kosi-Katarmal)

The Institute celebrated its 29th Annual Day on September 10, 2017 at the Institute headquarters at Kosi-Katarmal, Almora, & its regional units at Kullu (HP), Srinagar (Uttarakhand), Gangtok (Sikkim), and Itanagar (Arunachal Pradesh). At headquarters the 23rd Pt. Govind Ballabh Pant Memorial Lecture was the main event of the function. Hon'ble Sri Ajay Tamta, the Minister of State for Textiles, Govt of India, inaugurated and presided the function as the Chief-Guest. Dr. Dhan Singh (Education Minister, Govt. of

initiatives made by the Institute in devising alternative uses of pine needles to minimize the forest fire occurrences. Hon'ble Dr Dhan Singh Rawat said in modern times the environmental awareness & education are very important, and applauded Institute's efforts in this context. Dr Dhyani, the Director G B Pant Institute, in his short address broached the audience about the institute's works and achievements, and the progress of newly initiated eight initiatives. Retd. Admiral D. K. Joshi and Sri A. S. Nayal, the Commissioner Kumaun Division, also

expressed their views by recounting the contributions of Pt Pant for the nation and hill regions of the Himalaya. Nearly 200 representatives from various government departments, academic institutions, NGOs, teachers & students participated in the function. Nearly 200 persons representing various institutes/ academic institutions, Government departments, NGOs working in Himalaya, & the students and teachers attended the function.



Uttarakhand), Shri Raghunath Singh Chauhan (MLA Almora), Retd. Admiral D.K. Joshi, and Shri A.S. Nayal, (Director, Uttarakhand Academy of Public Administration) were the other important dignitaries on the Dias. Prof. S. P. Singh (Chairman GBPNIHESD Scientific Advisory Committee, & Former Vice Chancellor HNB Garhwal University) was the Guest Speaker who delivered the G B Pant Memorial Lecture on "Climate change in Himalayas: Research Findings, Complexities, and Role of Research Institutions in the Himalaya" wherein he summarized the changing environmental and livelihood scenario across IHR. Highlighting the impending threats and challenges of climate change, he emphasized on incorporation of climate adaptation and mitigation as an important focus of all developmental research and planning in the Himalaya. Hon'ble minister Shri Ajay Tamta, appreciated the achievements of the Institute and the

In the regional centers of the institute, the Annual Day was celebrated the by organizing popular lectures on region specific issues under the banner of 'Popular Lecture Series', a major program under 'Institute's New Initiatives'.



## Himachal Regional Center :

In Himachal Pradesh the event was organized at the campus of the Himachal Unit at Mohal- Kullu. Dr. S. K. Sharma, Emeritus Scientist, CSIR-IHBT, Palampur (Former Vice Chancellor, CSK HPKV, Palampur & Former Director, NBPGR, New Delhi) was the Guest Speaker who delivered a comprehensive lecture on



“Protection of Indian Biodiversity with special reference to Himalayas”. He highlighted the importance of biodiversity, its status (India and Himalaya) and threats, and suggested mechanisms to prevent its loss; and also provided a very vivid orientation on various biodiversity acts and presented Geographical Indication Act in detail, he urged the audience to take a pledge for conservation of biodiversity through its sustainable use. The Chief Guest, Dr. Om Hari Chaturvedi Head, ICAR-North Temperate Regional Station, Garsa spoke on the life values of Pandit Govind Ballabh Pant and emphasized on conservation and management of biodiversity through poetic verses. Guest of Honor, Shri B. S. Parsheera highlighted the importance of rich traditional knowledge stored in tribal areas of the Himalaya, and emphasized on the benefit sharing of rich wealth of traditional knowledge for its long lasting existence. Dr S. S. Samant in his briefing highlighted the achievements of the Himachal Unit, and introduced the Guest Speaker to the audience. Nearly 150 representatives of Line Departments,

NGOs, Academic Institutions, and Students and Teachers from Govt Degree Colleges participated in the function.

## Garhwal Regional Center :

In Garhwal Center, the Himalayan Popular Lecture on - "Concept and implementation of water conservation and accumulation in mountainous areas" was delivered by Mr. Sachida Nanda Bharti (JalYodha), the Guest Speaker. In his address Mr Bharti underlined on the need for combining the experiences of traditional conservation practices with that of scientifically



designed advanced practices for better/efficient management and use of water. The lecture was followed by open discussions and experience sharing on the subject. The event helped in providing better understanding of water scarcity in the region and the conservation initiatives taken up by different stakeholders. The function was attended by around 120 participants comprising of students from Govt. Polytechnic College Srinagar, Faculty & Research Scholars from HAPPRC and Garhwal University, the NGOs and other stakeholders from the region.

## Sikkim Regional Center :

In Sikkim the event was organized at Chumbi Residency, Gangtok. Prof. T.B. Subba, Vice-Chancellor, Sikkim University was the Chief Guest & the Guest Speaker who delivered a popular lecture on "Himalayan Way of Life in the context of climate change" . Dr Thomas Chandy Principal Secretary cum

PCCF - Sikkim Wildlife, Forest & Environment, who was the Guest of Honour speaking on 'Impacts of Climate Change on Forests & Environment' said that the climate change impacts on Himalaya will be



Approximately 95 representatives from Government Departments, Scientific Institutions, NGOs, and Faculty and Students participated in the function.

### NE Regional Center:

In North-East a popular lecture on this occasion was organized at Itanagar; Prof. R.M. Pant, Director, NIRD & PR-NERC Guwahati, Assam was the Guest Speaker who delivered a popular lecture on the topic “Rural tourism for sustainable development: Insights from North East India” where he demonstrated as to

how the rich culture and traditional knowledge of the tribal communities can be harnessed for conservation, livelihood and sustainable development in the region. Er. M. S. Lodhi, welcomed the participants, and highlighted the achievements of the NE Unit. The event was attended by a large number of representatives of Government Organizations, NGOs, students, teachers, and civil society members.

## Skill and Capacity Building for Improved Tourism Services (GBP-SRC)

GBPNIHESD in collaboration with Khanchendzonga Conservation Committee (KCC) organized a five day training during September 20 - 24, 2017 at Yuksam under KLCDI project. The purpose of the program was to improve the tourism services in the three pilot sites of Khangchendzonga landscape (KL) in India. It aimed at providing basic knowledge and training to the participants on every sphere for a successful ecotourism development in the identified pilot sites; subject experts from various fields of eco-tourism such as birds and butterfly, waste management, camping, hiking, etc. imparted training instructions and exposure to practical demonstrations thru onsite visits. Around 40 participants, 10 each from the four villages from the three pilot sites, were identified for this training by using a predefined criteria.



## Citizen Science Program (GBP- HRC)

The Himachal Regional Centre of the Institute in collaboration with Earth Watch International organized a Citizen Science Program for the volunteer group of 12 participants from India, Poland, US, UK, Bulgaria, Malaysia and Australia during Oct 5-14, 2017 under GBPIHED-EWI Himalayan Ecosystems Service, Citizen Science and Community based research projects. The program included trainings/ work scheduling under 4- standard modules wherein the participants were given instructions and training on methodologies for qualitative and quantitative assessment of biodiversity, pollinators assessment, and identification and assessment of preferential bee foraging resources. The practical demonstrations about the qualitative and quantitative assessment of vegetation, and assessment of the insect pollinators' diversity were given in the Institute's Arboretum. In addition, the participants were also given orientation about Institute, its laboratories and facilities, and the Ecosystem Service Project. The achievements of the project were also shared with the participants, and also briefed thru lectures on 'Pollination, pollinators and their importance for food security' by the PI & Head Himachal Regional Centre Dr S. S. Samant. The participants were taken to orchards/ farmer's field for data collection, and presented their reports in the concluding sessions and their feedbacks on the program were obtained.



## Training programme cum consultative meeting on rejuvenation of springs-and spring-fed-streams organised at Bhimlitali village (GBP-GRC)

A one-day training programme and stakeholders consultative meeting on rejuvenation of springs- and spring-fed streams was organised by Garhwal Regional Centre (GRC) of the Institute at village Bhimlitali (Pauri Garhwal) on 17th October 2017. The major objectives of the meeting were to interact and share experiences



and knowledge with stakeholders about how to rejuvenate the springs and spring fed streams which they were utilizing for a various purpose such as drinking, irrigation and other daily chores. Secondly, it also intended to sensitize the stakeholders about the various groundwater augmentation techniques suggested for watershed development and their applicability in the present terrain conditions. The consultative meeting also identified the need for priority interventions and skill development of village community with regards to successful intervention and to enhance water recharge from the treated areas with proactive community participation and coordination. The programme was followed by a site visit to the proposed intervention site.



## Diversity - Our Identity Our Heritage

The G B Pant Institute in collaboration with Indian partners in Kailash Sacred Landscape Conservation and Development Initiative (KSLCDI) project, organized a series of showcasing events and state level science-policy dialogues during November 22-26, 2017 at Pithoragarh in Uttarakhand. The events included, (i) Exposure cum learning visit to successful interventions for representative cultural groups and departmental representatives (November 22-23, 2017) (ii) Mainstreaming of Kailash initiative dialogue forum for Peoples Representatives (November 24, 2017), (iii) My viewing of Kailash landscape contest of expressions and exhibition



(November 25-26, 2017), (iv) Diversity - our identity our heritage workshop for students and teachers (November 25-26, 2017), and (v) Innovative thinking for conservation and development in KSL- Policy and Program Consultative meeting (November 26, 2017). All these events were conducted as part of assessment of final delivery of efforts and achievements under KSLCDI (Phase I) during 5 years of implementation,



and to seek guidance from stakeholders for the next phase.

### Stakeholder's Consultation Workshops GBP-NERC

The Northeast Regional Centre of the Institute organized 2 Stakeholder's Consultation Workshops under (i) NMHS sponsored project entitled "Anthropogenic impacts and their management options in different ecosystems of the Indian Himalayan Region" and (ii) In-house project entitled "Enhancing eco-cultural livelihoods in biodiversity rich areas of Arunachal Himalaya", at Mother's Home Museum Hall, Ziro (Lower Subansiri District, A.P.) on 7<sup>th</sup> December, 2017. The basic objectives of the workshops were to introduce the aims and objectives of the project to the stakeholders, the targeted activities, stakeholders' role in project implementation, and the envisaged expected outcomes. A total of 30 persons from local community, government departments, NGOs, Biodiversity Management Committees (BMCs) etc. participated in the workshops.

## International Mountain Day

The Institute celebrated the International Mountain Day (IMD) 2017, at the institute's headquarters at Kosi-Katarmal, and its 4 - Regional Centers by organizing lectures and discussion sessions on the International Mountain Day's Theme of the year titled - "Mountain under Pressure: climate, hunger, migration" on December 11, 2017.

In Institute headquarters after a briefing about the International Mountain Day, a discussion session was organized in which Institute faculty and research staff actively participated. In Himachal Unit the event was organized in the committee hall of the Himachal Pradesh Fruit Growers Association at Mahili, PatliKuhl, where after an orientation lecture on Mountain Day, lectures relevant to the Mountain Day Theme contexts were delivered; namely, Climate Change - by Dr J C Kuniyal, Water Resources by Shri B. R. Negi (Retd. DFO) and Er. Vaibhav E. Gosavi and

Migration issue s by Dr . Renu Lata. Shri Rajgi



r Mahant, President Fruit Growers' Association shared farmers' experiences regarding climate change impacts on apple and other horticultural crops. About 90 representatives from Fruit Growers' Association, farmers, Mahila Mandals and Yuvak Mandals & institute faculty members & staff participated in the celebration. The Sikkim and NE unit also organized in-house discussions on Mountain Day Theme and mountain problems.



## Workshop on climate change impact on natural resources, adaptation and management strategies in central Himalaya (GBP-GRC)

A one day workshop on climate variability/change impact on natural resources and possible adaptation strategies was organized at Garhwal Regional Centre, Srinagar Garhwal on 20th December 2017. The workshop attempted to bring together experts, the local farming communities, and the local NGOs, to start a dialogue on how to discuss experiences and strategies to deal with the impacts of climate change in hilly region of Garhwal Himalaya. About 60 participants representing farmers from nearby villages, and representatives from academic Institutions (HNB Garhwal University, Govt. line agencies) and NGOs participated in the program. The workshop helped in identifying areas for capacity building of farming communities, and assessment of adaptation strategies for best results at the community level.



## Capacity Building Training Programme NMSHE Task Force-3 (GBP-SRC)



The Institute's Sikkim Regional Center (SRC) under NMSHE Task Force 3: Forest Resource and Plant Diversity project, organized a capacity building training programme on 'medicinal plant cultivation and conservation' on 27<sup>th</sup> December 2017 at the SRC campus at Pangthang, Gangtok. The training aimed at creating awareness amongst the farmers, and the panchayat and forest officers for cultivation and conservation of medicinal plants in Sikkim. During the program an orientation on practices used for medicinal plant cultivation and conservation was provided by the subject experts from the various institutes; market potential of medicinal plants was also highlighted to encourage farmers to take up its cultivation.

## Training and capacity building programme on bioresources utilization through simple technological intervention for livelihood enhancement of disaster affected villages of Kedar valley (GBP-GRC)

A two-day training and capacity building programme on bioresources utilization through simple technological intervention for livelihood enhancement of disaster affected villages of Kedar valley was organized by Garhwal Regional Centre of GBPNIHESD at village Badasu district Rudraprayag, Uttarakhand between 7-8 February, 2018. The aim of the workshop was to provide an umbrella for sharing experience and ideas among wider stakeholders such as scientists, officials of state government line departments, villagers, NGOs, and students in the context restoring means of livelihood of disaster affected local people of the region. The programme identified the need for capacity building programmes for farming communities in the region, review current and future plans for adapting strategies

and discussed how to best implement strategies at the community level. The programme also identified the key factors of climate change and their impact on traditional farming system and promotion of organic cultivation and climate resilient technologies to cope the adverse impact of climate change.



## Training on vegetation assessment and statistical analysis

The Institute's Centre for Biodiversity Conservation and Management (CBCM), under its in-house project on 'Long-term ecological monitoring in western Himalaya and knowledge generation for decision making', organized a two week long hands-on training course titled - 'Vegetation assessment, Herbarium methods and Statistical analysis for Long-Term Ecological Monitoring' at Nature Interpretation and Learning Centre, at GBPNIHESD, Kosi-Katarmal, during Feb 19, 2018 to March 13, 2018. . The training course provided basic exposure on (i) methods of field surveys, data collection, analysis and interpretation; (ii) herbarium specimen collection, preparation, preservation, accessioning and the record keeping;



and (iii) effective use of statistics for analyzing field datasets. A total of 60 scholars / students from nine different institutions and organizations participated in the training.

## Project Evaluation Committee (PEC) meeting cum IERP workshop

Project Evaluation Committee (PEC) meeting cum Integrated Eco-development Research Program's workshop were jointly organized by the Institute with Tripura University, Agartala, Tripura on February 27-28, 2018 (for evaluation of IERP sponsored on-going projects and funding of new projects considered and duly approved by the committee). During this workshop various projects sponsored under IERP were evaluated and new ones were sanctioned for funding. In the meeting it was suggested and

highlighted that there is a need of implementation of - quality action oriented research, development and extension projects for North Eastern Region. Out of the 42 projects proposals that were invited from North-Eastern states for presentation in the meeting, only 38 projects PIs presented their project proposal before PEC members. From Tripura University, the Department of Botany, collaborated in conducting this PEC meeting cum workshop.

## Workshop cum Training Programs on Forest Resources and Plant Biodiversity (GBP- HRC)

The GBPNIHESD Himachal Regional Centre organized two '1-day Workshop cum Training Program' on Forest Resources and Plant Biodiversity at 'Fruit Growers Association Office, Patlikuhl, Kullu' on Feb 27, 2018, and the Institute's Campus at Mohal Kullu on March 23, 2018. In the first program at Patlikuhl 61 participants from Upper Kullu Valley representing local farmers, panchayat representatives, and members of Biodiversity Management Committees of Upper Beas Valley of Kullu were engaged enlightened on concepts of sustainable harvesting of forest resources, factors responsible for environment degradation, impacts of climate change, sustainable development, and importance of bees in pollination & sustainable

agriculture and horticulture in the valley. In the second program over 80 participants including representatives from - Forest departments, District Administration, NGOs, Women Self-Help Groups, and Village Panchayat, participated and were given orientation on topics such as Impacts of climate change on agricultural, horticultural and vegetable diversity of the Kullu Valley, vulnerability assessment of the forest resources, and value addition of non-timber forest produces (NTFPs) and their sustainable harvesting. The programs also included an interactive session where queries of participants were answered, 'Training Material' in the form of booklet on forest resources and plant diversity was also distributed to the participants.



## Training-cum-Capacity Building Workshop on Solid Waste Management (GBP- HRC)

GBPNIHESD, Himachal Regional Centre, organized 2- Training-cum-Capacity Building Workshops on 'Solid Waste Management' at the Institute Campus Mohal-Kullu on 24th February 2018 and Hotel Chandermukhi, Rangri (Manali) on 22nd March 2018 under the project activity “Community driven solid waste management in Himachal Pradesh: A step towards Swachh Bharat Mission”. Dr. S. S. Samant, the Scientist Incharge & Convener broached the participants about the project objectives and concept, and provided orientation about solid waste types, management choices etc. Nearly, 200 persons representing ward members, gram pradhans, officials from municipal council, tourism department, hoteliers, town and country planning office and local inhabitants of Kullu and Manali areas, and the researchers and staff of the Institute, participated in the workshop. The participants also shared their experiences on Solid Waste Management, and assured for their cooperation for the initiative. Dr. Renu Lata anchored the program and Dr. J. C. Kuniyal proposed the vote of thanks.



## International Day for Biological Diversity 2018

The International Day for Biological Diversity was celebrated at Institute headquarters and its regional centers. At the headquarters events were organized for the farmers, and the students & teachers of the Chaudas Valley of Pithoragarh District. The farmers' program was hosted at Sri Narayan Ashram, on May 22, 2018, aimed at creating awareness about biodiversity conservation and promoting cultivation of medicinal plants.

The farmers were given orientation about the importance medicinal plant cultivation as an income supplementing activity, and the ex-situ conservation site developed at Sri Narayan ashram was demonstrated to them. Nearly 93 farmers from 11 villages participated in the event. The students awareness program was organized at Govt Inter College Pangu, on May 23, 2018 and May 28-29 at Institute HQs (Kosi-Katarmal); field visits for creating appreciation and affiliation with nature and awareness for biodiversity conservation were organized, and around 200 students and 20 teachers were sensitized. In Himachal Regional Centre a discussion session on the Theme - 'Celebrating 25 Years of Action for Biodiversity' was organized. Dr S S Samant briefed the audience about the IBD Them, and made a power point presentation on- Biodiversity conservation, ecosystem services and climate change. He also highlighted the various government initiatives for biodiversity conservation and efforts made by the Institute in this front. Mr. B. L. Negi, Conservator Kullu and the Chief Guest addressed the audience about Forest management, Biodiversity Acts, Wildlife Protection Acts, and importance of biodiversity management and its sustainable development. Dr. Kirupa Shankar, DFO, GHNP shared information about the human dependency on the forest resources and importance of their conservation in GHNP. Nearly 73 participants including members of BMCs, Pradhans and Members of different Panchayats in Upper Kullu Valley, senior forest officials from Kullu forest circle, and faculty and researchers from the Institute attended the function.

In Sikkim Regional Centre Exposure Visits and Quiz Contest for school students was organized; the students were given orientation about the biodiversity day, the theme, the importance of biodiversity and pollution related threats to biodiversity. In North East Regional Centre the event was celebrated by cleaning drive and plantation of saplings in the Rural Technology Centre (RTC) of NERC located at Dera Natung College campus.



## Global World Environment Day & Pre Events

On the eve of Global World Environment Day a series of programs were organized by the Institute HQs and its Regional Centers on the GWED Theme - 'Beat the Plastic Pollution'. The programs focused on generating awareness and sensitizing people on the plastic pollution, its impacts, and ways and measures



to minimize plastic pollution and discouraging single use of plastic in our daily life. The programs mainly targeted the junior and senior level students, and several events such as skit/declamation contests, poetry/ painting/poster/ quiz competitions etc at schools, and cleanliness drives in the villages were



organized; the programs also given widespread publicity for awareness building and to mobilize collective action against plastic pollution. At institute HQs, all the 4- Thematic centers organized these programs at different-different places. The events organized are briefly mentioned below.

### GBPNIHESD -HQs

**Awareness Program for students on Beat the Plastic Pollution (GBNIHESD-HQs)** - CLWRM organized 3 awareness programs for school students on May 9, 2018 at Govt Inter College Kanda, May 15, 2018 at Govt Inter College Someshwar, and May 24, 2018 at Govt Inter College, Chaukhutia. Under these programs besides orientation lectures on 'Plastic Pollution Awareness', interschool competition on events such as declamation, quiz, painting, poetry, skits etc were organized amongst the junior and senior section students, and the winners were awarded prizes. Over 237 students from 33 schools attended these programs.

**Plastic Free Cleanliness Drive (GBNIHESD-HQs)**-CBCM organized several events under this program at GBPNIHESD, Kosi-Katarmal - 22nd May 2018, different villages at Chaudas Valley (Pithoragarh) - 27-29th May 2018, and GIC Shitlakheth(Almora) on 30th May 2018. Nearly 350 students, 20 teachers and 200 villagers participated in these programs. Cleanliness campaigns, awareness program/ lectures, Nukkar-Natak, and drawing/ slogan writing/ poetry/ crafts from plastic were the major activities covered under this program.



### Himachal Regional Centre -

**Plastic Free Cleanliness Drive:** This program was organized on May 19, 2018, Under which 101 members from 7 Mahila Mandal and 5 Village Panchayats were given demonstration in waste segregation, and were divided in 11 groups to carrying out cleaning in the Mohal Khad area. The garbage collection and segregation by different groups was evaluated, and the groups standing first, second & third were awarded prizes. The event was coordinated by Dr JC Kuniyal.



**Awareness Program cum Workshop on Plastic Pollution:** This program for students and teachers was organized on May 19, 2018 at HRC Mohal-Kullu; the participants were given orientation lecture on GWED and its Theme by Dr S S Samant, the Scientist Incharge HRC & coordinator, which was followed by the address of the Chief Guest Prof. Deepak Pant

Ziro, Lower Subansiri District, of Arunachal Pradesh on May 17, 2018. A total of 19 participants (12 boys and 7 girls) took part in the competition. The participants were also given briefing on GWED Theme and instructions thru posters about plastic pollution, its impacts, and reusability.

**Brainstorming Meeting on “Plastic Free Himalaya” at APRC-Botanical Survey of India (BSI), Itanagar** -The Brain Storming Meeting on “Plastic Free Himalaya” was hosted at APRC-Botanical Survey of India (BSI), Itanagar on May 17, 2018. The meeting included lectures by SIC NERC on the 'GWED Theme and the Impact of Plastic Pollution in Himalaya', Officer Incharge BSI-APRC on 'Impact of Pollution on Floral Diversity', and Dr. K.S. Kanwal, Scientist NERC on 'Reduction in use of Single Use Plastic. This was followed by discussion on plastic pollution on biodiversity. The meeting concluded with screening of documentary on diversity of Rhododendron species of North-East India made by BSI Scientists.



(Department of Earth and Environment Sciences, Central University, Dharmshala), on 'Entrepreneurship Development from Plastic', and a talk by Dr J C Kuniyal on 'Plastic Pollution and Management'. This session was followed by declamation and painting contests for Junior group and Senior Group students; the winners were awarded with prizes. In all, 142 students and teachers representing 17 Government and Public schools of the Kullu Valley and faculty and staff of the center participated in the event.

**Awareness Program on “Plastic Free Himalaya” at Mother's Home Ziro, Lower Subansiri District :**

The program was organized on June 4, 2018; it started with a brief introduction about the Institute and a talk on plastic pollution by Er M S Lodhi SIC-NERC, where he explained about the plastic pollution, waste management issues, harmful effects of plastic on both terrestrial and marine ecosystem. This was followed by a speech by Mr. Rubu Tadii, Chairman, Ziro Valley School on environment and plastic pollution; he emphasized on good practices amongst the Apatani community of planting 3-4 trees after felling one, and also cited examples of neighboring villages about reuse of plastic bottles for making plastic ropes, and use of plastic caps in foot-path to prevent slipping during rainy season. Smt. Talyang Shanti, Chairperson Achukuru Welfare Society, emphasized that controlling plastic pollution would be much easier when everyone become involved. The program was attended by 23 participants comprising of students from Ziro valley School & TISS- Guwahati, members of Achukuru Welfare Society, and Scientists of NERC.

**Plastic and Litter Free Drive :** The event was organized in the HRC Campus on June 4, 2018. After a briefing by Scientist Incharge about the plastic pollution and an appeal to minimize the use of plastics; 70 participants including the staff of the center participated in cleaning of the Institute HRC campus.

## North East Regional Centre -

**Essay Competition and Awareness Program at Ziro :** The essay writing competition on GWED Theme - 'Beat the Plastic Pollution' was organized for the Class-X students of Ziro Valley School, at Lempia,





**Awareness-cum-education program on “Plastic Free Himalaya” in Balijan Village** - In the program awareness lectures on plastic pollution, its impact on ecosystem components/human health, its long decomposition time & trail of footprints, different types of plastics & their hazard potential etc. were delivered by the NERC faculty, and the subject was also explained through relevant posters. Afterwards, together with villagers cleaning in Balijan Market area was carried out, and low cost bamboo dustbins were installed; participants were also distributed saplings for plantation. The program was organized on May 19, 2018; around 130 villagers including village head man, members of SHGs, and secretary Balijan Welfare Committee along with Institute's scientists and staff participated in the event.

### Sikkim Regional Center -

**Plantation Drive and Swachh Bharat Mission Campaign in Upper Samdong, East Sikkim)** - At Government Senior Secondary School, Samdong village, East Sikkim on June 1, 2018 a briefing about the World Environment Day & GWED Theme was given by Dr Y.K. Rai, which was followed by a talk by Dr. M. Shahid explained about the significance of plantation in school and villages. The saplings of Lapsi (*Choerospondias axillaris*), Mail (*Eriolobus indica*), Phoenix *rupicola*, Pampsi (*Machilus edulis*), etc. were planted in school premises and a cleanliness campaign was carried out in the school and the village. The segregation of biodegradable and non biodegradable waste was also encouraged thru demonstration. The school Principal and the Panchayat President thanked the Institute for hosting the program in their school/village.

### Global World Environment Day 2018-

The GWED main program at HQs was organized at Institute Campus at Kosi-Katarmal. The winners (students and student groups, and school team) of the different categories of the interschool contests, that were organized at various places by under different Thematic Centers, were the special guests of this program. The best performances under each category of events were repeated live by the concerned winning schools of that category and the overall best performances were awarded prizes and certificates. The program began with a general orientation lecture on World Environment Day History, and the Theme of the year - Beat the Plastic Pollution'. Over 200 participants including the institute faculty and staff participated in the program.

In Himachal Regional Center at Mohal-Kullu 121 participants from different Line Departments, Eco-clubs, municipal council, local panchayats, biodiversity management committees and NGOs attended the program. Dr. S. S. Samant, delivered a lecture on 'Plastic Pollution and Management', the Chief Guest Dr. G C Bains (Deputy Director cum



Project Officer, DRDA Kullu) in his address highlighted the various issues related the environment and its management. A video on 'Plastic Pollution and Management' was also shown and CDs were distributed to the participants. In Sikkim Regional Centre students of Sikkim Government College Tadong, and Sikkim Government College Burtuk were invited to the SRC campus at Pangthang for participation in a discussion session, and Painting & Quiz competition. The participants were briefed by the



Dr Mithilesh Singh (Scientist Incharge), about the GWED, its significance, and the 'Initiatives of Sikkim Government to Reduce Plastic Waste'; Dr M Shahid gave a talk on Plastic Pollution & its Environmental Impacts. In NERC, the centre in collaboration with Zoological Survey of India, Arunachal Pradesh Regional Centre, Itanagar, organized a one day Workshop on “Plastic pollution and its impacts on Environment including Biodiversity and Society – The Arunachal Pradesh perspective” at ZSI, APRC, Conference Hall, at Itanagar.



## Meetings of National Mission on Himalayan Studies (NMHS)

### NMHS -STAG and Steering Committee Meetings

In response to NMHS call for new projects under six Broad Thematic Areas, the 7<sup>th</sup> Scientific and Technical Advisory Group (STAG) meeting was held at MoEF&CC New Delhi on 13 February 2018. The meeting was presided by the Additional Secretary, MoEF&CC Govt of India. After a thorough review of the screened projects by the STAG, a total of 21 projects, 5 State Government Projects (SGPs) and one Him-Nature Learning Centre (Him-NLC) were recommended for the consideration of the Screening Committee. The 5<sup>th</sup> Steering Committee Meeting was held under the Chairmanship of the Secretary, MoEF&CC, New Delhi on 19 February 2018, which after intense discussion and deliberations approved 34 projects, 2 Him-Nature Learning Centres (NLCs) and 5 State Government Projects (SGPs).

The 8<sup>th</sup> Scientific and Technical Advisory Group (STAG) meeting was held under the Chairmanship of the Additional Secretary, MoEF&CC at New Delh on 20 March 2018; the STAG after rigorous review recommended 20 projects and 11 institutional fellowship grants for consideration of Screening Committee. This was followed by 6<sup>th</sup> Steering Committee meeting held on 22 March 2018 at MoEF&CC New Delhi; the meeting was chaired the Secretary, MoEF&CC, Govt of India. The Steering Committee approved 19 projects and 10 institutional fellowship grants subject to compliance of subject-specific comments/remarks.

## NMHS- MLE Workshop

The NMHS Monitoring, Evaluation and Learning Workshop was organized at GBPNIHESD, Kosi-Katarmal, Almora during October 13-14, 2017 where the Annual Project Progress of NMHS funded projects in Large Grant (> 5 Crore), Medium Grant (50 Lakhs to 5 crore) and Small Grant (< 50 Lakhs) fund



categories were reviewed by panelists and subject experts in broad thematic group based Technical Sessions; the workshop also evaluated presentations of new projects submitted for funding for experts comments and further consideration. The workshop were presided by Dr Lalit Kapoor, Advisor MoEF&CC, New Delhi.

## NMHS - 1<sup>st</sup> Himalayan Researchers Consortium

The first Himalayan Researchers Consortium under the aegis of National Mission on Himalayan Studies was organized during 26—27 April 2018 at UCOST, Dehradun in Uttarakhand. The Secretary, MoEF&CC, Govt of India inaugurated and chaired the event. The event was organized into different technical sessions under the broad theme of Biodiversity Conservation and Management. During the event, 60 young Himalayan researchers participated and presented their fellowship progress in front of the MLE Panel, subject experts and other invited eminent resource persons.







## SIGNIFICANCE OF CARBON STOCK IN FORESTS OF NORTHEAST INDIA

Yumnam Johnson Singh, Sunumoni Kumari, Rubu Challa  
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Forest is one of the most important renewable natural resources which play an extravagant role in the survival of human beings and animals. They are often termed as 'Green gold'. Being a natural storehouse of biomass and store maximum carbon than any other terrestrial ecosystem, while influencing the global climate by changing the atmospheric CO<sub>2</sub>. The relationship between species richness, aboveground biomass and carbon stock can have crucial implications for the management and conservation of carbon sinks. However, these natural resources are constantly under threat and over exploited in various parts of the country especially in the Indian Himalayan region.

The Indian Himalayan region constitutes a major geo-ecological feature of the planet spanning 12 Indian states namely, Jammu & Kashmir, Himachal Pradesh, and Uttarakhand in the north. Sikkim, Arunachal Pradesh, Meghalaya, Nagaland, Manipur, Mizoram Tripura and hill regions of Assam and West Bengal in the Northeast. Arunachal Pradesh has the maximum area under forest cover while Jammu and Kashmir has the least. Total forest cover in the NER is 171,306 sq.km which is 65.34% of its geographical area in comparison to the national forest cover of 21.54%. The region is responsible for providing water to a large part of the Indian subcontinent. The region is bestowed with rich biodiversity and diverse array of cultural communities which ultimately made it an interesting area to focus and study because of its diverse nature of flora and fauna, contributing more than half of the total species diversity of the country. However, its vulnerability to global warming is relatively high due to various factors.

Anthropogenic factors like increasing excessive emissions of greenhouse gases, urbanization and deforestation and other natural phenomenon like rainfall and humidity variability, volcanic eruptions, variation of earth's orbit around the sun etc. lead to the change in climate. Among the various factors of forest degradation and exploitation, shifting cultivation is quite prevalent accounting for large tract of forest exploitation in the Northeastern Himalayan region.

Greenhouse gases like carbon dioxide has a vital role in the system wherein

the proportional increase results in steadily rising amount of GHGs. Therefore, to check the GHGs is an extensive global concern and carbon sequestration is one of the significant measures which is possible by either increasing forest resources or conserving them to a better extent.

Carbon sequestration is the process of removing excess carbon from the atmosphere and depositing in other reservoir principally through changes in the land use system which practically occurs mostly through expansion of forests. Furthermore, the terrestrial carbon sequestration is the net removal of CO<sub>2</sub> from the atmosphere and storing it in the terrestrial ecosystems. The problems of CO<sub>2</sub> accumulation in the atmosphere could only be mitigated by either reducing emission or by developing other applicable strategies. The forest biomass is now becoming the key parameter in dealing with the current climate change issues as it is able to mitigate the effect of global warming. Under Kyoto Protocol, forests are considered for their unique role as carbon sinks because they are capable of capturing and storing carbon dioxide from the atmosphere (FAO, 2005). Forest absorbs CO<sub>2</sub> continuously from the atmosphere and release oxygen through photosynthesis by plants. They store carbon as a necessary component for their growth and thus increase the biomass. For the proper management of forest, the knowledge on carbon sequestration is necessary to support the conservation and restoration of the forest. State wise carbon stock of the Northeastern states are given in the table 1:

**Table 1: State wise Carbon stock in the Northeast:**

STATE	Geographical area	AREA	AGB	BGB	DEAD WOOD	LITTER	SOC	TOTAL
Arunachal Pradesh	83,743	66,964	243,462 (36.36)	53,378 (7.97)	4,305 (0.54)	16,231 (2.42)	677,163 (101.12)	994,539 (148.52)
Assam	78,438	28,105	47,343 (16.85)	10,824 (3.85)	1,093 (0.39)	5,240 (1.16)	112,352 (39.98)	176,852 (62.93)
Manipur	22,327	17,346	27,253 (15.71)	8,821 (5.09)	530 (0.31)	3,909 (2.25)	102,578 (59.14)	143,091 (82.49)
Meghalaya	22,429	17,146	25,168 (14.68)	6,835 (3.99)	881 (0.51)	5,184 (3.02)	117,772 (68.69)	155,840 (90.89)
Mizoram	21,081	18,186	15,359 (8.45)	3,173 (1.74)	633 (0.35)	2,652 (1.46)	73,224 (40.26)	95,041 (52.26)
Nagaland	16,579	12,489	16,151 (12.93)	4,150 (3.32)	666 (0.53)	2,432 (1.95)	101,661 (81.40)	125,060 (100.14)
Sikkim	7,096	3,344	13,379 (40.01)	3,735 (11.17)	211 (0.63)	585 (1.75)	30,624 (91.58)	48,534 (145.14)
Tripura	10,491	7,726	15,674 (20.29)	3,224 (4.17)	556 (0.72)	1,613 (2.09)	42,341 (41.45)	63,408 (82.07)

(Source: Carbon Stocks in forest of India, ISFR Report, 2017)

AGB= Above Ground Biomass, BGB= Below Ground Biomass, SOC= Soil Organic Carbon



After the analysis of carbon stock related studies and statistics it has been observed that Arunachal Pradesh has the maximum carbon stock of 994.5 million tonnes followed by Assam with 176.8 million tonnes. Per hectare carbon stock among different states of Indian Himalayan region indicates that Arunachal Pradesh is contributing maximum per hectare carbon stock of 148.52 tonnes followed by Sikkim (145.14 tonnes). At national level 32% of carbon stock is in AGB whereas about 56% in SOC in all the Northeastern states. It is also observed that SOC is more than double the carbon in AGB in all other major states this ratio is around 1:1.5. Carbon sequestration rate were better if dry deciduous open forest is converted to dry deciduous moderately dense forest while the Tropical wet evergreen forest has maximum per hectare carbon stock of 157.18 tonnes, followed by the Himalayan Moist temperate forest (142.03 tonnes) and sub-alpine forest with 127.04 tonnes.

The Northeastern region of India has great potential for carbon sequestration due to its rich species diversity that includes species like bamboo which is an important component of rural landscapes in the Northeast region of India. Bamboo widely occurs in most of the homesteads of the region. Observation of carbon assimilation ratio from the existing published papers and data on pure plantation forest of Shorea

robusta, Terminalia arjuna and Dalbergia sissoo shows 3.34%, 12.07% and 11.11% respectively which reveals bamboo farming as a cost-effective and promising carbon potential with 16-20%. (Nath, A.J. and Das, A.K., 2011).

Through observations of bamboo grooves of NE, India, bamboo clumps are also used for commercial purposes through deliberate management systems of clear felling (Montagini, F and Nair, P.K.R, 2004).

From the analysis of various studies regarding the carbon sequestration, it is highlighted that bamboo farming is an efficient carbon sequester than pure plantations or natural forest. Bamboo agroforestry can also eliminate the ill effects of poverty and environmental degradation through sustainable management practices. Carbon storage and sequestration potential of bamboo in smallholders agroforestry remains underexploited which through proper management, effective policies and utilization can go a long way while maintaining carbon sinks of the environment. Monitoring on a systematic approach so as to developed strategic and sustainable measures to mitigate the current problems of climate change and its impacts. Promotion of afforestation and encouragement of bamboo farming systems to reduce atmospheric greenhouse gas is highly recommended.

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## Vegetation and regeneration potential analysis of *Myrica esculenta* an actinorhizal plant in Uttarakhand

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Actinorhizal plants are a group of angiosperms and have symbiotic association with di-nitrogen fixing actinobacteria known as Frankia. Actinorhizal species are distributed in Asia, Africa, Europe, Australia, North America and South America and grow in a variety of ecosystems like coastal dune, arctic tundra region and forest, glacial sediment and alpine region. Table 1 exhibit the altitudinal distribution range of representative members of 8 families of actinorhizal plants (Norris et al., 1994). These are a group of woody plant (trees), shrubs, having 4 subclasses, 8 families, and 24 genera and posses over 194 species (Benson

and Silvester, 1993). Except for the genus *Datisca*, which is herbaceous all these species have multiple value such as soil restoration, fuel wood, agro forestry and prevention of desertification as well as fixing nitrogen in the ecosystem. Thus these species play an important role in regeneration of nutrient deficient soil and also help in reducing the use of fertilizer in horticultural crops and waste land rehabilitation.

Table 1. The altitudinal distribution range for representative members of 8 families of actinorhizal plants

s.no	Species	Common name	Family	Range altitude
1	<i>Alnus nepalensis</i>	Utees	Betulaceae	1200m-2500m
2	<i>Casurina equisetifolia</i>	Beefwood	Casuarinaceae	800m
3	<i>Coriaia nepalensis</i>	Makroli/masuri	Coriariaceae	1200-2600m
4	<i>Datisca cannabina</i>	Bujr-bhang	Datisceae	900-1500m
5	<i>Elaeagnus umbellate</i>	Silver berry	Elaeagnaceae	1500-2200m
6	<i>Elaeagnus latifolia</i>	Bastard Oleaster	Elaeagnaceae	1500-2000m
7	<i>Hippophea salicifolia</i>	Khatai, Amesh, Seabuckthorn	Elaeagnaceae	1500-3500m
8	<i>Myrica esculenata</i>	Kaphal	Myricaceae	1500-2200m

Frankia is a filamentous gram-positive nitrogen-fixing actinobacterium found in root nodules or in soil and form symbiotic association with actinorhizal plant. Based on morphological and biochemical attributes along with 16S rRNA sequence information the genus Frankia is classified under the order of Actinomycetales. Actinorhiza is a non leguminous group of nitrogen fixing plants which fix atmospheric nitrogen by forming symbiotic association with Frankia. These plants are distributed across the globe. The root hair of the host plant is invaded by Frankia in many plant species belonging to family Betulaceae, Casuarinaceae and Myricaceae. However, members of Eleagnaceae, Rosaceae and Rhamnaceae families are invaded internally. During the inter invasion mechanism the mitotic division occurred in root corticals which leads to the start of prenodulation and in this process pericycle root cell are further divided and form primordial nodules.

Frankia hyphae infection process ultimately starts cell divisions and caused inter cellular infection by secretion of a fluid to the infection site. During the infection process primordium is infected followed by infection to corticals which enables the suitable condition for formation of multiple lobe nodules (Franche and Bogusz, 2011). The results on the direct inoculation of living cultures of Frankia (strains ORS 021001) to Casuarina plants in a nursery condition before transplantation was carried out in 1984 in Senegal and demonstrated that Frankia strains were effectively associated with *C. equisetifolia* (Sougoufara et al., 1989). Likewise degraded land rehabilitation program was initiated in china by introducing Frankia with more than 6 species of Casuarina. This study highlighted that Frankia can act as a biofertilizer and a life enhancing mediator to improve plant survival, growth and biomass productivity (Zhong et al., 2010). Other studies reveal



**Fig. 1.** Seed germination of *M. esculenta* at GRC using different methods

that association of Frankia with actinorhizal plant provides higher vigor and efficiency to tolerate more abiotic conditions and stresses. Therefore, keeping the potential of the actinorhizal species in mind the present study is attempted to investigate the vegetation and regeneration potential analysis of *M. esculenta* along with its germination studies.

In the present study, 10 distant sites of an actinorhizal plant *Myrica esculenta* from Uttarakhand (Tehri, Pauri, and Chamoli) district were selected for detailed vegetation analysis and regeneration study. Vegetation and regeneration pattern analysis was conducted following standard quadrat method (10m×10m) for target species across all studied sites. Seed germination experiments were carried out at Garhwal Regional centre of the Institute. Several parameters like, species area, frequency, density, abundance, importance value index (IVI) were calculated using standard methodologies and

approach. Regeneration potential of the target species was calculated by summing seedling and saplings. The average frequency (82%), abundance (2.6%), density (2.33%), and IVI (38.49%) were recorded across the studied sites of *M. esculenta*. However, no regeneration potential of *M. esculenta* across all studied sites and no seedlings/ saplings was recorded. Highest density (4.4%) and IVI 63.08% were observed for the species in Kirhsu forest which demonstrated that this site may have the potential to accumulate more nitrogen. However, further quantitative and qualitative experimentation and soil sample analysis are needed for detailed investigation. Seed germination experiments conducted at GRC, GBPIHESD Srinagar on *M. esculenta* seeds without any treatment showed only 1.8% seed germination. The germination of seeds of *M. esculenta* under various treatment using physical and chemical methods (physical scarification, hot and cold water treatment, and H<sub>2</sub>SO<sub>4</sub> treatment) was also performed however the results are still awaited (Fig. 1). Our finding suggested that there is urgent need to develop strategies to rejuvenate the *M. esculenta* forest in Uttarakhand to maintain forest health. Our study suggested that *M. esculenta* has very low regeneration in their natural habitat which might be due to the vast competition between *M. esculenta* and other herbaceous plant species and hard seed coat. Therefore use of biotechnological interventions is needed so as to obtain better re-generation patterns in vitro conditions. Use of tissue culture laboratory and poly houses conditions, and its transplantation in the field followed by inoculation with suitable Frankia strain are required to maintain the regeneration potential of the species. Further in-situ and ex-situ conservation measures may help to promote this actinorhizal plant species for developing biorepository such as Gene bank, seed bank, etc. in Uttarakhand.

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## Hawthorn (*Crataegus songarica* K. Koch) - A Miraculous Species of North Western Himalaya

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Hawthorn belongs to the *Crataegus* Genus and Family Rosaceae and 250 species of this genus have been recorded in the northern temperate regions of the Old and New World. The species ranges from a small shrub to a tree and is widely distributed in western Asia, North America and Europe. It is considered one of the oldest pharmaceutical plants of the western world, and is described in various pharmacopoeias. Historical records of *Erya*, were written by an unknown author in 600 B.C. In China, Hawthorn is known as “Qiu” which means “fruits for good health”. China is one of the major sites of origin of *Crataegus* species and has a long history of hawthorn cultivation. Many species and hybrids are used for horticultural purposes and street trees.

Indian hawthorn, *Crataegus songarica* K. Koch (synonym *Crataegus fischeri* C. K. Schneid.) is a shrub

serrate, apex acuminate; petiole 2 - 2.5cm, glabrous or sub-glabrous; leaf blade rhomboidal-ovate to broadly ovate, 3.5 - 6.5 × 2.5 - 5.5 cm, both surfaces pubescent when young, glabrescent, base cuneate, rarely broadly cuneate, margin remotely serrate and with 2 or 3 pairs of deep lobes, or apically shallowly lobed; lobes oblong, apex acute. Corymb 3 - 5 cm in diameter, many flowered; Young peduncle glabrous or slightly pubescent; bracts caducous, linear, membranous. Pedicel 0.5 - 1.5 cm, slightly pubescent when young. Hypanthium campanulate, initially pubescent, soon glabrous. Sepals triangular-ovate or broadly lanceolate, ca. 3 mm, abaxially initially pubescent, glabrescent; petals absent; stamens 15 - 20. Ovary pubescent apically, 2 or 3-loculed, with 2 ovules per locule; styles 2 or 3. Fruit reddish black with yellow pulp, sparsely punctate, globose, rarely ellipsoid, 1.2 -



**Fig. 1.** *Crataegus songarica* fruits



**Fig. 2.** *Crataegus songarica* tree

or small tree distributed between 800 - 2700 m amsl altitude in India, Pakistan, China, Iran Afghanistan and Kazakhstan. In Himachal Pradesh, it is found in the marginal land, agriculture fields, mountain valleys and rocky slopes of the Pattan Valley of district Lahaul & Spiti, Pangi, Churah and Holi Valley of Chamba districts. In Jammu & Kashmir, it is found in Paddar Valley of Kishtwar district, and Bandipora and Poonch district. In the Pangi and Lahaul valley, it is locally known as Pingyath and Ramjag.

Taxonomic description: *Crataegus songarica* K. Koch is a shrub or small tree with thorns up to 4 - 5 m height. Young branches are purplish brown and old grayish brown, sparsely pubescent, glabrate, terete; buds reddish brown, ovoid, glabrous. Stipules falcate or lanceolate, ca. 8 mm, herbaceous, glabrous, margin

1.6 cm in diameter, glabrous; sepals persistent, reflexed; pyrenes 2 or 3, smooth on both inner sides. It flowers during May- June and pome ripens during August-September.

Indigenous uses and traditional practices: Wood of the species is heavy, hard and tough, used to make plough, agricultural tools, mallets, and other small items, and as fuel. The ripe fruits are eaten by the inhabitants of the region, preferred by children. The inhabitants of region, collect the fruits and sold to the contractors at 18 - 20 Rs/kg. These can be used in the preparation of jams, jellies and wines too. Heart patient eats fruits as cardio tonic. These are fondly eaten by birds and wildlife too. Leaves are used for fodder. A beverage similar to tea is also prepared from the rind and pip. In

Mughal Gardens of Kashmir, these plants are used for the landscaping.

**Medicinal uses:** *Crataegus songarica* is used for cardiovascular problems such as congestive heart failure, coronary circulation problems, and arrhythmias. It is also used to increase cardiac output reduced by hypertension or pulmonary disease, to support hypotension and hypertension, atherosclerosis, hyperlipidemia, and buerger's disease. The barriers of the plant possess antihypertensive and cardio tonic potential. In addition, the plant improves cardiac activity in patients with congestive heart failure. *C. songarica* is also used as a sedative, antispasmodic, astringent, and diuretic, as well as for gastrointestinal conditions, such as indigestion, enteritis, epigastric distension, diarrhea, and abdominal pain. It relaxes the uterus and intestine smooth vessel; however, it constricts the bronchi and coronary vessels. *C. songarica* fruits are also effective orally for tapeworm infections, acute bacillary dysentery, and amenorrhea. *C. songarica* fruit liquid preparations are used as washes for sores, itching, and frostbite.

**Phytochemistry:** The flowers of *Crataegus songarica* yield phenyl-ethylamine, O-methoxy phenethylamine and tyamine. Fruits are source of vitamin C, carotene, tannins, catechins, epicatechin, leucoanthocyanidin. Several flavonoids, 2-phenylchromone derivatives and chlorogenic acid have also been reported from the plant. Amines showed cardiotoxic activity. Bioflavonoids of hawthorn relax and dilate the arteries, especially the coronary arteries. This increases the flow of blood to the heart muscles and reduces the symptoms of angina. Bioflavonoids are also strongly antioxidant, helping to prevent or reduce degeneration of blood vessels. *C. songarica* methanol extract may be an effective hepatic protective agent and viable candidate for treating hepatic disorders and other oxidative stress-related diseases.

**Strategy for Conservation:** As for propagation; harvest ripe fruits, extract the seeds, soak seed in water for 24 hours or scarify in acid, germinate immediately in a spot protected from winter freeze but be patient because germination may take as long as 18 months. They can be planted on their permanent site once they reach 6 or more inches in height. Cultivars can be reproduced from budding in autumn.



## Livelihood improvement through *Nephrolepis cordifolia* in Himalayas: a case study of Kamrang village, South Sikkim

Prashanti Pradhan and Mithilesh Singh ((GBPNIHESD, SRC, Sikkim)

### Introduction

*Nephrolepis cordifolia* (L.) C. Presl is a terrestrial fern belonging to the family Nephrolepidaceae. It is commonly known as “tuberous sword fern” in English and “Pani amala” in Nepalese. It is an epiphytic, epilithic and terrestrial plant producing

and 88° 21'16.91"E. The females from households collect this fern from nearby forests after completion of their daily chores at home which is also accompanied by teenagers on weekends and holidays. The fronds of fern are valued, so only the upper portion is plucked leaving the underground parts intact. They are used for decorative purpose. Many floral shops utilize them for making bouquets; it is mostly used during matrimonial ceremonies with roses and other flowers to decorate foyers, halls and vehicles.

### Economic value

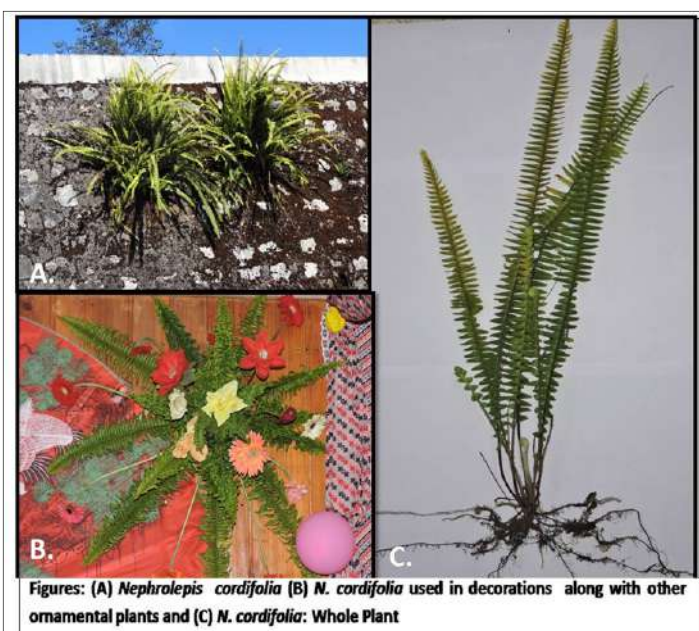
Villagers collect these ferns, packing 100 fronds making one bundle and finally 60 bundles are placed inside a sack. The payment for one sack is priced INR 450-500. It normally requires 2-3 days to gather one sack of ferns for the villagers. Further it is supplied to the dealer (sardar) who trades the accumulated ferns outside the state (mostly West Bengal). Only after trading the fern, the payment is provided by dealer to the villagers.

### Livelihood improvement

The income generated by trading *N. cordifolia*, has been assisting villagers to meet their basic needs especially for women and youngsters in Kamrang village despite of the problems they face in forest such as mosquito bites, bee stings and leech sucking. Some youngsters enrolled in school, visits forest during weekends and collect the fern. They make use of the payment received to purchase stationary products, eatables and fulfilling other needs. While older women utilize the money in household's requirements supporting their family. *N. cordifolia* has been improving some aspects of living, yet its cultivation has not been initiated in this village as it takes a month or two to grow completely after being plucked and the delay of payment by dealers (sardars) is also another problem faced by the villagers.

### Medicinal value and Chemical composition

The plant additionally possesses medicinal properties. In Arunachal Pradesh, the plant is used in the treatment of various ailments. The rhizome is used during cough, rheumatism, chest congestion, nose blockage,



small scaly tubers on their roots and possess short rhizome. The plant is fertile throughout the year producing numerous spores. It mostly inhabits tropical to sub tropical climatic eco-zones. This plant is native to Australia and it occurs in rainforest or open forest in eastern Queensland and north eastern New South Wales. It is widely naturalized in Africa, temperate Asia, Southeastern United States, New Zealand and Macaronesia. In India, six species of *Nephrolepis* are found and Sikkim has two species (Envis Centre Sikkim).

### Ornamental value

*Nephrolepis cordifolia* is one of the most commonly used ornamental fern species. It is commonly cultivated as an ornamental fern in Shillong. It is traded as an ornamental plant to other states from some parts of Sikkim and West Bengal. The studied Kamrang village of Namchi, south Sikkim is located at 1260m asl with geographical location 27° 10'2.215"N

loss of appetites and as antibacterial. The leaflets are used as anti-tussive, styptic, antifungal and in wounds. The decoction of the fresh frond is given as a drink for treating jaundice. The entire fern resembles medicinal property and is used to cure renal, liver and skin disorder while the juice of root tubers is taken to treat fever, indigestion, headache, cough, cold and hematuria (Dhiman, 1998). The nutrient analysis of different parts of the fern showed that the large amount of carbohydrate and calcium are found in tubers (Gauchan et al, 2008). In the studied village, locals consume the tubers to quench their thirst but are yet unexplored to the medicinal assets of the plant.

### Conclusion and Future prospects

*N. cordifolia* has been a source of improvement in the livelihood condition of local people in villages of Sikkim. It has been helping to generate some financial assistance mostly among women and youngsters. Therefore, it is essential to take some steps for its proper cultivation and to provide appropriate market for its supply keeping in mind the time allocated for providing payment to the villagers. With proper investigation of its medicinal value, *N. cordifolia* can open gates to economic escalation in the Himalayas. Since there is only limited information available so far, more studies are encouraged.

### References

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## Visitors (July 1, 2017 - June 30, 2018)

- Dr. Eklabya Sharma, ICIMOD, Kathmandu, Nepal visited GBPNIHESD HQs during **July 11-13, 2017**.
- Dr. Lal Singh, Director, Himalayan Research Group, Shimla visited GBPNIHESD, Himachal Regional centre on **August 3, 2017**.
- Shri Hem Pande, IAS, Former Secretary Govt of India, visited GBPNIHESD HQs during **August 4-6, 2017**.
- Commandent Ranjan Kumar from Sashastra Seema Bal (SSB) visited GBPNIHESD, Himachal Regional centre on **September 10, 2018**.
- Commandent Surendra Kumar from Indo Tibetan Border Police (ITBP) Force visited GBPNIHESD, Himachal Regional centre, on **September 10, 2018**.
- Shri B. L. Negi, Conservator of Forests (CF) Kullu visited GBPNIHESD, Himachal Regional Centre on **14/10/2017**.
- Prof A. R. Nautiyal, H.N.B. Garhwal University (Srinagar) and Member GBPNIHESD Scientific Advisory Committee visited GBPNIHESD HQs during **August 28-30, 2017**.
- Dr. V. P. Dimri, CSIR Hyderabad & , Chairman GBPNIHESD Scientific Advisory Committee visited GBPNIHESD HQs, visited GBPNIHESD HQs during **August 28-30, 2017**.
- Prof. S. P. Singh, Member GBPNIHESD Governing Board, visited GBPNIHESD HQs during **September 8-11, 2017, Oct 13-15, 2017, & June 4-5, 2018**.
- Shri B. S. Parsheera, IAS (Rtd.), Former Special Secretary Raj Bhasha Aayog Govt of India, visited GBPNIHESD, Himachal Regional centre on **September 10, 2017**.
- Dr. S. K. Sharma, Former Vice Chancellor CSK HPKV Palampur, Former Director, NBPGR, New Delhi and Emeritus Scientist, CSIR-IHBT, Palampur visited GBPNIHESD, Himachal Regional centre on **September 10, 2017**.
- Dr. Om Hari Chaturvedi, Head, ICAR-NTRS (North Temperate Regional Station), Central Sheep and Wool Research Institute (CSWRI), Garsa, Kullu, visited GBPNIHESD, Himachal Regional centre on **September 10, 2017**.
- Commandent Ranjan Kumar, from Sasastra Seema Bal (SSB) Kullu visited GBPNIHESD, Himachal Regional centre on **September 10, 2017**.
- Commandent Surendra Kumar from Indo Tibetan Border Police (ITBP) Force visited GBPNIHESD, Himachal Regional centre on **September 10, 2017**.
- Dr Subrata Bose, MoEFCC New Delhi, visited GBPNIHESD HQs during **September 8-11, 2017 & Oct 13-14, 2017**.
- Prof. A. K. Saraf, IIT Roorkee, visited GBPNIHESD HQs during **October 12-17, 2017**.
- Dr Lalit Kapoor, Advisor MoEFCC New Delhi, visited GBPNIHESD HQs during **October 13-14, 2017, March 31 - April 1, 2018, & April 12-13, 2018**. Shri B. L. Negi, Conservator of Forests (CF) Kullu visited GBPNIHESD, Himachal Regional Centre on **14/10/2017**.
- Dr. D. C. Upreti, Emeritus Scientist visited GBPNIHESD HQs during **January 9-10, 2018**.
- Prof. Dr. T Pant, visited GBPNIHESD HQs during **January 9-11, 2018**.
- Dr. J C Bhatt, Former Director VPKAS, visited GBPNIHESD HQs during **January 9-11, 2018**.
- Dr. C. C. Pant, Geology Department, Kumaun University, Nainital, visited GBPNIHESD HQs during **January 31 - February 2, 2018**.
- Dr. Jayant Kumar, Associate Director, Regional Horticulture Research and Training Station, Dr Y.S Parmar University of Horticulture & Forestry Bajaura visited GBPNIHESD, Himachal Regional Centre on **March 19, 2018**.
- Dr. Raj Kumar, Head, Indian Agriculture Research Institute (IARI), Katrain visited GBPNIHESD, Himachal Regional Centre on **March 19, 2018**.
- Dr T. Hota, Former Advisor MoEFCC, visited GBPNIHESD HQs during **April 29-May 2, 2018**.
- Prof. V. K. Gaur. Distinguished Professor CSIR-4PI, Bangalore, visited GBPNIHESD HQs during **May 6 - 7, 2018**.
- Prof. M. P. S. Bisht, Director USAC Dehradun, visited GBPNIHESD HQs during **May 23-25, 2018**.
- Dr Lalit Kapoor, Advisor, MoEFCC, New Delhi, visited GBPNIHESD, Himachal Regional Centre During **June 16-17, 2018**.

## हिमालयी औषधीय पौधे :-एंटीमाइक्रोबियल यौगिकों के मुख्य स्रोत

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### 1. परिचय

पैनिंसिलिन नामक एंटीबायोटिक की खोज एलेक्सजेन्डर फ्लेमिंग ने सन् 1928 में की थी जिसके बाद एंटीबायोटिक्स शोध का एक महत्वपूर्ण विषय बन गया है। एंटीबायोटिक्स अथवा एंटीमाइक्रोबियल वे रासायनिक यौगिक हैं जो कि सूक्ष्मजीवों द्वारा होने वाले संक्रमण को रोकते और रोग फैलाने वाले जीवों को मारते या कम करते हैं। एंटीमाइक्रोबियल यौगिकों का प्रमुख स्रोत सूक्ष्म जीव जैसे बैक्टीरिया, कवक, शैवाल और एक्टीनोमाइसीटिस हैं। यद्यपि सूक्ष्म जीवों से स्रावित होने वाले यौगिकों का लगातार प्रयोग होने के कारण रोग फैलाने वाले सूक्ष्म जीवों में इन यौगिकों के लिए प्रतिरोधक क्षमता का विकास हुआ है, जिसके कारण अन्य जैविक स्रोतों जैसे औषधीय पेड़, पौधे आदि से निकलने वाले एंटीमाइक्रोबियल यौगिकों का अध्ययन भी जरूरी हो गया है। इस परिपेक्ष्य में आज के समय में इन औषधीय पेड़-पौधों पर शोध कार्य को प्राथमिकता दी जा रही है।

पूरे संसार में 250,000 से 500,000 के लगभग पेड़-पौधों की प्रजातियाँ हैं, जिसमें से कुछ प्रतिशत औषधीय पेड़ों की पादप रासायनिक गुणों का अध्ययन किया गया है। वर्तमान समय में इन पेड़-पौधों से स्रावित होने वाले प्राकृतिक एंटीमाइक्रोबियल यौगिकों के कारण यह पौधे काफी लोकप्रिय हुये हैं। पौधों से स्रावित होने वाले इन एंटीमाइक्रोबियल यौगिकों के अध्ययन से यह पता चला है कि ये पेड़-पौधे वर्तमान समय में चिकित्सा एवं पारम्परिक औषधी के रूप में प्रयोग किये जाते हैं। इन पेड़-पौधों का प्रयोग काफी पुराने समय से मनुष्य द्वारा चाय, पाउडर, टिन्चर तथा हर्बल दवाइयां बनाने में किया जाता है।

औषधीय पेड़-पौधों को दवाइयां बनाने में उपयोग होने वाले सक्रिय फार्मास्यूटिकल इन्ग्रिडिएंट्स के रूप में किया जाता है। जिसके लिए इनके अलग-अलग भागों जैसे पत्ती, तना एवं फूल आदि से औषधि बनाने के लिए

वैज्ञानिक निरंतर शोध कर रहे हैं। आज के समय में औषधीय पेड़ों द्वारा निकलने वाले पादप रासायनिक यौगिकों का उपयोग एंटीमाइक्रोबियल के रूप में करने के कारण काफी चर्चा में है। हिमालय के पर्वतीय क्षेत्रों में पाए जाने वाले कुछ प्रमुख पौधों का विवरण तालिका 1 में दिया गया है। टैक्सस (थूनेर) प्रजाति के वृक्षों जैसे ब्रेविफालिया, बकाटा एवं वालीचियाना में एंटीमाइक्रोबियल यौगिकों जैसे टैक्सोल और एंटीमाइक्रोबियल गुणवत्ता होने के कारण यहाँ की ग्रामीण जनता में काफी प्रसिद्धि प्राप्त है। टैक्सस के अलावा गिन्गो बाइलोबा जिसे जीवित जीवाश्म या ब्रह्मकुमारी भी कहा जाता है। इस वृक्ष में मिलने वाले काफी यौगिकों जैसे फ़लेवोनाइट्स, गिन्गोलाइट्स एवं ग्लाइकोसाइड्स काफी महत्वपूर्ण हैं। इन यौगिकों का उपयोग स्मरण शक्ति को बढ़ाने, चक्कर आने को कम करने तथा एंटीमाइक्रोबियल क्षमता के लिए जाना जाता है। इस लेख में पेड़ों से मिलने वाले एंटीमाइक्रोबियल यौगिकों की खोज, औषधीय निर्माण की प्रक्रिया और इसके साथ ही भविष्य से जुड़ी हुई चुनौतियों की ओर केन्द्रित किया गया है। टैक्सस एवं गिन्गो बाइलोबा को चित्र सं0 1 में दर्शाया गया है।



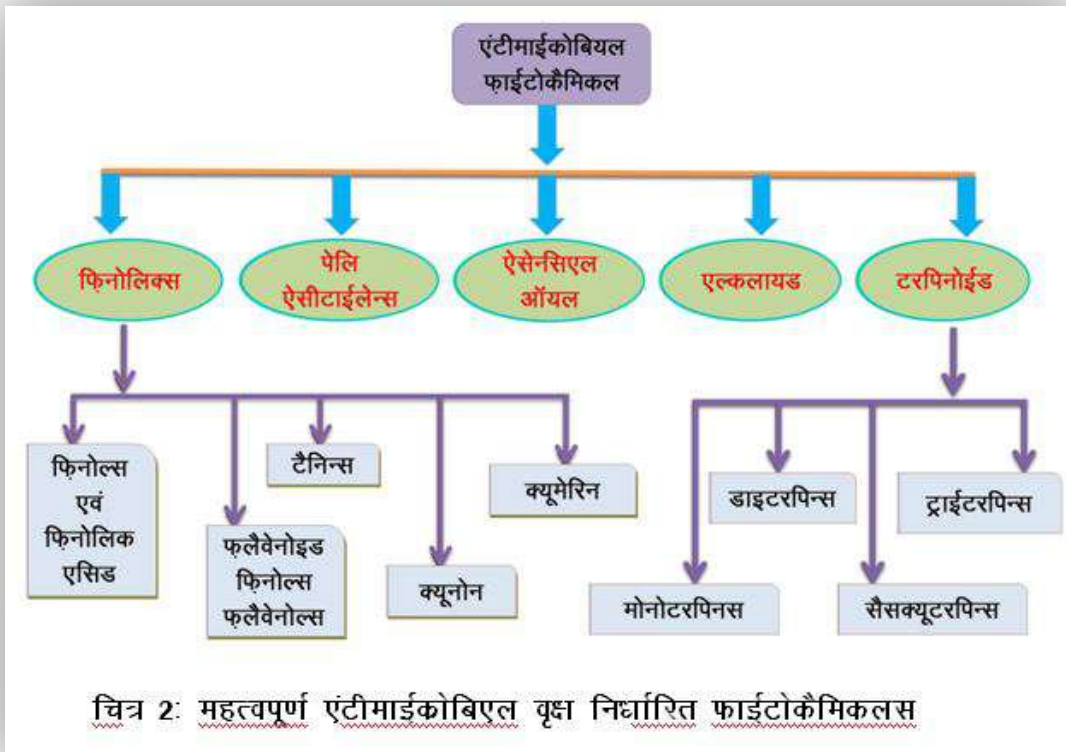
चित्र 1: हिमालयी क्षेत्र में पाये जाने वाले दो प्रमुख एंटीमाइक्रोबियल औषधीय वृक्ष (क) गिन्गो बाइलोबा, (ख) टैक्सस वालीचियाना जूक

## 2. पादप रासायन (एंटीमाइक्रोबियल यौगिक)

मनुष्य की तरह पेड़-पौधे भी अपनी विभिन्न शारीरिक क्रियाओं (मैटाबोलिज्म) के दौरान बहुत प्रकार के प्राथमिक एवं द्वितीय (सैकण्डी) रासायनिक यौगिकों का उत्सर्जन करते हैं। जिनमें से सैकण्डी यौगिक मुख्यतः फिनोलिक्स और इनके आक्सीजन यौगिक होते हैं। ये यौगिक पेड़ों में होने वाली विभिन्न प्रक्रियाओं जैसे स्वाद, गंध एवं रक्षा की प्रक्रिया आदि में अपना महत्वपूर्ण भूमिका निभाते हैं। इनमें से कुछ यौगिकों जैसे फिनोलिक अम्ल, फ्लैवोनाइड्स, क्यूमेरिंस, टरपेनाइड्स, टैनिन टरपेनाइड्स एल्कोलाइड्स एवं पालीपैन्टाइड्स में एंटीमाइक्रोबियल क्षमता पायी गयी है। इनका विवरण चित्र संख्या 2 में दिया गया है।

तालिका 1: औषधीय पौधों तथा उनके उपयोग

क्र. सं.	औषधीय पौधों का नाम	हिन्दी नाम	एंटीमाइक्रोबियलयौगिक	एंटीमाइक्रोबियल प्रक्रिया
1	रुबिया कौडिफोलिया	मंजैठ	रुबियाकोडोन ए	एंटीबैक्टियल
2	गिन्नो बाइलोबा	बालकूमारी	फिनोलिक एसिड, बिसलोबल	एंटीबैक्टियल
3	डियोसपाइरोस मोनटाना	विषतेन्दु	डियोएसपिरिन	एंटीबैक्टियल
4	किप्टोमेरिआ जापोनिका	जापानी देवदार	किप्टोविबिनोन	एंटीफंगल
5	ओसमियमटेनरीफोलियम	तुलसी	कैमफर, यूकैल्पटोल, यूग्नोल	एंटीबैक्टियल
6	बाकोपा मोनेरी	ब्रह्मी	बैटयुलिनिक एसिड, बैकोसाइड	एंटीबैक्टियल
7	इन्जुला रेसीमोसा	पुष्कर मूल	एलेन्टोलेवटोन, आइसोएलोनटोन	एंटीबैक्टियल
8	बरबेरिस वलगैरिस	किलमोड़ा	बरबेरिन	एंटीबैक्टियल
9	पाइपर नाइग्रम	कालीमिर्च	पैप्रिन	एंटीमाइक्रोबैक्टियल
10	टैक्सस बकाटा एवं वालीचियाना	थुनेर	-	एंटीबैक्टियल, एंटीफंगल



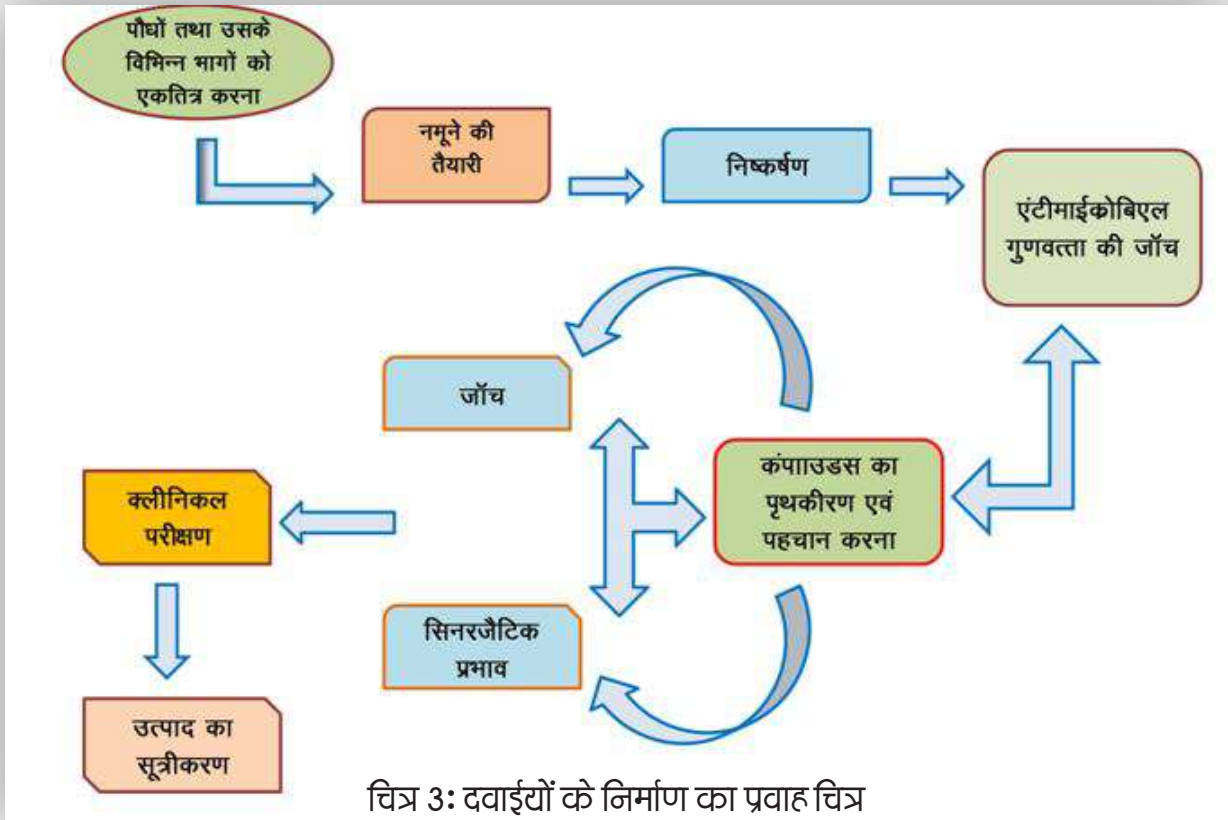
चित्र 2: महत्वपूर्ण एंटीमाइक्रोबियल वृक्ष निर्धारित फाइटोकैमिकल

### 3. एंटीमाइक्रोबियल दवाओं का निर्माण

पेड़-पौधों को उनके औषधीय गुणों के कारण चिकित्सा के क्षेत्र में विशेष स्थान प्राप्त हुआ है। इनसे स्त्रावित होने वाले सक्रिय जैविक यौगिकों पर काफी शोध कार्य भी आज के समय पर किया जा रहा है। लेकिन वर्तमान समय में इन यौगिकों से नयी दवा का निर्माण करना अपने आप में एक बड़ा लक्ष्य है। इन दवाइयों के निर्माण में सर्वप्रथम पेड़ों को उनकी एंटीमाइक्रोबियल गुणवत्ता के आधार पर चयनित किया जाता है जिसमें प्राकृतिक उत्पादों की प्रचुर मात्रा हो जिससे कि हम वांछित उत्पाद की अत्यधिक मात्रा में प्राप्त कर सकें। इन कंपाउंड्स की गुणवत्ता एवं मात्रा बहुत सी जैविक एवं अजैविक स्थितियों जैसे मिट्टी की फिजियो-कैमिकल, माइक्रो बायोलॉजीकल एवं जलवायु आदि की स्थिति पर निर्भर करती है। तत्पश्चात् औषधीय पौधों को सर्वोत्तम क्षेत्रों से निकालकर प्रयोगशाला में लाया जाता है, जिसके बाद इन वृक्षों को विभिन्न प्रकार की ड्राइंग की विधियों द्वारा सुखाया जाता है। जिसमें सूक्ष्मजीवों द्वारा होने वाले कंटामिनेशन को कम से कम किया जाता है। फिर उचित निकास प्रणाली द्वारा इन प्राकृतिक उत्पादों को एकत्र किया जाता है। जिसमें से

निकलने वाले एंटीमाइक्रोबियल यौगिकों की गुणवत्ता का अध्ययन किया जाता है। इसके बाद इन यौगिकों को इनकी गुणवत्ता के आधार पर विभिन्न तकनीकों के द्वारा पृथक किया जाता है। इन तकनीकों में कालम क्रोमेटोग्राफी, थिनलेयर क्रोमेटोग्राफी (टी.एल.सी.), हाईप्रोफोर्मेंस लिक्विड क्रोमेटोग्राफी (एच.पी.एल.सी.) आदि और रोगाणु रोधक क्षमता की जांच करने के लिए विभिन्न तकनीकों जैसे डिस्क डिफ्यूजन, वैल डिफ्यूजन बायोआटोग्राफी आदि का प्रयोग किया जाता है। इन प्रक्रियाओं के बाद जब एक शुद्ध रोगाणुरोधी यौगिक मिल जाता है तो उसके पश्चात उसकी रासायनिक संरचना गैस क्रोमेटोग्राफी मांस स्पेक्ट्रोस्कोपी (जी.सी.एम. एस.), लिक्विड क्रोमेटोग्राफी, मांस स्पेक्ट्रोस्कोपी (एल. सी.एम.एस.) और निक्चूलर मैग्नेटिक रिजोनेंस (एन. एम.आर.) आदि तकनीकों द्वारा जांच की जाती है। जिसमें उससे होने वाले लाभ एवं हानि का मूल्यांकन किया जाता है।

चित्र सं0 2 में दवाइयों के निर्माण का, प्रवाह चित्र दर्शाया गया है।



चित्र 3: दवाइयों के निर्माण का प्रवाह चित्र



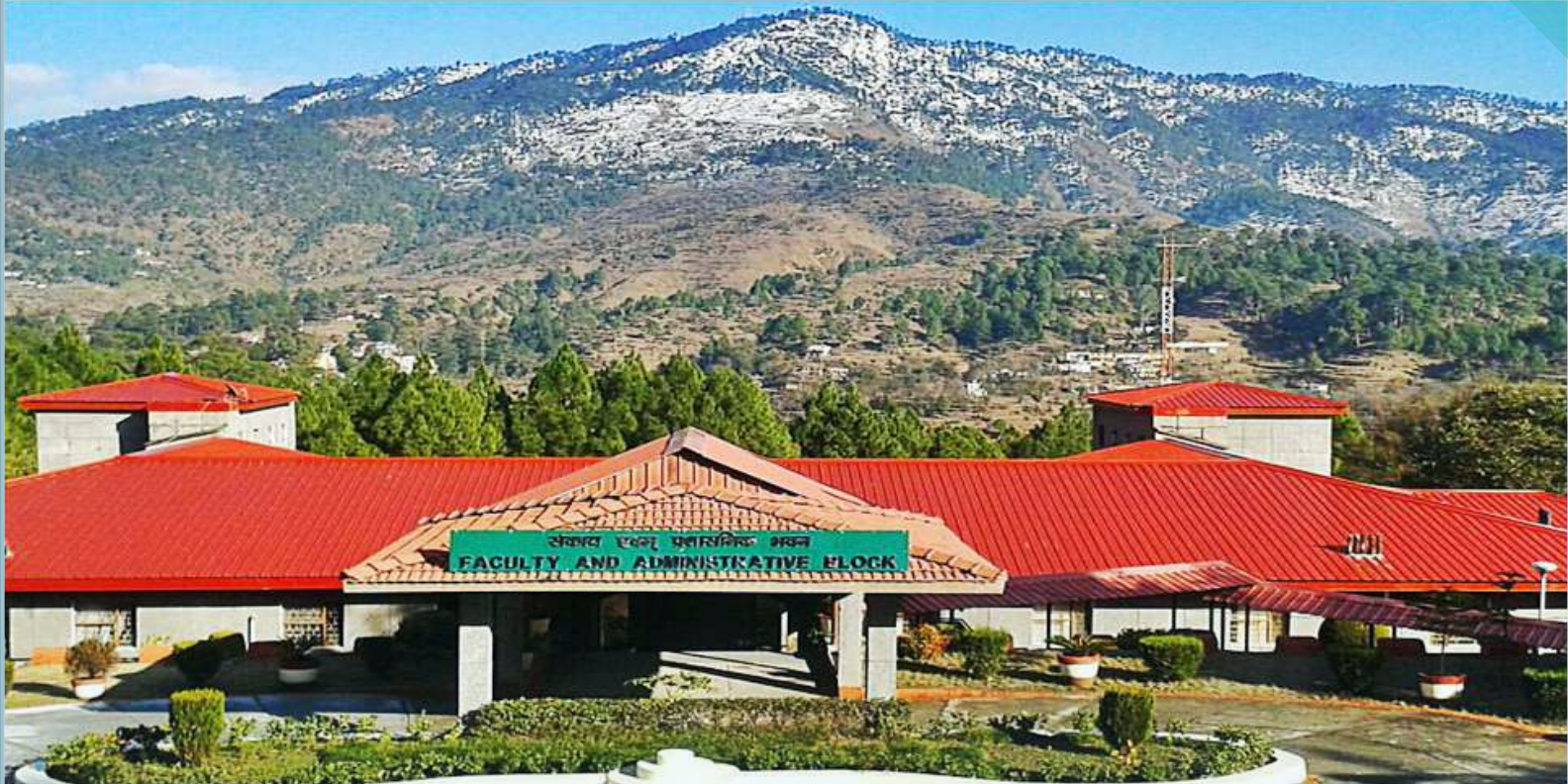
#### 4. भविष्य के परिपेक्ष में

संक्रमित रोगों के कारण पूरे विश्व में मृत्यु दर 50 प्रतिशत तक बढ़ती जा रही है, जिन्हें रोकने के लिए अथक प्रयास किये जा रहे हैं। इस क्षेत्र में विभिन्न एंटीबायोटिक्स जैसे स्ट्रेप्टोमाईसिन, पैनिसिलिन एवं क्लोरोमाईसिटिन आदि की खोज के बाद संक्रमित सूक्ष्म जीवों से होने वाले संक्रमण के इलाज को एक नई दिशा मिली है। जिसके चलते वैज्ञानिकों को अन्य अनेक एंटीबायोटिक्स की खोज की प्रेरणा मिली है। पौधों से निकलने वाले एंटीबायोटिक यौगिकों का अपना एक अभिन्न स्थान है। इन यौगिकों की खोज, निरीक्षण एवं परीक्षण आदि अपने आप में एक बड़ी चुनौती है। माइक्रोबियल स्रोतों से बनने वाली एंटीबायोटिक्स के लिए सूक्ष्मजीवों में बढ़ने वाली प्रतिरोधक क्षमता का विकास होने के कारण वैज्ञानिक अन्य स्रोतों की ओर कार्य कर रहे हैं। औषधीय पौधों को बहुत सारे बायोएक्टिव यौगिकों के स्रोत के रूप में जाना जाता है। जिसके कारण इन पेड़-पौधों के फाइटोकैमिकल यौगिकों को संक्रमित रोगों के इलाज के लिए उपयोग किया जाता है। औषधीय वृक्षों के बारे में मिली पारम्परिक जानकारियों का उपयोग करके अलग-अलग क्षेत्रों में हर्बल दवाइयों के निर्माण करने हेतु शोध किया जा रहा है। संपूर्ण शोध के लिए औषधीय वृक्षों एवं उनके मुख्य भागों का चयन एवं ज्ञान बहुत आवश्यक है, जिसके लिए शोधार्थियों को इसके बारे में शिक्षा देना काफी जरूरी है। औषधीय वृक्षों जिसमें

स्थानीय, दुर्लभ, विलुप्त होने वाली तथा थेटेन्ड प्रजातियों का संरक्षण एवं प्रलेखीकरण भी आवश्यक है, क्योंकि ये वृक्ष फाइटोकैमिकल जैसे एंटीमाइक्रोबिएल यौगिकों का बहुत बड़ा स्रोत होते हैं। औषधीय वृक्षों को उनकी फाइटोकैमिकल गुणवत्ता के आधार पर प्राथमिकता देनी चाहिए। काफी लेखों में एंटीमाइक्रोबिएल यौगिकों के उत्पादन को बढ़ावा दिया गया है। जिसमें सिर्फ डिफ्यूजिएबल यौगिकों पर ध्यान केन्द्रित किया गया है। एवं वोलेटाइल यौगिकों पर ध्यान देने की जरूरत है। इन यौगिकों को उनके गुणों जैसे एंटीबैक्टीरियल, एंटीफंगल, एंटीवायरल एवं एंटीमलेरियल के आधार पर विभाजित करना भी आवश्यक है। आने वाले समय में इन यौगिकों पर होने वाले शोध के कारण होने वाले विकास से विभिन्न स्तरों जैसे किसान शोधार्थियों और उद्योग जगत के लिए भी लाभदायक सिद्ध होंगे।

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