To,
Prof Annpurna Nautiyal
Hon'ble Vice-Chancellor,
Hemvati Nandan Bahuguna Garhwal university (A Central University) Srinagar Garhwal
Uttarakhand

Subject: Academic, Administrative Audit Report of the University- Regarding

Dear Madam,

In pursuance to university letter under reference IQAC/AAA/01-21/030 dated 05/12/2022

regarding the Academic, Administrative Audit of HNB Garhwal University, Srinagar, the committee has conducted Academic, Administrative Audit of all three campuses viz. Srinagar, Pauri and Badshahithaul (Tehri) from 26th June 2023 to 28th June 2023 successfully.

Please find herewith the Academic, Administrative Audit Report for your kind pursual and further necessary action.

Enclosure: As Above

Prof U S Rawat,
Ex-Vice Chancellor, Sri Dev Suman University
& SGRRU Dehradun

Prof J P Pachauri
Ex-Vice Chancellor,
Himalayiya University
Dehradun

Prof M S M Rawat
Ex-Vice Chancellor, HNB Garhwal University Srinagar

Director IQAC for N.A.
6.7.2023

For record, M. in new file.
6/7/2023.

IQAC

Academic, Administrative Audit (AAA) Report
of
HNB Garhwal University Srinagar Garhwal

Date of Visit: 26th June 2023 to 28th June 2023

The Registrar of the university Prof N S Panwar initially welcomed to the members of Academic, Administrative Audit Team on 26th June 2023 at Seminar Hall, Academic Activity Centre Chauras Campus alongwith the Directors, Deans, Faculty Members, IQAC Director and Assistant Directors, Officers and other staff of the University. After that, he has requested to the Director, IQAC to present the overview of the University alongwith Academic, Administrative activities before the committee and other members presenting in the seminar hall.

The Director IQAC has presented all kind of activities running in the university highlighting the strength and weaknesses of the university through power point presentation followed by presentations of all Deans of the faculties & officers of the University. The members of the AAA have raised so many queries during the presentation of the report and necessary clarification/suggestions were given for the improvement of quality in higher education.

On the basis of interactions with the Director, IQAC, Deans, Librarian, Finance Officer, Registrar, Controller of Examination and other in-charges, the following observations and suggestions are given for the improvement of Education system specially with reference to New Education Policy and NAAC visit in the University.

General Observations

The central university was established alongwith its three campuses viz. Srinagar, Pauri and Badshahithaul (Tehri Garhwal) during the year 2009. The University has the total area of 267.93-acre alongwith buildup area of 179000 square meters (one lakh seventy-nine thousand). Apart from these campuses, the university has 72 affiliated colleges situated at various area of the Garhwal Region.

1. The University having 11 school of studies covering 49 departments.
2. The university has total number of 484 sanctioned teaching posts, out of which 247 are in position and 237 are vacant.
3. The total non-teaching posts are 570, out of which 276 are filled and 94 are vacant.
4. The total numbers of students in all campuses are 13314, in which 6853 are girls and 6461 are boys, out of which 12 percents students are from other states.
5. Out of 137 programmes, 81 are running under CBCS system and university has switch over the New Education Policy in 2020.
6. University has introduced value added courses along with skill developments and professional courses following guidelines of New Education Policy.
7. University also introduced the feedback mechanism from the students about the curriculum and faculties' performance and point raised thereby are settled as per norms.
8. The students in-take 72 percent against the total seat available.
9. In most of the department of the campuses are lacking the use of ICT platforms, such as Teaching through LCD projectors, using of smart phones etc.
10. Only one or two departments have developed courses on SWAYAMplatform and MOOCS.
11. The concept of the program outcome and course outcome are not clearly defined and correlated.
12. The ability enhancement Compulsory courses of Environmental Sciences, English Communications and other modern languages in UG programs already operational in Srinagar campus but not available at Pauri and Badshahithaul Campus.
13. University has not mentioned the student progression and drop out of admitted students.

14. Although the passed percentages in all disciplines are satisfactory but there is no mention of actual teaching days in each semester?
15. How many online courses are approved by the University and follow up action thereon is not explicit which is an important point according to NEP.
16. During the period under report, 2094 papers and 236 book chapters have been published and 21 Patents are filled.
17. A total number of 145 research scholars have been awarded PhD Degree.
18. There were ongoing 20 projects amounting Rs 547.4 Lakhs, running presently.
19. Being a central University, the numbers and quality of publications are not sufficient and satisfactory.
20. To promote the research and innovative program, the university should provide more facility and conducive environment to the faculty and other stake holders.
21. It seems that only few departments have been published quality research papers while other department of the campuses are silent and not making any sincere efforts in this regard.
22. The students who qualified National Eligibility Test (NET) for research are satisfactory.
23. Although National Collaborations with various organizations are made but the details of MOUs signed for various purposes such as exchange program of students, teachers, nature of research works are not enumerated.
24. The university has not given any reference about Institutional Development Plan for the future.
25. Although placement cell is active at Srinagar Campus but not existing at Pauri and Badshahithaul, resulting a less number of placements of students in various organizations.
26. The central library at Srinagar Campus and campus library at Pauri are partially automated.
27. The university has different cells and centers for various purposes and doing good work under outreach program.
28. The examination system of the university although not fully automated but it is robust, transparent, and catering the requirements of the students upto satisfactory level.
29. The IQAC cell of the university is functional.

30. The participation of the students in sports and other cultural activities is noteworthy therefore more efforts be made to encourage the students.
31. It is noteworthy that the most of the courses are having value added components in their courses.
32. University follows e-Governance and has adopted e-file, FTS, admission through SAMARTH portal, ERP, online filing, e-market, PFMS.
33. The regular internal audit alogwith the audit by CAG is in place.
34. During visit in the campus, it is observed that the maintenance of the buildings, labs, classrooms, gardens, hostels is not worthy and satisfactory.
35. No efforts are made for interdisciplinaryresearch program.
36. It is praiseworthy to note that Pauri Campus is publishing Two Peer Reviewed Research Journals regularly for the benefit of the stake-holders since 2005.
37. There is shortage of various kinds of infrastructure facilities at Pauri and Badshahithaul Campuses.
38. The list of distinguished alumni is not available.
39. The infrastructure modifications for the physically challenged persons/students in some buildings are not available.
40. It is also observed that there is lack of coordination between IQAC Cell and Departments.
41. At Badhsahithaul campus, a significant contribution is made by using waste/ old papers for recycling and making handmade papers which can be followed by other campus also.
42. The legal aid programme by law department at Badshahithaul campus is praiseworthy.

Suggestions

1. Efforts be made to appoint regular teaching and non-teaching staff against vacant posts.
2. Placement cell need to be strengthen in all the campuses.
3. Departments should take help from SWAYAM platform and massive open online Courses and develop new courses on these platforms.
4. University is required to elaborate with evidences regarding continuous evaluation system, minor and major test and redressal grievance raised by the students.
5. Mechanism to be developed to find out program and course outcomes.
6. It would be better to reduce the hindrance by the administration in the smooth running of the projects by the Investigators and Project Investigators should be given more freedom as per terms and conditions of the granting agencies to improve the research environment.
7. The Best Reader Award should be given to the students.
8. Best Teacher Award in Teaching/Research should also be given.
9. Faculty needs to increase the research publications in reputed journals.
10. Faculty should be motivated to submit research projects in various funding agencies.
11. Alumni of the University should be motivated for the placements of the students and generate funds for research and teaching.
12. **"Earn while you Learn" scheme** should be initiated for the students in each school and library.
13. E-copy of the Journals published by the university should be uploaded on the website.
14. Sufficient trained staff need to be appointed in the Pauri/Badshahithaul/Srinagar libraries for the proper functioning.
15. Corpus fund for the research should be created for young Faculty.
16. More efforts should be made by the students to qualify NET/JRF/GATE/SRF etc.
17. University should made short- and long-term Institutional Development Plan for the future development.
18. University should have separate remedial measures for slow and advanced learners.
19. All the campus libraries should be automated and interconnected.
20. One Account Officers/ Assistant Registrar should be placed in other campus (Pauri/Badshahithaul) for the smooth running of the campus.

21. Both the directors (Pauri/Badshahithaul) should be given Financial Power for the proper administration and maintenance of the campus.

22. Attention should be made the creation of need-based infrastructure at Pauri/Badshahithaul.

23. Training Program for Non-Teaching staff should be organized for the upgradation of the knowledge.

24. Adventure sports in collaboration with THDC should be introduced at Badshahithaul Campus (Tehri Garhwal)

Letter of Intent with

1. Central University of Kashmir
2. Tripura University
3. Tezpur University
4. Sikkim University, Gangtok
5. Rajiv Gandhi University, Itanagar
6. North Eastern Hill University
7. Nagaland University
8. Mizoram University
9. Manipur University
10. CSIR-Institute of Himalayan Bioresource Technology, Palampur (HP)
11. Central University of Jammu
12. Central University of Himachal Pradesh
13. Assam University, Silchar

14. MoA with Uttarakhand State Council for Science & Technology

15, 16. MoU with IIT Kanpur (2017, 2021)

17. MoU with Rishikesh Yogpeeth

18. MoU with The Swiss Federal Research Institute WSL Switzerland

19. MoU with Jivanti Welfare and Charitable Trust

20. MoU with ISF College of Pharmacy, Moga

21. MoU with Texas Tech University, USA

22. MoU with University of Copenhagen, Denmark

23. MoU with South Asian Institute (SAI) Ruprechit-Karis Universitate, Heidelberg, Germany

24. MoU with University of Haifa, Haifa, Israel

25. MoU with University of Applied Forest Science, Rottenberg, Germany

26. MoU with CSIR-National Bureau of Botanical Research (NBRI)

27. MoU with ICAR-National Bureau of Agriculturally Important Microorganisms (ICAR-NBAIM), Kushmaur, Uttar Pradesh

28. MoU with ICAR-National Bureau of Fish and Genetic Resources, Lucknow

29. MoU with Indian Council of Forestry Research and Education (ICFRE), Dehradun (an Autonomous Council under the Ministry of Environment, Forest and Climate Change)

30. MoU with Cultivator Natural Product Private Limited (CNPPL) Jodhpur Rajasthan

31. MoU with The Graduate School of Human Health Sciences Tokyo Metropolitan

32. MoU with National Institute of Technology (NIT) UK

33. MoU with CSIR Institute of Himalayan Bioresource Technology Palampur (HP)

34. MoU with Ahmedabad Textile industry's research association (ATIRA)

35. MoU with Dr. Ambedkar Foundation, Ministry of Social Justice & Empowerment, GOI

Activity done under MOU between HNBGU, Srinagar Garhwal and WSL, Switzerland

MOU between two institutions (i.e. HNBGU & WSL) came into existence on 20 July 2020 after signing by the Heads and Group Leaders of the both institutions. The main objectives of the MOU were to encourage visits by faculty for the purpose of engaging in research and educational activities, to support the exchange of Master and Doctoral students, to foster the exchange of academic publications and scholarly information and to develop joint research activities & to promote other academic activities, which enhance the above mentioned goals.With this brief background, the following progress has been made:

1. Online meetings and discussion on glacier studies

Soon after the MOU, we held several virtual meetings regarding the course of action on the objectives. However due to COVID-19, it was impossible for WLS Scientists to visit Indian Himalayan glaciers for the field work in the year 2020 and even in 2021.

2. Joint field work on one of the Indian Himalayan glaciers

A group of four European Research Scholars/Scientists lead by Dr. Marin Kneib (WSL) conducted fieldwork on Satopanth Glacier, Chamoli District Uttarakhand, along with HNBGU Glaciology research team during September 2022. During this field trip, various instruments (weather station, time lapse camera and pressure sensors) were setup and valuable scientific datasets including ice melting, air temperature, pressure and wind speed were observed at an altitude of 4300 m amsl over Satopanth Glacier. Some glimpse of the glacier field work is shown below.

Photograph: 1- Swiss team at Geology Department, HNBGU Srinagar; **2**-Team at Mana (Badrinath) before going to Satopanth Glacier; **3**- Temperature sensor; **4**- Time lapse camera; and **5**- Researchers working on Satopanth Glacier.

3. Setting up new proposal and funding acquisition

During the period of MOU with WSL, we have formulated a joint research proposal to study the behaviour of Himalayan and Swiss glaciers under changing climate in response to a call of the Ministry of Earth Science, Govt. of India, and the Swiss National Science Foundation (SNSF), Switzerland. The project is funded now entitled "Understanding and modeling the interactions between Debris and glacier Ice in a changing ClimatE (D-ICE)".

The above research proposal under the "Cryopsheric Modelling" theme is led by Prof. H C Nainwal (as Indian PI) and Prof. Andreas Vieli, University of Zurich, Switzerland (as Swiss PI). The other project partners of the projects are Dr. Argha Banjeree & Dr. Arjun Datta (Indian Institute of Science Education and Research, Pune), Dr. Francesca Pellicciotti (Swiss Federal Research Institute WSL, Switzerland), Dr. Atanu Bhattacharya (JIS University, Kolkatta) Dr. Bharath Shekar (Indian Institute of Technology, Bombay), Dr. Madhu Sudan Sati & Dr. Alok Sagar Gautam (HNBGU Srinagar), Prof. Ramachandran Shankar (The Institute of Mathematical Sciences, Chennai), Dr. Guillaume Jouvet (University of Zurich, Switzerland) and Dr. Tobias Bolch (University of St. Andrews, Great Britain and Northern Ireland).

Department of Zoology, HNB Garhwal University

MoU with University of Copenhagen, Denmark (11.10.2019)

1. Under Indian-Danish Network project a Workshop on "Arctic and Alpine Aquatic Science-implications of climate change on proglacial freshwater ecosystems functioning and services" (October 11-22, 2019).
2. Field visit to Lake Satopanth; Sampling in lake and streams in the Alaknanda Valley at Badrinath.
3. Due to Covid-19 Pandemic further activities under the MoU could not be undertaken as the grant was terminated.

MoU with National Bureau of Fish Genetic Resources (NBFGR), Lucknow.

1. Ph.D. Thesis entitled "Evaluation of season specific differential gene expression in the Snow trout (*Schizothoraxplagiostomus*) Testis by Next Generation Sequencing (NGS)" submitted by Ms. Shriya Purohit (LZ-17196); Supervisor: Dr. Indrashis Bhattacharya, Assistant Professor, Department of Zoology; Co-Supervisor: Dr. Mahender Singh, Principal Scientist, NBFGR, Lucknow

2. Mr. Rakesh Kumar (LZ-19070) registered for Ph.D. on the topic "A study of the bacterial pathogens in some Schizothoracine fish species inhabiting the Gangariver system in Uttarakhand"; Supervisor: Prof. O.P. Gusain, Department of Zoology; Co-Supervisor:Dr. Gaurav Rathore, Principal Scientist & Head, Fish Health ManagementDivision, NBFGR, Lucknow.

3. Ms. Yasmeen Kousar (LZ-20101) registered for Ph.D. on the topic "", Supervisor: Prof. Deepak Singh, Department of Zoology; Co-Supervisor: Dr. Mahender Singh, Principal Scientist, NBFGR, Lucknow

Research Publications

1. Purohit, S., Sharma, P., Bhatt, G., Kothiyal, S., Singh, M., Nautiyal, P., & Bhattacharya, I. (2022) Evaluation of seasonal cyclicity of testicular development in adult Himalayan snow trout, *Schizothoraxplagiostomus*. Zoology Aquaculture Reports 27: 101333, 2352-5134https://www.sciencedirect.com/science/article/pii/S2352513422003295

2. Purohit, S., Sharma, P., Kothiyal, S., Singh, U., Nautiyal, P., Singh, M., Bhattacharya, I. (2023). Resolving the phylogenetic relationship of Himalayan snow trout Schizothoraxplagiostomus with other species of Schizothoracine using mitochondrial CO-I and Cyt b genes. Molecular Biology Reports50(4):3927-3933https://doi.org/10.1007/s11033-023-08274-y

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क: / शैक्षणिक / 2020 / 325 दिनांक: 21. 9. 2020

सेवामें

Shriya Purohit D/O Shri Pankaj Purohit
Phase II, Kargi Chawk, Dehradun

पाठ्यक्रम समिति जन्तु विज्ञान विभाग की बैठक दिनांक 27 फरवरी 2020 की मद संख्या 17.06 मे लिये निर्णयानुसार एवं कुलपति महोदया के अनुमोदनोपरान्त डा0 महेन्द्र सिंह मुख्य वैज्ञानिक एन0 बी0 एफ0 जी0 आर0 लखनऊ को आपका सह–शोध निदेशक नियुक्त किया जाता है।
अत: आप नव नियुक्त सह शोध निदेशक के निर्देशन मे कार्य करना सुनिश्चित करे।

भवदीय,

21/9/20
अनुभाग अधिकारी, शैक्षणिक

प्रतिलिपि :

1. डा0 इंद्रेश भट्टाचार्य, जूलॉजी विभाग, चौरास परिसर, ।
2. डा0 महेन्द्र सिंह वैज्ञानिक एन0 बी0 एफ0 जी0 आर0 लखनऊ।
3. विभागाध्यक्ष, जूलॉजी विभाग, चौरास परिसर, ।

21/9/20
अनुभाग अधिकारी, शैक्षणिक

...ANISH NETWORK PROJECT, FIRST WORKSHOP 06th 11–22nd Oct
Department of Zoology & Biotechnology, HNB Garhwal University, 2019
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(केन्द्रीय विश्वविद्यालय)
Hemvati Nandan Bahuguna Garhwal University Srinagar (Garhwal), Uttarakhand- 246174-
(A Central university)

Tel : 01346-25225224
Email:Registrar.hnbgu@gmail.com
Website: www.hnbgu.ac.in

पत्रांक: शैक्षणिक / 2022/1056 दिनांक 28/5/2022

सेवा में,

Yasmeen Kousar D/O Mohd Azam
Ward No. 13, Nowshera
Dist- Rajouri, J&K- 185151

पाठयकम समिति जन्तु विज्ञान विभाग की बैठक दिनाँक 29.04.2022 की मद संख्या 22.03 में लिये निर्णयानुसार एवं कुलपति महोदया के अनुमोदनोपरान्त Dr. Mahender Singh, Principal Scientist, NBFGR को आपका सह शोध निर्देशक नियुक्त किया जाता है।

अतः आप नव नियुक्त शोध निर्देशक के शोध निर्देशन मे कार्य करना सुनिश्चित करें।

भवदीय,

अनुभाग अधिकारी,शैक्षणिक

प्रतिलिपि : 1. डा0 दीपक सिंह, जूलॉजी विभाग, बिड़ला परिसर श्रीनगर गढ़वाल।
2. Dr. Mahender Singh, Principal Scientist, NBFGR
3.विभागाध्यक्ष जूलॉजी विभाग,बिड़ला परिसर, श्रीनगर गढ़वाल।

अनुभाग अधिकारी,शैक्षणिक

HEMVATI NANDAN BAHUGUNA GARHWAL UNIVERSITY,
SRINAGAR GARHWAL
(A CENTRAL UNIVERSITY)

NO: Acad/2021/ 337 Dated: 17.09.2021

To,

Rakesh Kumar S/O Shri Hari Saran
C/o Shri Datta Ram Bahuguna, Madhi Chauras
Kirtinagar, Tehri Garhwal – 249161

Sub: Registration for Ph.D. Programme of the HNBGU.

In response to your application for Registration to the Ph.D. Programme of the University, the competent authority of the University is pleased to approve your candidature for registration to the Ph.D. Programme of the University as per followings:

TOPIC of Research: **"A study of the bacterial pathogens in some Schizothoracine fish species inhabiting the Ganga river system in Uttarakhand"**

Decision of the Committee held on **18.02.2021:** The Title, synopsis, centre & supervisor is approved.

Name of the Supervisor: **Prof. O.P. Gusain**

Name of the Co-Supervisor (if any) : **Dr. Gaurav Rathore**

Subject: **Zoology**

Centre: **Birla Campus, Srinagar**

You have been registered since **09.08.2019** and your registration No. is **LZ- 19070**

By Order
Registrar

Copy to:

1 Supervisor – **Prof. O.P. Gusain, Dept. of Zoology, Birla Campus, Srinagar Garhwal.**
2 Co-Supervisor (if any) – **Dr. Gaurav Rathore, Head, Fish Health Management & Exotics Division, ICAR NBFGR, Lucknow.**
3 Head of the Department – **Prof. P. Nautiyal, Dept. of Zoology, Birla Campus, Srinagar Garhwal.**
4 Dean of School – **Prof. A.K. Dobriyal, School of Life Science, HNBGU, Srinagar Garhwal.**

17/9/21
Deputy Registrar (Academic)

Instructions:

Your registration to Ph.D. Programme is to be governed as per rules, regulations and Ph.D. ordinances of the University. You are required to submit half yearly (Six months) reports to the Board of Studies, through the supervisor, on the work done by you and the work you proposes to do in the ensuing academic year.

Ph.D. programme shall be for a minimum duration of **three** years, including course work and a maximum of **six** years. The candidate shall be required to complete his/her research work and submit the thesis within a period of **six** years reckoned from the date of his/her enrolment, **the date of taking admission (submitting fees) for the pre-PhD. course.**

Provided that the School Board may, after considering the recommendation of the Board of Studies, in a very special case and for reasons to be recorded, grant further extension, of not more than one year.

Provided further that in case the candidate fails to submit the thesis within the period permitted for the submission of the thesis, including the periods of the extension thereof his/her admission to the Ph.D. programme shall be liable to be terminated and he/she shall, upon such termination, forfeit all the fees and other dues paid by him/her for and during such admission.

The woman candidates and persons with disability (more than 40% disability) may be allowed a relaxation of two year for Ph.D. in the maximum duration.


INDIAN-DANISH NETWORK PROJECT
FIRST WORKSHOP
Arctic and Alpine Aquatic Science- Implications of climate change on
proglacial freshwater ecosystems functioning and services


INDIAN-DANISH NETWORK
FIRST WORKSHOP
Arctic and Alpine Aquatic Science- Implications of climate cha
proglacial freshwater ecosystems functioning and service
October 11th – 22nd, 2019


Lenovo


INDIAN-DANISH NETWORK PROJECT
FIRST WORKSHOP
Arctic and Alpine Aquatic Science- Implication of climate change on proglacial freshwater ecosystems functioning and services
October 11th - 22nd, 2019


SHOT ON MI A2
MI DUAL CAMERA


Are there any lakes in Greenland?


nal Bureau of Fish Genetic Resources-Lucknow
(Indian Council of Agricultural Resources)
December 5, 2019
PARTMENT OF ZOOLOGY & BIOTECHNOLOGY CHAURAS
CHAIRPERSON
PROF. ANNPURNA NAITYAL
(VICE CHANCELLOR)
DR. K K TAL
(DIRECTOR, NBFGR)


THE NORTH FACE

हेमवती नन्दन बहुगुणा गढ़वाल विश्वविद्यालय
Hemvati Nandan Bahuguna Garhwal University
श्रीनगर गढ़वाल (उत्तराखण्ड)–246174
Srinagar Garhwal (Uttarakhand) - 246174
(केन्द्रीय विश्वविद्यालय)
(A Central University)

पत्रांक : हे॰न॰ब॰ग॰वि॰वि॰/DACE/2022/01 दिनांक : 20/05/2022

NOTIFICATION (/2022)

In compliance to the directions issued by the Ministry of Social Justice and Empowerment, Government of India, New Delhi regading **Dr. Ambedkar Centre of Excellence (DACE)**, Prof. M.M. Semwal, Department of Political Science, HNB Garhwal University is hereby nominated/appointed as "**Programme Coordinator**" of Dr. Ambedkar Centre of Excellence (DACE) in the University. His contact details are as under:

1. Mobile No. – 9412079266
2. E-mail Id. – mmsemwal@gmail.com

This issues with the approval of the competent authority.

Registrar 20/05/2022

Copy for information and necessary action to:-

1. Prof. M.M. Semwal, Department of Political Science, HNB Garhwal University.
2. Shri Vikas Trivedi, Director, Dr. Ambedkar International Centre, Ministry of Social Justice and Empowerment, Government of India, New Delhi – 110001.
3. Pro Vice Chancellor for kind information.
4. All Deans/Hods.
5. Campus Directors (Tehri/Pauri/Chauras)/Director IQAC/FDC.
6. Finance Officer/Controller of Examination.
7. Joint Registrar/All Deputy Registrars.
8. In charge System Manager for uploading on the University Website.
9. PS to VC, for kind information of the Hon'ble Vice Chancellor.
10. Guard file.

Registrar 20/05/2022

Information Brochure

Dr. Ambedkar Centre of Excellence (DACE)
H. N. B. Garhwal University, Srinagar Garhwal
(A Central University)
(Under the Ministry of Social Justice and Empowerment, Govt. of India)

General Guidelines for admission in DACE (2023-24)

Important Information:

1. This brochure is only for general guidance for the candidates. The Common Entrance Test (CET) and admission to the DACE program shall be governed by the relevant provisions of the Ministry of Social Justice & Empowerment, Govt. of India.

2. The admission to this scheme is suggestive of the fact that the terms and conditions laid down in this brochure are acceptable to the candidate and his/her guardian.

3. Benefits under the Scheme (DACE) can be availed by a student not more than twice, irrespective of the number of chances he/she may be entitled to take in a particular competitive examination. The student will be required to submit an affidavit in this regard.

4. DACE program is **ONLY for the Scheduled Caste and Other Backward Classes (OBC) Students** to offer them **'Free Coaching'** for the Civil Services/Allied Services Examinations conducted by UPSC/State Public Service Commission and Staff Selection Commission (SSC).

5. Out of **100** sanctioned seats, **70% of seats are reserved for SC** and **30% of seats are reserved for Other Backward Classes (OBC)** Students. As per directions from the ministry 33% of seats in each category shall be filled by eligible female candidates.

6. **There is No actual fee for applying, admission and coaching (the course fee paid is 100% refundable) under the DACE scheme. Course fees paid at the time of admission will be refunded by the Ministry in Aadhar linked bank account of the student after submission of a receipt. The process of refund of the course fee details will be shared on the University website in due course of time as per directions from the ministry.**

7. **A stipend of Rs. 4000/ (Rupee four thousand) per month will be provided to all the students by the ministry.**

8. **An incentive of Rs 15,000/ (Fifteen thousand) shall be provided to all the successful students to prepare for the interview after being successful in the mains stage of Central Civil Services / State Civil Services Exams for Class 1 and Class 2 posts.**

9. The candidates enrolled under this scheme shall have to attend all the classes. **If any student remains absent (for more than 04 days) without acceptable reasons like medical or household emergencies, his/her candidature for the scholarship shall be cancelled.** Biometric attendance based on Aadhar of the students will be recorded and shared with the ministry on a monthly basis**. Leaving the coaching midway without prior approval of the competent authority, the expenditure incurred on the candidate will be recovered from the candidate concerned.**

10. **Duration of the course will be one year in case of UPSC/State Civil Services applicants and 6-9 months for SSC candidates.**

11. **Eligibility Criteria for Admission:**
    1. Only students belonging to SC and OBC categories, having a total family income of Rs. 8.00 lakh or less per annum from all sources will be eligible for benefits under the Scheme.
    2. SC/OBC candidates belonging to a Minority community are not eligible under this scheme.
    3. Income Certificate: The income declaration of self-employed parents/guardians should be in the form of a certificate issued by a Revenue Officer, not below the rank of Tehsildar. Employed parents/guardians are required to obtain an income certificate from their employer and submit a consolidated certificate from the Revenue Officer including any other additional source of income.
    4. The minimum marks in the Graduation degree should be 50% in aggregate.
    5. The applicants appearing in the last year/ Semester of Graduation are also eligible to apply, but Graduation degree is mandatory at the time of final admission in this programme.
    6. **Only those candidates who have passed the Common Entrance Test (CET), and have graduation degree, would be eligible for admission in DACE.** The CET will be conducted by the University as per the directions provided by the Ministry of Social Justice & Empowerment, Govt. of India.
    7. The Candidates appearing in the final semester/ year of Graduation will not be admitted to the scheme only on the basis of qualifying for the Common Entrance Test (CET). **Graduation Degree/mark sheet** shall be mandatory at the time of admission.
    8. Final selection of the candidates for admission to the program will be strictly on the basis of CET merit. **Preference may be given to the students of the last batch (2022-23) admitted under the DACE scheme subject to receiving detailed direction from the ministry.**

Important Note:

1. It shall be the duty of the applicant to produce the prescribed/desired documents for admission. In case of non-production of the required documents, his/her claim for admission shall automatically stand cancelled.
2. The applicant is advised to remain vigilant in collecting information regarding the Common Entrance Test (CET), its results and other details, published at the University website and other relevant sources. The University shall not be responsible if the applicant fails to collect such information.
3. The information regarding the Common Entrance Test (CET) and admission process will be published on the portal of the University website.
4. The information supplied by the applicant in his/her application (Online) shall be final. Any subsequent change in the Online Registration Form will not be allowed. If any information provided by the applicant is found to be false or forged at any stage, his/her admission shall be cancelled.
5. The applicant is advised to take the print-out of Online Registration Form and keep it with him/her for future correspondence and reference.
6. Any additional information will be published from time to time on the University website.

Admission Procedure:

Admission will be through the Common Entrance Test (CET) conducted by the University. Candidates have to apply online for CET. Date of the entrance test (tentatively third or fourth week of September) shall be notified in due course of time on university website.

Common Entrance Test (CET) Syllabus:

The Admission Test will be of Two Hours duration. The candidate has to answer 100 questions of multiple choice (MCQ) nature. For every correct answer, 02 marks will be awarded. There will a negative marking for attempting wrong answer and 0.25 marks will be deducted for every wrong answer.

The question paper for CET would comprise of following sections, and the questions will be of intermediate standard.

1. General English & General Hindi
2. General studies related to history, polity, economy, culture, geography etc.
3. General Science and Environment
4. Reasoning and Mental ability

Counselling and Admission Process:

1. Admission will start in the month of the last week of September 2023 on the merit basis of CET and by the process of 'Counselling'.
2. The details of information regarding CET and counselling will be available on the University website: **www.hnbgu.ac.in.**
3. The purpose of Counselling is to provide information regarding the availability of category-wise seats on the basis of the merit of CET.

4. The candidate will be required to present themselves in person for Counselling and admission.
5. If the candidate does not turn up on such date & time along with the required documents, his/her claim for the admission will be automatically cancelled, and the candidate next in merit will be accommodated against such seat.
6. All the required documents, mentioned below, are to be submitted at the time of admission, failing which the applicant's claim will not be entertained. The list of documents required is as follows:
    a. High School or equivalent examination mark sheet and certificate in original along with a photocopy thereof.
    b. Intermediate or equivalent examination mark sheet and Certificate in original along with a photocopy thereof.
    c. The graduation Mark sheet/Degree in original along with a photocopy thereof.
    d. Scheduled Caste/Other backward classes Category Certificate.
    e. Admit Card and Score card of CET/Qualifying Proof published by the University.
    f. Proof/Details of earlier enrolment (session 2022-23) to any DACE centres in India, if any.
    g. Income certificate issued as per provision of the scheme (issued after 31 March 2023).

Examination Centers:

There will be three centres of Examination, within the state of Uttarakhand, for appearing in CET.

1. Srinagar Garhwal
2. Dehradun
3. Roorkee

The University reserves all rights to change the examination centre in case of less number of applicants for any centre.

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Srinagar Garhwal (Uttarakhand) - 246174
(केन्द्रीय विश्वविद्यालय)
(A Central University)

पत्रांक: हे.न.ब.ग.वि.वि./DACE(P)/2022/60 दिनांक : 3/09/2022

–:अल्पकालीन संविदा शिक्षक भर्ती अधिसूचना:–

हेमवती नन्दन बहुगुणा गढ़वाल विश्वविद्यालय में सामाजिक अधिकारिता मंत्रालय भारत सरकार द्वारा वित्तपोषित **डॉ0 अम्बेडकर सेंटर ऑफ एक्सीलेंस (DACE)** के अन्तर्गत अनुसूचित जाति श्रेणी के छात्र/छात्राओं को संघ लोक सेवा आयोग **(UPSC)** सिविल सर्विसेज परीक्षाओं की कोचिंग प्रदान करने के लिये अल्पकालीन संविदा पर 03 शिक्षको (02 सामाजिक विज्ञान एवं 01 विज्ञान) की आवश्यकता है। संविदा शिक्षको को एक मुश्त रू0 1,15,000/– वेतन प्रतिमाह की दर से भुगतान किया जायेगा। विस्तृत दिशा–निर्देशों व सूचना हेतु विश्वविद्यालय वेबसाइट www.hnbgu.ac.in देखें।

ऑनलाइन आवेदन फार्म भरने की प्रारम्भ तिथि – 05 सितम्बर 2022 (10.00AM)
ऑनलाइन आवेदन फार्म भरने की अन्तिम तिथि – 25 सितम्बर 2022 (05.00 PM)

कुलसचिव 03/09/22

प्रतिलिपि– निम्न को सूचनार्थ एवं आवश्यक कार्यवाही हेतु प्रेषित।

1. कोर्डिनेटर, डॉ0 अम्बेडकर सेंटर ऑफ एक्सीलेंस (DACE) को सूचनार्थ।
2. समस्त संकायाध्यक्ष/विभागाध्यक्ष/निदेशक/टिहरी, पौड़ी परिसर।
3. समस्त प्राचार्य/निदेशक/सम्बद्ध महाविद्यालय/संस्थान।
4. समस्त उप कुलसचिव/सहायक कुलसचिव।
5. वित्त अधिकारी/परीक्षा नियंत्रक/कोर्डिनेटर, प्रवेश परीक्षा।
6. जनसम्पर्क अधिकारी, को इस आशय से प्रेषित कि उक्त विज्ञप्ति समाचार पत्रों में निःशुल्क प्रसारित करवाने का कष्ट करें।
7. सिस्टम मैनेजर, को इस आश्य से प्रेषित कि उक्त विज्ञप्ति को विश्वविद्यालय की वेबसाइट पर अपलोड़ करने का कष्ट करें।
8. कुलसचिव, समस्त केन्द्रीय विश्वविद्यालय/राज्य विश्वविद्यालय को सूचनार्थ।
9. मा0 प्रति कुलपति, महोदय को सादर सूचनार्थ।
10. निजी सचिव, कुलपति, माननीय कुलपति महोदया को सादर सूचनार्थ।
11. गार्ड फाईल।

कुलसचिव

Dr. Ambedkar Centre of Excellence (DACE)
Hemvati Nandan Bahuguna Garhwal University, Srinagar Garhwal
(A Central University)

Ref. No. HNBGU/DACE/2022/ CPI 60 **Date: 03/09 /2022**

Contractual Teacher Recruitment Notification

Dr. Ambedkar Centre of Excellence of HNB Garhwal University, Srinagar (Garhwal) invites online applications from eligible candidates (eminent and professional scholars in the subjects of Social Sciences and Sciences) for **performance based** three (03) short-term positions of **Contractual Teachers** on consolidated fix salary to provide specialized coaching to the Scheduled Caste (SC) students for the Civil Services examination conducted by the UPSC as per following details:

S. N.	Positions	Essential Qualification/Eligibility	Desirable Qualification
1	Social Sciences Two (02) Position	• PhD/NET *in the concerned/allied/relevant disciplines.* • PG- Political Science/History/Geography/ Economics/Sociology *A minimum of 55% marks (or an equivalent grade in a point-scale, wherever the grading system is followed) at the Master's level* • UG- Social Sciences *Applicant must possess a good academic record* • **Publications-** at least 3 research publications in peer reviewed/UGC CARE list journals	• Experience of coaching for UPSC Civil Services Exams • Qualified UPSC Preliminary exam in past. • Ability to teach History, Polity, Economics, Geography and other disciplines/topics for Preliminary and Mains exam of UPSC Civil Services. • Working knowledge of computer and other ICT mediums.
2	Sciences One (01) Position	• PhD/NET *in the concerned/allied/relevant disciplines.* • PG- Physics/Maths/Chemistry *A minimum of 55% marks (or an equivalent grade in a point-scale, wherever the grading system is followed) at the Master's level* • UG- Sciences *Applicant must possess a good academic record* • **Publications-** at least 3 research publications in peer reviewed/UGC CARE list journals.	• Experience of coaching for UPSC Civil Services Exams • Qualified UPSC Preliminary exam in past. • Ability to teach Logical reasoning, Aptitude reasoning and other Sciences related disciplines/topics for Preliminary and Mains exam of UPSC Civil Services. • Working knowledge of computer and other ICT mediums.

Note:

1. Contractual Teacher shall be paid a lump-sum monthly salary of Rs. 1,15,000/- per month only*. ***(Subject to release of fund by DAF to DACE Centre as per Scheme).**
2. In addition to teaching assignments with course module preparation, the contractual teacher shall perform all such other official duties which are essential for smooth functioning of the Centre.
3. The posts are purely contractual in nature and no claim for regularity at any stage will be entertained by the University.
4. **Preference will be given to candidates who have prior experience of appearing in UPSC Mains examination or Interview.**

Important Dates:

S.No.	Particulars	Start date &Time	Last date & time
1.	Submission of On-line Application Form	05/09/2022 & 10:00 AM	25/09/2022 & 5:00 PM

Application fees:

S.No.	Category	Fee
1.	UR/OBC/EWS Category	1000
2.	SC/ST Category and Women applicants	500

- Fees once paid will not be refunded under any circumstances.
- Payment should be made online only, through credit/debit card/Net Banking.

Important Instructions:

1. Applicants are required to apply online (Link: online.hnbgu.ac.in/dace_rec). The online link will be available live from 05/09/2022 (10:00 AM.) and will be closed on 25/09/2022 (5:00 PM).
2. Before applying for the post, applicants are advised to go through the Essential/ Desirable Qualifications and other general instructions carefully and satisfy themselves with their eligibility and candidature. Later on, no inquiry in this regard will be entertained.
3. Only completely filled forms with supporting documents will be considered for screening and incomplete applications in any respect shall be summarily rejected.
4. Applications must be submitted online only. The application form will be entertained through online mode only, however, applicants are also required to take print out of duly filled online application form and submit self-attested hard copy along with the requisite/uploaded certificates/documents through Registered post/ Speed post/ Courier/ by hand on the following University address, latest by 30/09/2022 (Friday) 5:00 pm. At the top of the envelope **"Application for the post of .....(*subject)*"** need to be mentioned clearly.
5. **Address for Correspondence: - Coordinator, Dr. Ambedkar Centre of Excellence, Department of Political Science, School of Humanities and Social Sciences, Hemvati Nandan Bahuguna Garhwal Central University, Birla Campus, Srinagar, District Pauri, Uttarakhand, India. 246174.** The University shall not be responsible for any postal delays and documents received after last date of submission i.e. **30/09/2022 (Friday) on or before 5:00 pm.**
6. Any communication including call for interview regarding this recruitment process will be made through e-mail provided by the applicant in on-line form only, therefore, applicant must ensure providing correct valid e-mail ID. No separate communication shall be entertained by any other medium.
7. The university shall process applications entirely on the basis of information/documents submitted by the candidates. In case, any information/document is found false or incorrect at any stage, the responsibility and liability shall lie solely with the candidates. Therefore, the applicants are advised to fill out the application form carefully.
8. The prescribed essential/desirable qualifications are the minimum and the mere possession of the same does not entitle candidates to be called for the interview.
9. If the number of applications received in response to the advertisement will be large and it will not feasible to interview all the candidates, the university at its discretion may restrict the number of candidates to a reasonable limit on the basis of qualifications/experience higher than the minimum prescribed for the post. The university, however, will prefer, candidates possessing higher qualifications and experience.
10. The process of selection may include a presentation/teaching demo at the time of the interview.
11. Candidates are advised to visit the university website at regular intervals for any update.
12. Advocacy or canvassing in any form will result in disqualification.
13. The university reserves the right to revise/reschedule/cancel/suspend the recruitment process at any stage without assigning any reason. The decision of the university shall be final and no appeal in this regard shall be entertained.
14. In case of any inadvertent mistake in the process of selection that may be detected at any stage after issuing an appointment letter, the university reserves the right to modify/withdraw/cancel any communication made to the applicant in this regard.
15. If the services of selected candidate are not found satisfactory at any stage, his/her services may be terminated forthwith without assigning any reason.

Application Form

Personal Details			
Post Applied for		Subject applied for	☐ Social Sciences ☐ Sciences
Full Name		Marital status	
Category		Gender	
Date of Birth		Nationality	
Father's Name		Whether you have qualified the Civil Services Preliminary examination? mention your roll no. of Pre/Main Examination (Attach proof)	
Mother's Name			
Aadhar No.			
Mobile No.			
E-mail ID			
Address of Correspondence		Permanent Address	

Academic Qualification					
Examination	**Subject(s)**	**Division**	**Marks/Total Marks**	**Year**	**Board/University**
10th					
12th					
Bachelor's					
Master's					
Others					

Ph.D. degree details			
S.No.	Subject(s)	Thesis title	Date of Award

National/State Level Examination Qualified		
Examination (NET/SLET/SET)	Subject(s)	Year

Experiences (Research/Teaching)							
Organization	Designation	Status	Pay Scale/Consolidated	Nature of Duty	From	To	Total Time

Current Employment					
Organization	**Designation**	**Status**	**Pay Scale/Consolidated**	**Nature of Duty**	**From**

Research Publication in peer reviewed/UGC listed journals											
S.No.	Title of the Paper	Journal Name	Year	Volume	Page No	ISSN	SCI Impact Factor	Authorship Author/Co-Author	UGC listed	Scopus	Publisher

Three Best Research Publication in peer reviewed/UGC listed journals											
S.No.	Title of the Paper	Journal Name	Year	Volume	Page No	ISSN	SCI Impact Factor	Authorship Author/Co-Author	UGC listed	Scopus	Publisher

Publication: others (Book/Book Chapter/Conference Proceeding)							
S.No.	Publication Type	Title	ISSN/ISBN	Authorship Author/Co-Author	Publisher	Year	National/International

Lecture Delivered						
S.No.	Title	Date	Seminar/Conference/Workshop	Organizer	State/National/International	Year

Award/ Fellowship				
S.No.	Name of the award	Name of the awarding body	Date	Level (National/International

Referees Details					
S. No.	Name	Designation	Organization	Email	Mobile

Discuss in about 150 words, your suitability for the post that you have applied for:

Candidate Declaration

I have read the applicable guidelines. I do hereby solemnly declare that the information given, the statements made and documents uploaded with this application form are correct and true to the best of my knowledge and belief. If any information given by me in this application is found to be false or misleading, my candidature is liable to be cancelled and I may be subjected to legal/disciplinary proceedings.

Candidate's Signature

हेमवती नन्दन बहुगुणा गढ़वाल विश्वविद्यालय
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Srinagar Garhwal (Uttarakhand) - 246174
(केन्द्रीय विश्वविद्यालय)
(A Central University)

पत्रांक: हे०न०ब०ग०वि०वि० / प्र0परी0 / 2022 / 128 दिनांक : 29/06/2022

(कार्यालयादेश / 128)

विश्वविद्यालय द्वारा पूर्व में निर्गत अधिसूचना सं0– **हे०न०ब०ग०वि०वि० / प्र0परी0 / 2022 / 121 दिनांक 30.05.2022 के क्रम में** एतद्द्वारा सूचित किया जाता है, कि हेमवती नन्दन बहुगुणा गढ़वाल विश्वविद्यालय श्रीनगर गढ़वाल के द्वारा संचालित **डॉ0 अम्बेडकर सेंटर ऑफ एक्सीलेंस (DACE)** में प्रवेश परीक्षा के माध्यम से यूपीएससी **(UPSC)** परीक्षाओं के लिये निःशुल्क कोंचिग कार्यक्रम में प्रवेश के लिए ऑनलाइन आवेदन फार्म भरने की अन्तिम तिथि **दिनांक 10 जुलाई 2022** तक विस्तारित की जाती है।

कुलसचिव

प्रतिलिपि– निम्न को सूचनार्थ एवं आवश्यक कार्यवाही हेतु प्रेषित।

1. कोर्डिनेटर, डॉ0 अम्बेडकर सेंटर ऑफ एक्सीलेंस (DACE) को सूचनार्थ।
2. समस्त संकायाध्यक्ष / विभागाध्यक्ष / निदेशक / टिहरी, पौड़ी परिसर।
3. समस्त प्राचार्य / निदेशक / सम्बद्ध महाविद्यालय / संस्थान।
4. वित्त अधिकारी / परीक्षा नियंत्रक / कोर्डिनेटर, प्रवेश परीक्षा।
5. समस्त उप कुलसचिव / सहायक कुलसचिव।
6. जनसम्पर्क अधिकारी, को इस आशय से प्रेषित कि उक्त विज्ञप्ति समाचार पत्रों में निःशुल्क प्रसारित करवाने का कष्ट करें।
7. सिस्टम मैनेजर, को इस आश्य से प्रेषित कि उक्त विज्ञप्ति को विश्वविद्यालय की वेबसाइट पर अपलोड़ करने का कष्ट करें।
8. निजी सचिव, कुलसचिव, कुलसचिव महोदय को सूचनार्थ।
9. मा0 प्रति कुलपति, महोदय को सादर सूचनार्थ।
10. निजी सचिव, कुलपति, माननीय कुलपति महोदया को सादर सूचनार्थ।
11. गार्ड फाईल।

29/06/2022

कुलसचिव

हेमवती नन्दन बहुगुणा गढ़वाल विश्वविद्यालय
Hemvati Nandan Bahuguna Garhwal University
श्रीनगर गढ़वाल (उत्तराखण्ड)–246174
Srinagar Garhwal (Uttarakhand) - 246174
(केन्द्रीय विश्वविद्यालय)
(A Central University)

पत्रांकः हे.न.ब.ग.वि.वि. / प्र0परी0 / 2022 / 73 दिनांक : 31 / 10 / 2022

प्रेस विज्ञप्ति

एतद्द्वारा सूचित किया जाता है कि हे0न0ब0 गढ़वाल विश्वविद्यालय श्रीनगर की डॉ0 अम्बेडकर उत्कृष्टता केन्द्र (DACE) की प्रवेश परीक्षा, दिनांक 30 अक्टूबर 2022 को अयोजित की गई थी। इस प्रवेश परीक्षा की उत्तर कुँजी (Answer Key) से सम्बन्धित छात्रों से प्राप्त आपत्तियों का निस्तारण करते हुये आज **दिनांक 31 अक्टूबर 2022** को परीक्षाफल घोषित किया जा चुका है। परीक्षाफल विश्वविद्यालय की वेबसाइट ***https://online.hnbgu.ac.in/Ambedkar_hnb/*** पर उपलब्ध है।

(प्रो0 अनिल कुमार नौटियाल)
कोर्डिनेटर, प्रवेश परीक्षा

प्रतिलिपि– निम्न को सूचनार्थ एवं आवश्यक कार्यवाही हेतु प्रेषित।

1. कोर्डिनेटर, डॉ0 अम्बेडकर सेंटर ऑफ एक्सीलेंस (DACE) को सूचनार्थ।
2. समस्त संकायाध्यक्ष / विभागाध्यक्ष / निदेशक / टिहरी, पौड़ी परिसर।
3. समस्त प्राचार्य / निदेशक / सम्बद्ध महाविद्यालय / संस्थान।
4. वित्त अधिकारी / परीक्षा नियंत्रक।
5. समस्त उप कुलसचिव / सहायक कुलसचिव।
6. जनसम्पर्क अधिकारी, को इस आशय से प्रेषित कि उक्त विज्ञप्ति समाचार पत्रों में निःशुल्क प्रसारित करवाने का कष्ट करें।
7. सिस्टम मैनेजर, को इस आश्य से प्रेषित कि उक्त विज्ञप्ति को विश्वविद्यालय की वेबसाइट पर अपलोड़ करने का कष्ट करें।
8. निजी सचिव, कुलसचिव, कुलसचिव महोदय को सूचनार्थ।
9. मा0 प्रति कुलपति, महोदय को सादर सूचनार्थ।
10. निजी सचिव, कुलपति, माननीय कुलपति महोदया को सादर सूचनार्थ।
11. गार्ड फाईल।

(प्रो0 अनिल कुमार नौटियाल)
कोर्डिनेटर, प्रवेश परीक्षा

Dr. Ambedkar Centre of Excellence (DACE)

Hemvati Nandan Bahuguna Garhwal Central University

Srinagar Garhwal, Uttarakhand

Notice for the DACE Vacant Seats

All the interested aspirants are informed that the admission for the DACE program 2023-24 is underway and first merit list is notified on 30.11.2023 at the university website (www.hnbgu.ac.in).

After notification of first merit list, now the SAMRTH portal for admission to the remaining seats shall be opened from 01.12.2023 (Friday) to 03.12.2023 (Sunday). All the interested candidates may apply on the online admission portal.

Date of re-Opening of Admission Portal: 1st Dec. 2023

Date of Closing of Admission Portal: 3rd Dec. 2023

Online Admission Link: https://hnbgudaceadmission.samarth.edu.in/

Coordinator DACE

Dr. Ambedkar Centre of Excellence (DACE)

Hemvati Nandan Bahuguna Garhwal Central University Srinagar Garhwal

Merit List (Session 2023-24)

Based on merit and recommendation of selection committee, the following list of candidates were found suitable for admission in UPSC/SPSC coaching program for session 2023-24.

Select List of Scheduled Caste (SC) Candidates
(Session 2023-24)

S.No.	Name of Candidate	Father's Name	Category
1	PRATIMA DAS	PRIYANATH DAS	SC
2	SAURABH KUMAR	UTTAM KUMAR	SC
3	NEETU VERMA	RAM JAGAT VERMA	SC
4	KM NEETU	RAJENDRA LAL ARYA	SC
5	SHAILJA SINGH	B L ARYA	SC
6	RAHUL KUMAR	SAJJAN LAL	SC
7	POOJA	DHEERAJ LAL	SC
8	SANDEEP	BISHU	SC
9	ANIL TAMTA	MAHESH CHANDRA TAMTA	SC
10	ANCHAL	VIRENDRA LAL	SC
11	VISHAL KUMAR	AWDHESH KUMAR	SC
12	AKANSHA	SUNIL KUMAR	SC
13	ABHISHEK KUMAR	SUNIL KUMAR	SC
14	RAVINDRA KISHOR	OM PRAKASH	SC

15	AKASH SINGHANIA	RESHAM PAL	SC
16	ARYAN VIKAS	PUSHKAR LAL	SC
17	NIKITA	BHOLA LAL	SC
18	KUMARI POONAM	RANVEER KUMAR	SC
19	DEEPAK SOURIYAL	NAND RAM	SC
20	POOJA SHAH	MANOHAR LAL SHAH	SC
21	SANJAY KUAMR	MOHAN LAL	SC
22	MUSKAN	VIKRAM	SC
23	KM USHA	PREM DAS	SC
24	RAJENDRA KUMAR	JASPAL LAL	SC
25	SAURABH	MUKESH KUMAR	SC
26	POOJA	VIJENDRA LAL	SC
27	HEMA	DINESH SINGH	SC
28	VISHAL KUMAR	PRADEEP KUMAR	SC
29	JITENDRA KUAMAR	JASPAL LAL	SC
30	SATENDRA SINGH	RAVINDRA SINGH	SC
31	RITIKA	VED PRAKASH	SC
32	SHAILESH RAJ	DINESH RAJ	SC
33	ROSHANI	VIRENDRA LAL	SC
34	RAMNEET	RAJVEER SINGH	SC
35	LALIT KUMAR	DAULAT RAM	SC
36	GANESH KUMAR	GORDHAN LAL	SC
37	DHARMENDRA KUMAR	UDAY LAL	SC
38	KM. USHA ARYA	BEERBAL LAL	SC

Select List of Other Backward Classes (OBC) Candidates
(Session 2023-24)

S.No.	Name of Candidate	Father's Name	Category
1	ADITYARAJ SHARMA	ASHISH KUMAR SHARMA	OBC
2	KAREENA RAWAT	JAGVEER SINGH RAWAT	OBC
3	RASHMI CHAUHAN	RAKESH SINGH CHAUHAN	OBC
4	AMRENDRA BEHERA	HARENDRA KUMAR BEHERA	OBC
5	MONA YADAV	HARIDAYNARAYAN YADAV	OBC
6	SIDDHARTHA NAUTIYAL	DINESH NAUTIYAL	OBC
7	OM PRABHA	VIJAY KUAMR YADAV	OBC
8	JITENDRA KUAMR	PARAS YADAV	OBC
9	DINESH RAJPOOT	SHIV RAM	OBC
10	TARUN GANGWAR	TULARAM GANGWAR	OBC
11	ASHISH BYAHUT	TRILOKINATH GUPTA	OBC
12	SHIVANI YADAV	KRISHAN PAL SINGH	OBC
13	VIKASH CHAUDHARY	MOHAN LAL	OBC
14	GAURAV	PITAMBER DUTT	OBC

	GOSWAMI	GOSWAMI	
15	JYOTI	MOHAN LAL	OBC
16	SHARAD YADAV	CHHOTE LAL YADAV	OBC
17	NIRBHAY KUMAR	HARI NARAYAN PRAMANIK	OBC
18	NEHA	PITAMBAR DUTT GOSWAMI	OBC
19	ASHOK SINGH	BALBEER SINGH	OBC
20	DEEPAK	TEERATH SINGH	OBC
21	NISHANT GUPTA	YOGENDRA Y	OBC

Note:

1. The above candidates are required to report DACE office latest by 05/Dec/2023. The classes shall begin from 06/Dec/2023 onwards.

2. The formal admission to the DACE program shall be based on verification of all documents in original and fulfilling DACE program guidelines.

3. For further information candidates may contact on: 9891591788, 9805667711 or may contact through DACE email dacehnbgu@gmail.com

4. Information about the vacant seats is notified on university website.

Coordinator DACE

“Sustainability and Culture in Himalayan Societies”

An International Workshop hosted by the University of Haifa, 13-15 March 2022

Goals

The aim of this present workshop is to promote and enhance academic collaboration and mutual projects between the University of Haifa and HNB Garhwal Srinagar (Uttarakhand) and the Indian Institute of Technology-Mandi (Himachal Pradesh), both of which are situated in the Indian Himalaya.
We focus on sustainability and culture in South Asian communities with an emphasis on Himalayan societies. Topics include resource management and reproduction, the use of new media in research, the politics of ethnic identities, and the uses of the Himalayan past.

1. Promoting sustainable environmental development and awareness among the local population of hill areas of Garhwal Himalayas, the reason being a large-scale migration from hill villages to plain areas, due to lack of natural resource conservation, unproductive agriculture, and natural disasters and calamities; 2. Conservation and promotion of tangible and intangible cultural heritage of disaster-affected hill areas; 4. Identification of gender disparity and vulnerability, promotion of equity; 5. Promoting ethnohistorical research and oral traditions in this area; 6. Preservation of the natural environment, traditional culinary practices and food consumption, and cultural heritage.

Participants:

University of Haifa, Israel:
Prof Amos Megged, University of Haifa
Prof Tali Katz-Gerro, University of Haifa
Dr Arik Moran, University of Haifa

Hemvati Nandan Bahuguna Garhwal University (HNBGU), Srinagar Garhwal, Uttarakhand, India:
Prof. Rajpal Singh Negi, HNB Garhwal
Prof. RC Bhatt, HNB Garhwal
Prof. R.K. Maikhuri, HNB Garhwal
Dr. Prashant Kandari, HNB Garhwal (via Zoom

Indian Institute of Technology-Mandi, Himachal Pradesh, India:
Dr Nilamber Chhettri, IIT-Mandi
Dr Shyamasree Dasgupta, IIT-Mandi
[1-2 more by zoom?]

DAY 1. Sunday, 13 March, Senate Hall, University of Haifa:

Greetings

Resource management and reproduction (14:45-15:30):

14:45-15:30:
Prof Talli Katz-Gerro, University of Haifa

The Cultural Politics of Household Sustainability

Research on the climate change and environmental sustainability has tended to pay significantly less attention to the cultural dimensions of adapting to climate change and environmental degradation. This means that little is known about how culturally-specific notions of sustainability, premised on reducing the impacts of Western over-consumption, are understood by immigrants to global North cities, by different religious groups, and by different lifestyle-communities. In this presentation I discuss the findings of two recent research projects. First, a mixed-methods research that explored the environmentally significant household practices of Somali immigrants living in Manchester, UK. Second, a project looking at household food practices of three social groups in Israel: religious Jews, secular Jews, and Muslim Arabs. I will discuss the way participants understand sustainability, how ideas around sustainability correspond to experiences of household resource use, how culture and religious norms shape household practices related to food behavior, and gendered and generational differences in participants' responses to policy messages about household sustainability. A main conclusion would be that cultural perspectives and practices can make important contributions to more inclusive sustainability governance.

15:30-16:15:
Prof. R.K. Maikhuri, HNB Garhwal
Socio-ecological approaches for bio-cultural and heritage resource conservation of Traditional/ethnic and indigenous communities of the Central Himalayan region–Uttarakhand

INTERMISSION (15 Minutes)

Environmentalism and Gender (16:30-18:00):

16:30-17:15:
Dr Shyamasree Dasputa, IIT-Mandi
TBC

17:15-18:00:

Dr. Prashant Kandari, HNB Garhwal (via Zoom):
Symbiotic relationship between Mountain women and Natural resources: Sustainability, policy approach and emerging issues towards women empowerment.

DAY 2. Monday, 14 March, Zippori National Park/Senate Hall, University of Haifa.

Tour Zippori National Park (9:00-12:00):

PIck up from dormitories, tour of Zippori National Park

Lunch break (Zippori) [סנדוויצ'ים ארומה]

Session in the university [find topic, roundtable?] (14:30-16:00):

14:30-15:15

15:15-16:00

Add a speaker from IIT Mandi?
TBC

DAY 3. Tuesday, 15 March, Jacobs Building, Room 305, University of Haifa

Ethnicity and Development in Himalayan Societies (9:00-12:00):

9:00-9:15: Gathering, Tea.

9:15-10:00

Dr Nilamber Chhettri, IIT-Mandi

Elusive Identities, Enduring Demands: Recognition struggle and scalar expression amongst the Hatti of Trans-Giri region in Himachal

10:00-10:45

Prof. Rajpal Singh Negi, HNB Garhwal
Study of Multimedia Documentation of Folk Rituals and Processional Performances in Uttarakhand

10:45-11:30

Prof. RC Bhatt, HNB Garhwal
“Territorial Jurisdiction and Interrelation among Gods and Goddess in Kinnaur, Himachal Pradesh, and Garhwal Central Himalaya, India”

LUNCH [on campus]

14:30-15:30: TOUR HECHT MUSEUM [תמי , להזמין סיור מודרך באנגלית]

[Retire to dorms]

20:30 – Workshop Dinner, Libira Restaurant (Downtown Haifa)

[pickup by Taxi from the dormitories at 20:00]

ABSTRACTS:

Dr Nilamber Chheettri, IIT-Mandi

Elusive Identities, Enduring Demands: Recognition struggle and scalar expression amongst the Hatti of Trans-Giri region in Himachal.

This paper is an empirical investigation into the claims made by the Hatti community of the Trans-Giri region in Sirmaur for recognition as a scheduled tribe. The paper traces the historical genealogy of this demand and discusses in detail Hatti’s long quest to

secure the coveted ST status in the state. The paper examines the multifaceted domains of identity claims by elucidating their structure and content. The paper focuses on territorial demarcation that is redrawing of state boundaries and its impact on the constitution of ethnic boundaries in the region. Amidst the contested paradigm of recognition, this paper notes the scalar expression of such demands often embedded in the politics of place-making in the region. It will try to delineate their struggle and show how boundary drawing practices in South Asia have led to the contestation of identities in the Himalayan region.

Keywords: tribe, schedule tribe, ethnic groups, myths, memories, ritual, culture, history.

Prof. R.C. Bhatt, HNBU Garhwal

Territorial Jurisdiction and interrelation among Gods and Goddess in Kinnaur, Himachal Pradesh, And Garhwal Central Himalaya, India

Present study is a piece of research work conducted in Kinnaur region of Himachal Pradesh and Garhwal region of Uttarakhand to explore the role of divinity in defining the territory and also to understand the interrelationship between different gods and goddesses. It shows how a large geographical area was divided into many units which are marked and governed by divine characters. The major categories are principal deity and subordinate deity in which the largest deity is called Kunth who governs the entire Pargana and smallest deity is called Khimsu which is a household deity. The entire structure consists Paragana, Ghori, Gaon and Kim. Each subdivision is ruled by the deity with both civil and judicial rights. They ruled from their shrines with their own administrators and oracles as agents or mediums. The categorization of deities is not merely restricted in political hierarchy but it also categorised with the nature of their interest like- Adhikristh Devta, Isht devta, Kul Devta, Krishi Devta, pashu devta and more. It clearly indicates the separate area of interest of different deities which is full of specific rights and duties. In this inimitable idea of politico- religious territoriality some Gupt devta (hidden deity) also played their role which are not resided in any shrines. It has also come to light that most of the deities are movable in nature. Their procession called Jaat / yatra which moves in a prescribed way and a specified orbit within a defined geographical territory in the mountains as per the rituals after an interval of one and two years or sometimes over a long interval of twelve years. In this context it is also pertinent to mention that such practice of moving deities is also widely prevailing in Garhwal Central Himalayan region. And one of the well know Nanda RajJaat (Royal procession), which take place after an interval of 12 years is deep-rooted in the politico-religious sphere of the Himalayan society as it was started in the early medieval period. Therefore, the present study also highlights the concept of the geo-political landscape of divine kingship of western and larger part of Central Himalayan region in a wider perspective which has been not delt before. These traditional practices will be highlighted in this presentation.

Key words: Divine kingship, geo-politics, territoriality, Village gods, Kinnaur

Prof. R.K. Maikhuri, HNB Garhwal

Socio-ecological approaches for bio-cultural and heritage resource conservation of Traditional/ethnic and indigenous communities of the Central Himalayan region– Uttarakhand

R.K.Maikhuri, Department of Environmental Sciences, HNBGU, Srinagar Garhwal, Uttarakhand, India (rkmaikhuri89@gmail.com).

The socio-ecological and natural characteristics of traditional/local communities are closely linked to this sensitive ecological setting. The extreme verticality of this region reverberates in major biophysical and socio-cultural peculiarities and globally significant for several reasons. With improvement in accessibility, bio-cultural and traditional systems are being increasingly impacted by external socio-economic political forces (conservative-developmental policies, economic globalization and democratization) coupled with the global environmental changes Conservation and management of natural resources under changed scenario is becoming a pressing challenge for sustainable development of the region. The traditional ecological knowledge and wisdom of the indigenous people have become a major focus of attention within the past decades. It is considered to have fundamental importance in management of local resources in the husbanding of the world' biodiversity and in providing locally valid models for sustainable living. It is now widely recognized that along with the conventional science and technology, the traditional knowledge products are of critical importance to overall development of the Himalayan region.

Globalization and homogenization have replaced local food cultures; high-yield crops and monoculture agriculture have taken the place of biodiversity; industrial and high-input farming methods have degraded ecosystems and harmed agro-ecosystem in diverse agro-ecological zones; and modern food industries have led to diet related chronic diseases and other forms of malnutrition. The stories show how traditional communities' food systems contain treasures of knowledge from long-evolved cultures and patterns of living in local ecosystems. However, these food systems which are intricately related to the complexities of social-cultural and economic circumstances are becoming increasingly more affected by the forces of globalization. With the passage of time, the knowledge and understanding on such a diversified food base has weakened considerably. This decline of knowledge base has wide range implication in view of resurgence of global interest on natural food and medicines. Considering this, it is high time to rejuvenate people's interest to harness the potential of these resources to counteract the impact of covid-19 and other diseases in future.

Further research to build on the present scenarios of traditional food systems could improve understanding of the forces driving negative environmental change that is decreasing availability of key food resources, and how to reverse these trends with local, regional and national policies. Understanding how to improve food choices, particularly among young generation youth, of both traditional and purchased foods with education and other incentives is greatly needed among the marginal and traditional communities of the Central Himalayan Region.

Socio-ecological approaches for bio-cultural and heritage resource conservation of Traditional/ethnic and indigenous communities of the Central Himalayan region–Uttarakhand

Prof. R.K. MAIKHURI

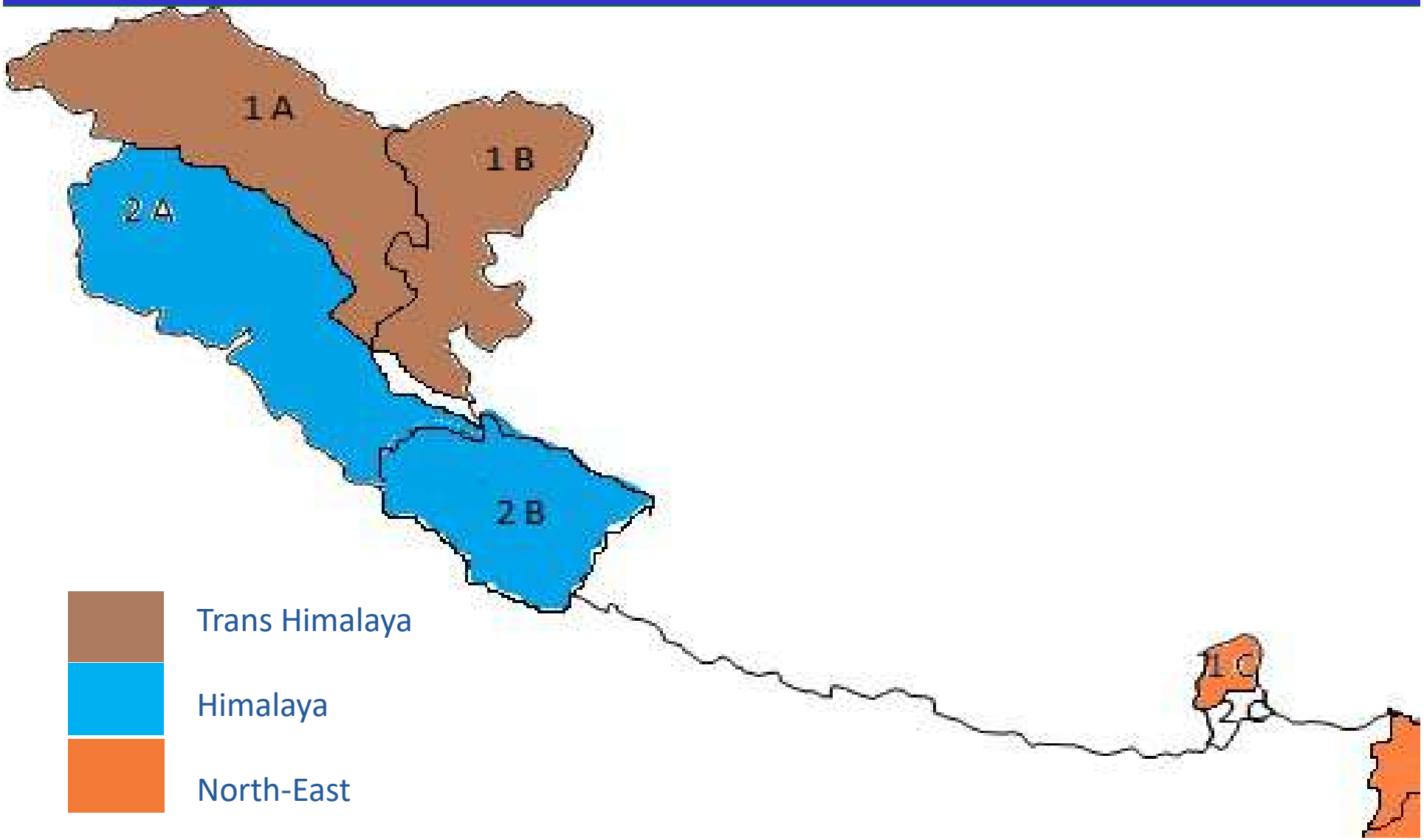
Dept. of Environmental Sciences

HNB Garhwal University

(A central University)

Srinagar Garhwal ,Uttrakhand, India

Extent and biogeographic divisions of Indian Himalayan Region (IHR)



Bio-geographic representation of Indian Himalayan Region (IHR)

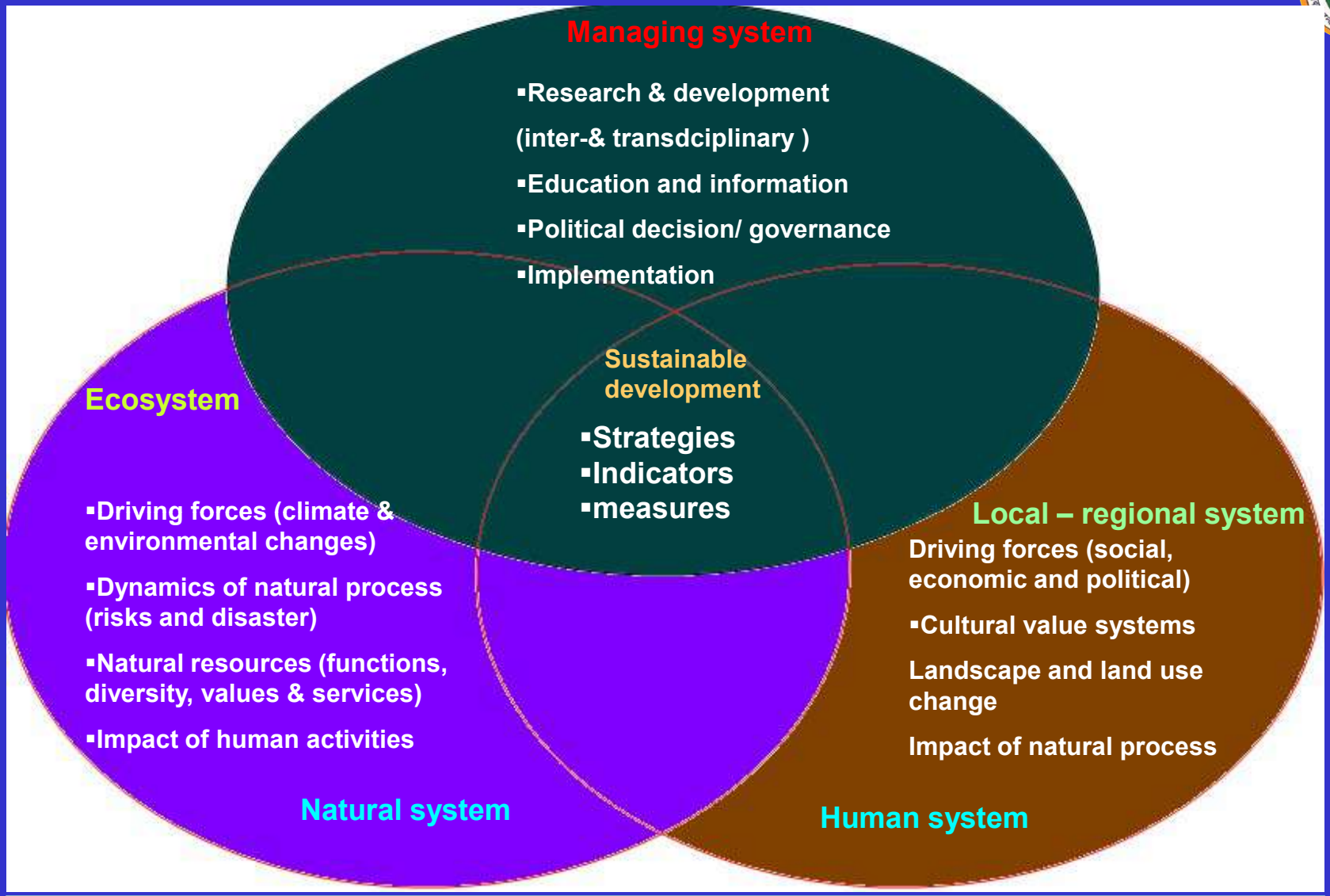
Bio-geographic Zones	Bio-geographic Provinces	Geographical area of India (%)	Major Biome Representation
Trans Himalaya	1A: Ladakh Mountains	3.3	Tundra
	1B: Tibetan Plateau	2.3	Alpine
	1C: Sikkim Trans Himalaya	<0.1	Alpine, Tundra
The Himalaya	2A: North West Himalaya	2.1	Alpine, Temperate, Sub-Tropical
	2B: West Himalaya	1.6	-- do --
	2C: Central Himalaya	0.2	-- do --
	2D: East Himalaya	2.5	-- do --
North East India	9A: Brahmaputra Valley	2.0	Tropical Evergreen Forest, Very Moist Sal Forest, Tropical Grass Lands
	9B: Northeast Hills	3.2	Tropical Evergreen, Tropical Moist Deciduous, Sub-Tropical, Montane Temperate, Wetland

Diversity of wild relatives in the Himalayan sub-centers

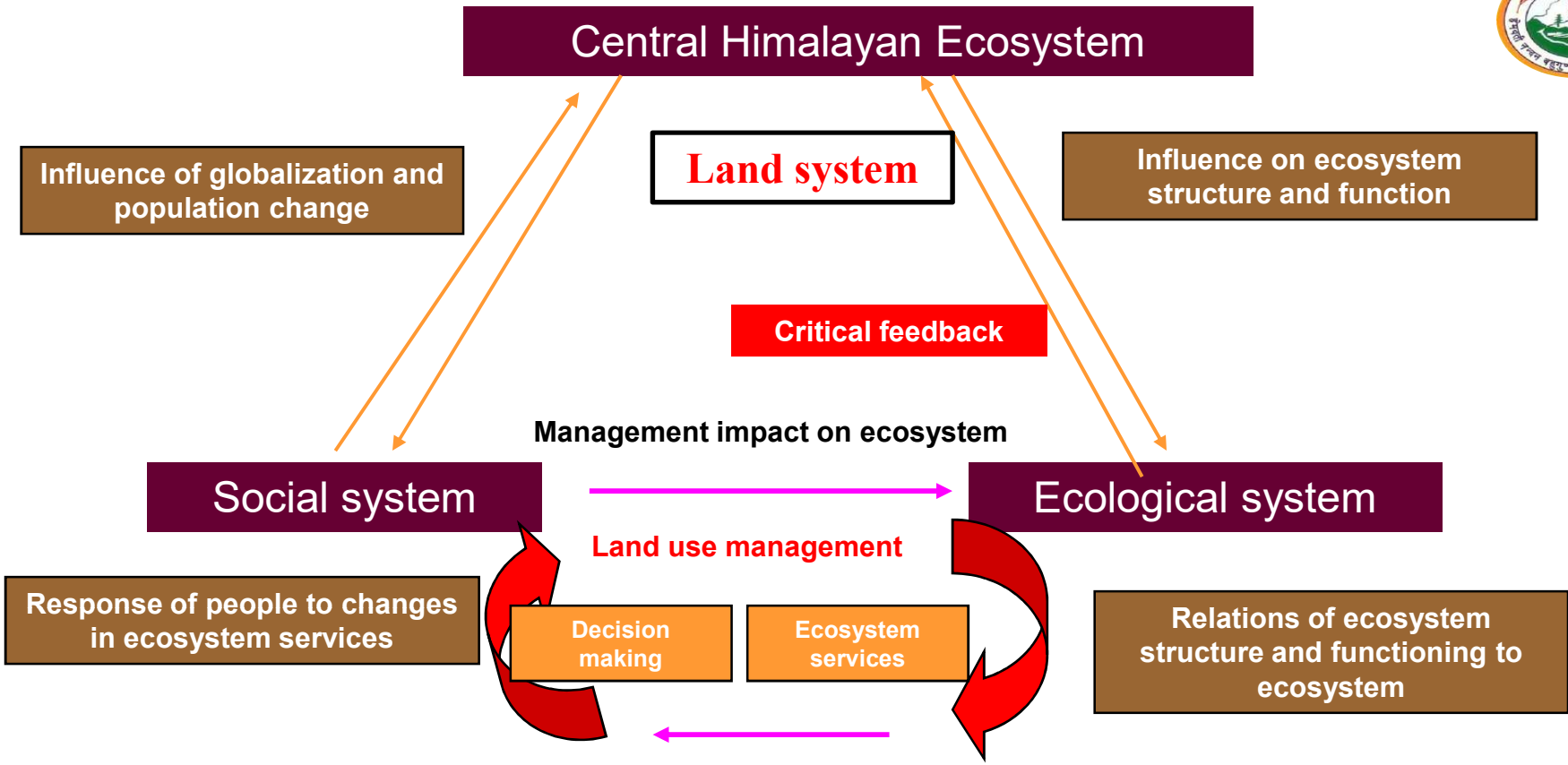
Category	Distribution in Himalayan Sub-Centers		
	West Himalaya	East Himalaya	North-east Region
Cereals and millets	29	07	16
Legumes	09	05	06
Fruits	37	32	51
Vegetables	25	12	27
Oilseeds	06	03	01
Fibres	04	04	05
Spices and condiments	10	09	13
Miscellaneous	05	10	13
Total spp. diversity	125	82	132

Indian Himalayan Region(IHR)

- **It covers a geographical area of 5.3 lakh km^2 which is 17% of the total geographical area of the country.**
- **The IHR inhabited by 49 million people which is about 4% of total population of the country, besides the region is home to more than 171 ethnic groups out of a total 573 schedule tribes reported in India.**
- **The IHR represent one-third of the total forest cover of India and nearly 45% of the very good forest cover in the country.**
- **The IHR is rich in biodiversity and represent diverse biomes and are about 1,740 species of medicinal and aromatic plants, 675 species of wild edibles and over 816 tree species reported.**
- **Temperatures across the IHR are expected to increase by 1–1.5^{o}C (and in some higher altitudes, by up to 3.5^{oC}) by the year 2050**
- **The IHR has the highest rate of outmigration, with mostly young men migrating for seeking employment and livelihoods**



Element of an integrated approach to help understanding of the driving forces in natural and human systems from local to global level in a time of rapidly growing process of globalization and global change



Linking ecosystem services to human well being

T1 – critical pathways of change

T2- vulnerability and resilience of land systems

T3- effective governance for sustainability

T1- dynamics of land systems

T2- Consequences of land system change

T3-integrating analysis and modelling for land sustainability

Central Himalayan Region (Uttarakhand)

- The Central Himalayan Region (CHR) is spread over 53,483 sq. km. and are susceptible to the impacts of natural perturbations such as natural disaster, climate change as other parts of IHR, HKH and elsewhere
- The CHR is home of 10.1 million people and the communities living in the rural landscape are economically weak and marginalized.
- The region occupy 35,394 sq. km. forest area which constitutes 64.8% of its total geographical area.

Issues and challenges for achieving the Sustainable livelihood in the CHR, Uttarakhand

- Deforestation, land degradation, forest fire and declining carrying capacity of forest and rangelands.
- Biodiversity loss (forest and agro-biodiversity)/biological invasion.
- Hydrological imbalance (drying springs/ water resources, etc).
- Predominance of rain-fed agriculture, small and fragmented land holding-low agricultural yield.
- Human wildlife conflicts (crop raiding/livestock depredation by wildlife).
- Lack of small scale industries and poor micro-macro-economic condition of the region.
- Low skill/capacity among local people for local value addition in agro-based products for entrepreneurship development
- No employment opportunities, inadequate livelihood options that leads to out migration
- Low level of technological adoption and poor infrastructural facilities
- Natural disaster, extreme events, landslides, cloudburst/flash floods ,etc.
- Expansion of protected area network (PAs).
- Low access to technical education
- Social disintegration

Linking cultural diversity with biodiversity and livelihoods

- With whole range of traditional and tribal communities, the human dimension of bio-resource utilization and management is enormous.
- Bio-resources of agro and wild origin constitute an important source of livelihood for million of people across the IHR.
- Out of 17,000 recorded plant species, over 9,500 wild plants are recognised to be ethno-biological values (THCS), of these about 190 have marketability.
- Traditional agro-biodiversity – Diverse culture have unique indigenous practices in the field of agriculture.

CHR – Rich in Bio-cultural/Ethnic Diversity

Ethnic/ Tribal and traditional Communities	Livelihood options
Bhotiya (Marcha,Tolcha , Jads) Van-Raji Boxa, Van Gujjars,Jaunsa ri, Barpatiyas, Garhwalis , Kumaonis	***Agriculture*** • Settled agriculture (rain-fed and valley land) • Horticulture • Nomadic pastoralists • Transhumant ***Livestock*** ▪ Cattle, sheep/goat, yak, poultry, rabbit, etc. ***Handicrafts*** ***Wild collection from forests***

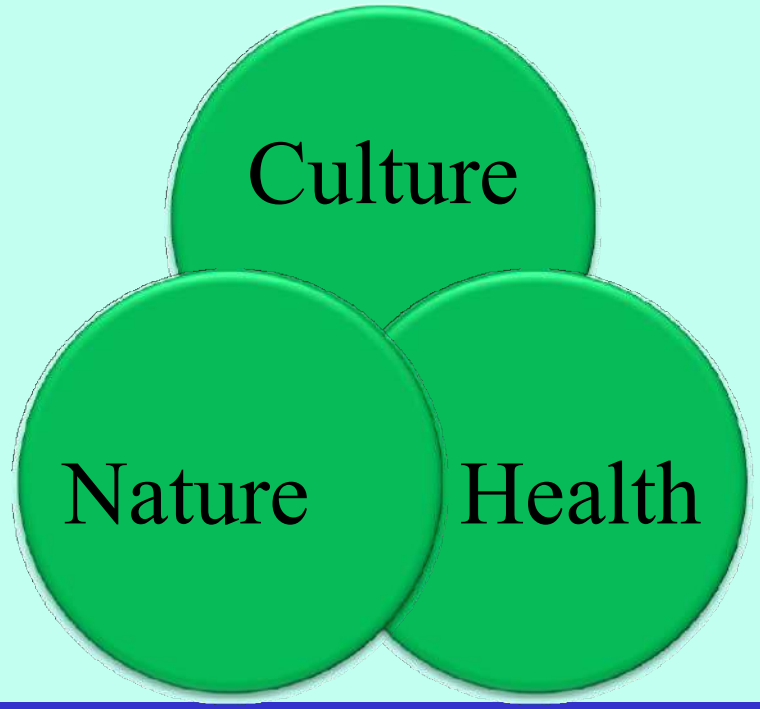





Culture, nature and health

•To understand the traditional knowledge in reality, the perspective culture-Nature-Health can be utilized

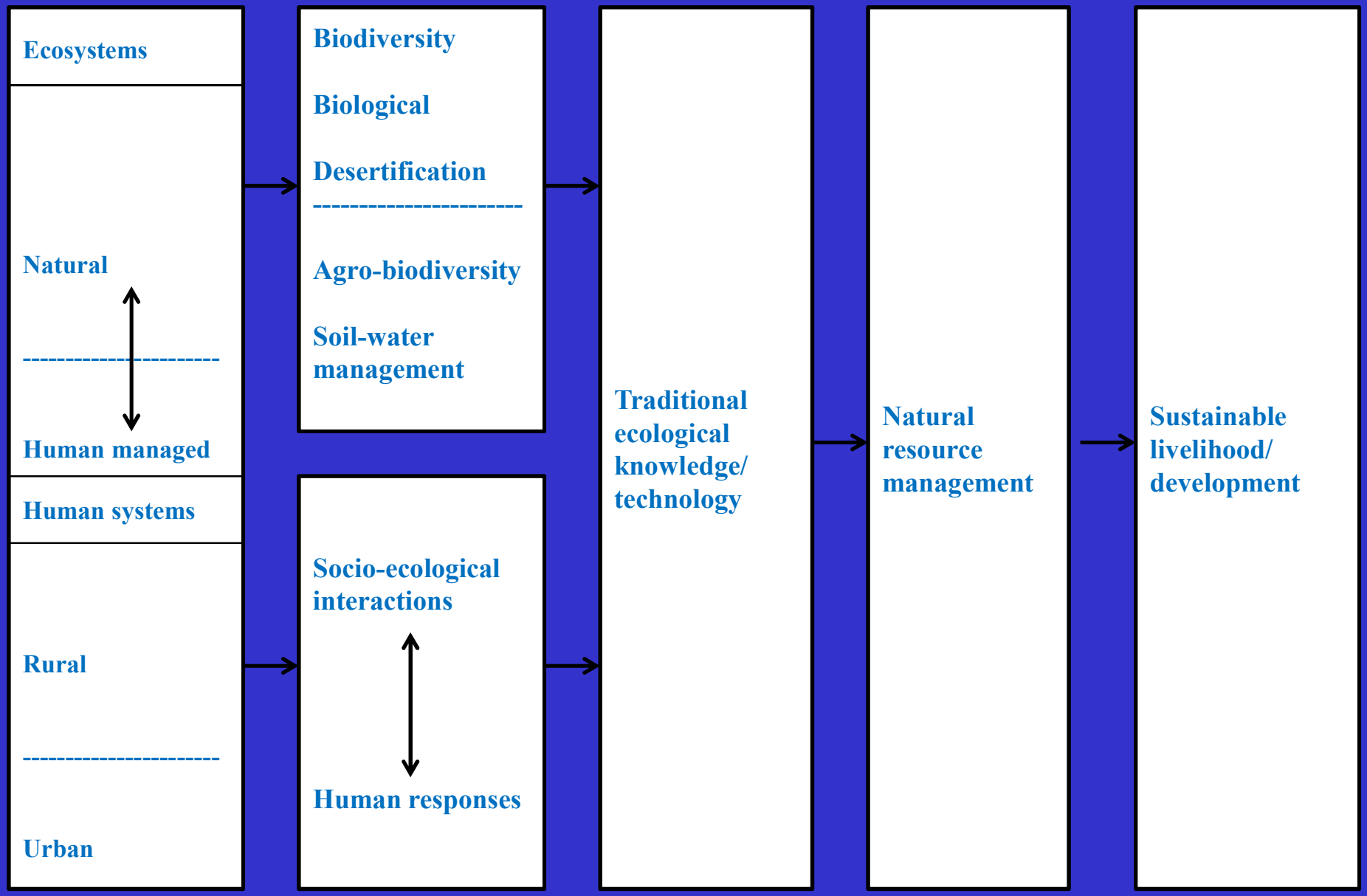
•However, to understand the interrelationship between the three concepts, one cannot fragment the analysis into independent categories.



There are four interstices among the three circles.

1. **Relationship health-nature:** There is a close relation-ship between health and nature, eg., traditional health care systems by traditional communities.
2. **Relationship nature-culture:** Ethno-biology interrelationship between nature and human culture.
3. **Relationship culture-health:** Traditional medicine is understood as the medicine system used by indigenous or local communities to manage health and sickness.
4. **Relationship health-nature-culture:** Western scientific thinking and its several disciplines still lack a science able to approach the integrality of the three relationships, but authentic shamanic systems can teach us about this integration of concepts.

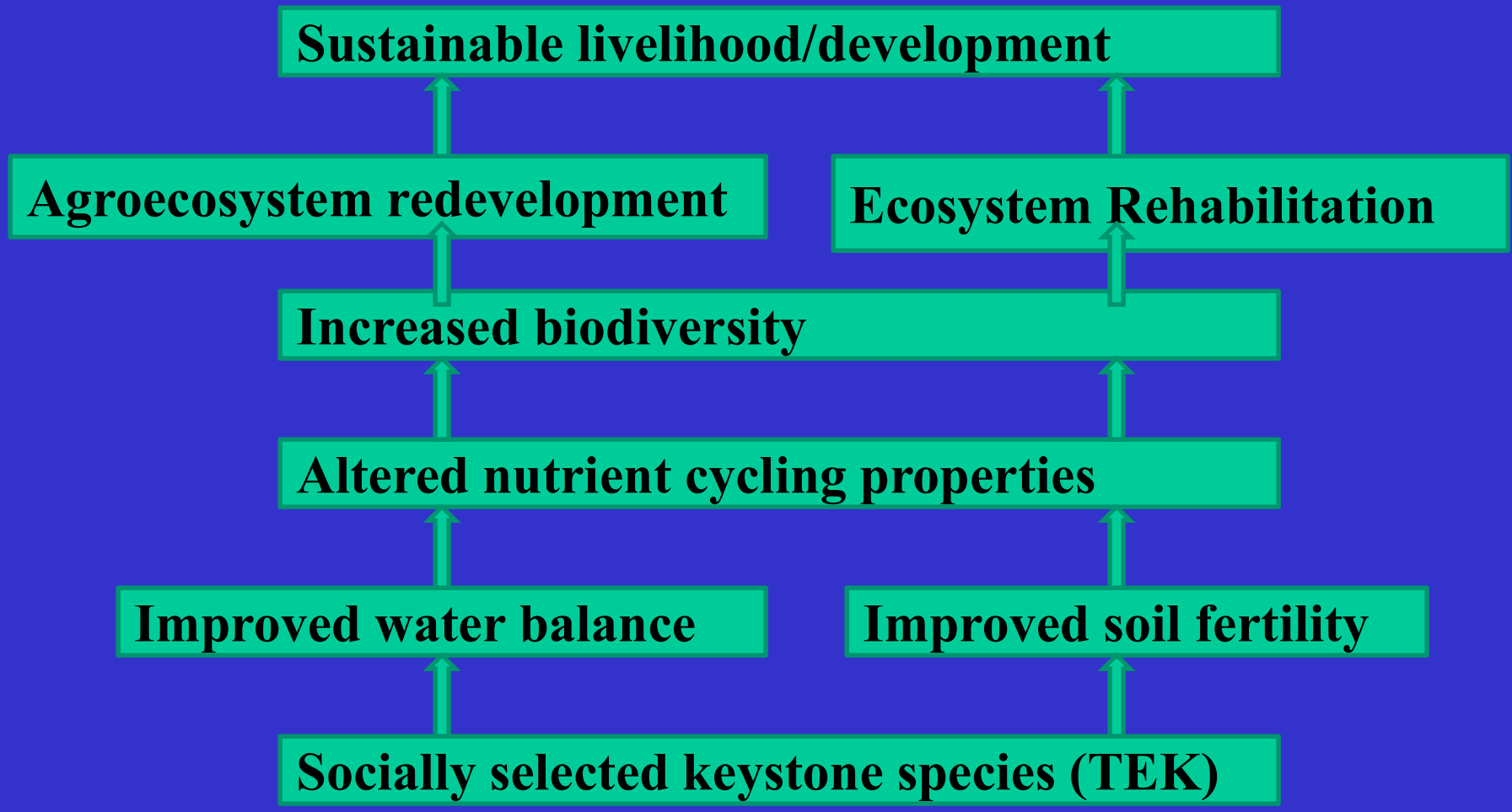
Ecosystem – social system linkages through traditional ecological knowledge for sustainable livelihood/development of traditional societies



Indigenous knowledge related to soil, space, water, soil fertility, crop and vegetation management systems developed by the farming communities of the Central Himalaya

Environmental and others constraint	Use for	Indigenous practice
Limited space	Maximize use of environmental resources and land	Intercropping, agroforestry, multi-story cropping, altitudinal crop zonation and crop rotation
Steep slope	Control erosion and conserve water	Terracing, leveling, continuous crop and/or fallow cover, stone walls
Soil fertility maintenance	Replenish soil fertility and recycle organic matter	Farm yard manure, crop rotations, leaf litter gathering, composting, green manuring, mulching, in-situ manuring, ash and kitchen waste, mixed cropping with legumes, recycling weeds, burning biomass, fallowing etc.
Flooding or excess water	Integrate agriculture with water supply	Raised field agriculture, ditched fields, etc.
Excess water	Channel/direct available water	Control floodwater with canals, canal irrigation fed from streams, lakes and reservoirs.
Unreliable rainfall	Best use of the available moisture	Use of drought-tolerant traditional crop species and varieties, mulching, crops with short growing periods.
Temperature or radiation extremes	Ameliorate microclimate	Shade reduction or enhancement, plant spacing, thinning, shade-tolerant crops, increased plant densities, mulching, weeding, intercropping, agroforestry.
Pest incidence	Protect crops, minimize pest populations	Thick planting, crop watching, hedging or fencing, mixed cropping
Unavailability of the seed store/ cooperatives	Selection of healthy seed	The care of seeds always in the hands of women and based on field observations and IKS available with women.

Traditional local knowledge centered around the socially selected keystone species, *Quercus* spp., acting as a trigger for ecosystem restoration of the mountain landscape in the Central Himalayas



Inter-linkages between forest, agriculture and livestock system-

Forest

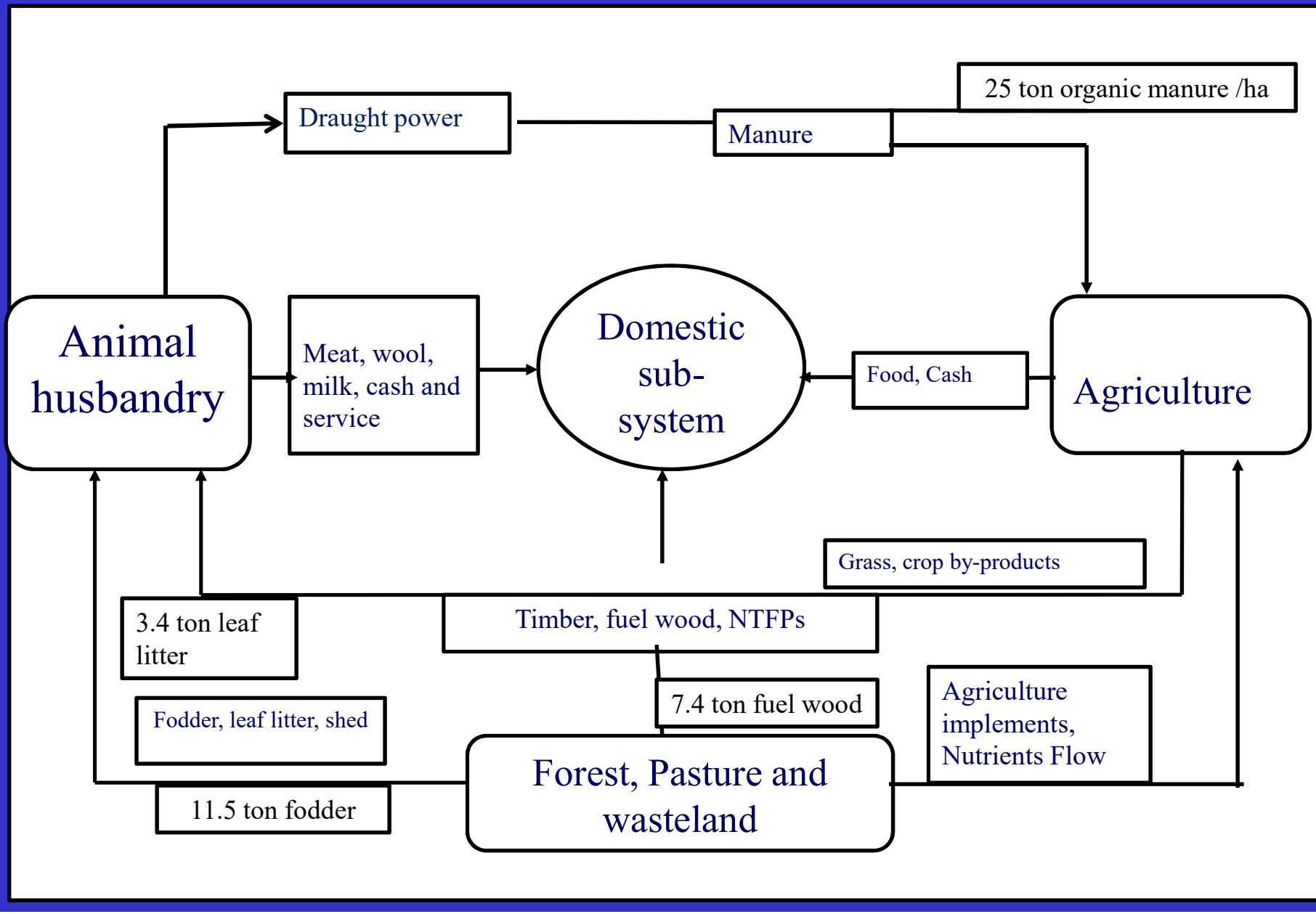
Changing livestock Composition and contribution to mountain farmers economy

Agriculture

Animal husbandry

Domestic system

Inter-linkages between the various sub-systems in a village ecosystem



Central Himalayan Region: A storehouse of forest Biodiversity & Agro-biodiversity (300-4500 masl)

No. of vegetation types		**8**
No of plant categories	**Trees**	**4248**
	Ferns	**241**
	wild edibles	**359**
	Medicinal plants	**850**
	Crop wild relatives	**132**
	Crop plants Grains/Cereals-5 Millets- 5 Pseudo cereals- 6 Pulses -15 Oil seeds- 4 Tuber /bulbs-4 Others -10	**49**

Traditional agro-diversity: key to sustainable agriculture

- Diversity and nutrient cycling
- Diversity and insect-pest management
- Diversity and plant disease and nematodes
- Diversity and weed control
- Diversity and nutrition
- Diversity and soil conservation
- Diversity and productivity, long term stability of the agroecosystem, food security, sustainability

Linkages between agro-biodiversity, provision of ecosystem services, and food security and resilience in the Central Himalayan Region

Agro-biodiversity	Ecosystem services	Contribution to food and nutrition security	Supplementary benefits
• Diversification of crops • Integration of MPTs and fruit trees • Revival of traditional crops • Integration of livestock • Introduction of honeybees of diverse species • Conservation and management of palatable plant species in agricultural land	**Provisioning services** • Diverse food items from various crops, animals • livestock feed • Medicinal plants and NTFPs • Seeds/Genetic material **Regulating services** • Pollination , Pest control • Soil fertility maintenance **Supporting services** • Soil protection • Organic manure **Cultural services** • Agro-tourism • Cultural use of traditional crops as food and medicine	• Improved dietary diversity and intake of micro-nutrients; • Diverse crops and food security • Alternative sources of income (purchasing power) • Reduction of risks • Enhanced agro-ecosystem resilience • Improved production stability • Increased income	Improved resilience of agricultural systems • Higher diversity and flexibility in local production systems

Major issues and changing scenario of Himalayan agro-ecosystems

- Himalayan agriculture transformation process.
- Subsistence farming, deterioration of the economy, environment, climate change and bio-resources.
- Illusions about quality of coarse and fine grains;
- Commercialization of agriculture: growth and economic prosperity.
- Unmindful introduction of HYVs and extinction scenario.
- Neglected mountain perspectives in agricultural policy and weak cross-sectoral linkages
- Research bias
- Unawareness about dimension of the threat.
- Lack of institutional arrangements, mechanisms and human capacity-building which would promote agro-biodiversity conservation
- Inadequate scientific and technical understanding and indigenous knowledge Himalayan agriculture
- Less attention on integrated components of hill agriculture

Area in ha/village under different traditional crops in *Kharif* and *Rabi* seasons during 1970-74 and 1990-94 in Central Himalaya (after Maikhuri *et al*. 1997,2001)

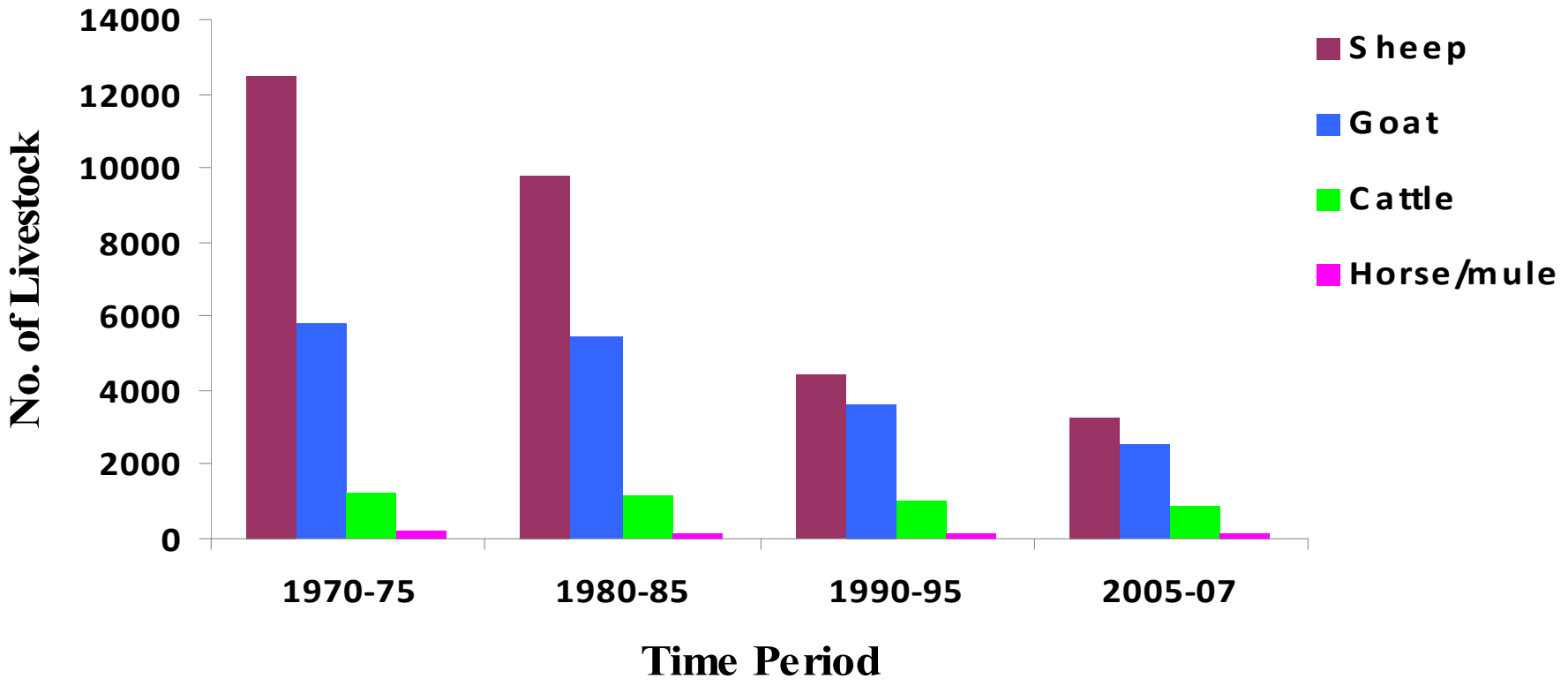
CROPS/ CROPPING SEASON	AREA IN ha/ VILLAGE		AREA IN ha REPLACED	AREA DECLINED IN %
KHARIF SEASON				
Panicum miliaceum	**14.2**	**4.9**	**By high yielding rice varieties**	**65.5**
Oryza sativa	**14.2**	**14.2**	**Traditional rice varieties by HYV**	**-**
Avenal sativa	**15.8**	**3.4**	**By potato**	**78.5**
Fagopyrum tataricum	**8.6**	**1.5**	**By potata + rajama**	**82.5**
Fagopyrum esculentum	**4.1**	**0.3**	**By rajma**	**92.7**
Perilla frutescense	**1.3**	**-**	**By soyabean**	**100.0**
Setaria italica	**2.3**	**0.8**	**-- do --**	**65.2**
Oryza sativa	**11.2**	**11.2**	**Traditional rice varieties by HYV**	**-**
Eleusine coracana	**9.6**	**6.1**	**By soyabean + amaranth**	**36.5**

Continue…..

Macrotyloma uniflorum	2.1	0.5	-- do --	100.0
Echinochloa frumentacea	2.5	0.7	By pigeon pea	72.0
Vigna spp.	3.3	-	By pigeon pea + amaranth	100.0
RABI SEASON				
Triticum aestivam	14.2	14.2	Traditional wheat varieties by HYV	-
Hordeum himalayens	17.1	4.7	By potato, amaranth + rajama	-
Hordeum vulgare	7.0	1.1	By improved mustard varieties	-
Brassica compestris	2.0	2.0	No change	No change

B. Pastoralism & Transhumance Pastoralism

- **Decline of livestock population due to various reasons (i.e. conservation policies, socio-economic changes, decline in carrying capacity of the alpine pasture etc.).**



Changes in livestock population between the 1970-75 to 2005-07 period as reported by the people of Niti valley (10 villages).

Ecological , socio-economic drivers and policy issues responsible for agro-biodiversity loss in Central Himalaya, Uttarakhand

Ecological drivers/indicators	Socio-economic drivers/indicators	Policy drivers/indicators
• Decline in carrying capacity of forests and rangelands • Increased abandoned land • Increased weed infestation/ invasive species • Climate change/variability • Soil erosion/run off • Hydrological imbalances • Low crop yield /productivity • Decline wild bio-resources affecting wildlife food chain systems	• Small holding and land fragmentation • Out- and in-migration • Change in food habits • Change in social values • Increased female literacy • Dependence on wild collection of high value resources • Decline traditional knowledge • Change in cropping pattern due to economic consideration	• Neglect of hill agriculture in policy and planning • Research bias • Land use policies • Subsidies on food import and credit policies • Strict Forest policies and wildlife conservation Act • Subsidies on agricultural implements • Fixed prices • Govt. support services e.g., MENREGA and cheaper food to BPL families-PDS • Lack of expertise in agro-technology transfer • Lack of human resources in agri-business

Challenges to traditional food dietary diversity and nutrition security

Challenge	Consequences	Dimension of food and nutrition security likely to be affected negatively
Deterioration of local food system	•Reduced food production & diversity	•Food availability utilization
Changing diets	• Reduced dietary diversity	•Food utilization
Lingering poverty	•Reduced food intake & Dietary Diversity	•Food accessibility & utilization
Abandonment of cultivable land	•Low returns, land abandonment and loss of production	•Food availability
Rapid urbanization	•Encroachment of agriculture land leading to reduced agricultural production	•Food availability
Depletion of natural resources	•Loss to water resources & biomass manure form forests •Reduced supply of wild edible, and reduced livestock production and income	•Food availability, availability, utilization, accessibility

Innovative (simple, cost effective and affordable) Technology Interventions used for livelihood enhancement and diversification in the CHR

Yield increasing

- Protected cultivation (Polyhouse, polypit, Poly trench)
- Bio-compost
- Vermicompost
- Vermiwash
- Cow pat pit
- Nadep compost

Life Supporting Activities

- Water harvesting
- Management and improvement of waste land
- Fodder grasses
- Traditional art
- Sewing & knitting
- Multipurpose tree plantation

Technology packages

Income generating

- Vegetable cultivation
- Cash crop cultivation
- Integrated Fish –farming
- Horticulture
- Apiculture
- Floriculture
- Nursery development
- Mushroom –cultivation
- Medicinal Plant cultivation

Other activities

- Bio briquetting
- Zero energy cool chamber
- Decorative items
- Bamboo propagation
- Drip irrigation
- Sprinkler
- PRA method
- Formulation of SHGs
- Bio- fencing

Types of traditional knowledge for adaptation in agro-ecosystem

Traditional knowledge about	How it helps adaptation in agro-ecosystem?
Resilient properties	Traditional farmers often live in marginal land where climate change impacts and selection pressures are greatest. This enables them to identify resilient crop species and varieties for adaptation
Farming practices	Traditional farming practices – conserve key resources for resilience and adaptation – such agro-biodiversity, water, soil and nutrients
Wild crops relatives	Local communities often draw on wild areas around farms for crop improvement and domestication, also provide food when crop fail
Plant breeding/seed selection	Traditional farmers particularly women conserving local landraces and selecting seeds for preferred and adaptive traits over generations
Climate forecasting	Traditional knowledge can help forecast local weather and provide accessible information to farmers at a local scale.

Climate change felt and response/adaptation using traditional knowledge and innovations in low elevation (300 – 3000 masl) in central Himalaya

- Low elevation (300 – 1000 masl)
- Nine hilly districts of Uttarakhand
- 54 villages, and 1620 HH
- Methods: People perception, workshop/PRA etc.
- Qualitative/quantitative studies of 6 years

Changes in climate

- Higher temperature
- Increased exotic weeds
- Shift in season
- Drought
- New pests
- Unpredictable rain
- Low rainfall (peak season)

Adapting with T K & Innovations

- Adopting traditional crops
- Tuber and rhizomatous crops under traditional agroforestry
- Monocropping of pulseszz

- ❖ Integration of *turmeric colocasia* and ginger under traditional agroforestry system
- ❖ Climate resilient traditional crops and pulses
- ❖ Irrigated land converted to rainfed due to water shortage
- ❖ Rainfed paddy replaced with millets (finger millet and barnyard millet)
- ❖ Delayed sowing of rainfed paddy (instead of 1st – 3rd week of March)
- ❖ Horticulture (mango) in rainfed land
- ❖ Increased corn cultivation in few villages
- ❖ Biocontrol (ash, cow urine and organic manure)

Evolution of the nutrition transition in the central Himalaya

Nutrition transition in full bloom: HYY displaced the indigenous varieties in the food systems and thus radically altered the dietary patterns and food habits of the population. This signaled the onset of the nutrition transition in the Himalayan region.

Is this trend reversible?

- The revitalization of traditional food systems
- Addressing important constraints to the production of traditional foods, TIME (Technology intervention in the mountain ecosystem), simple & affordable technology.

The transition from subsistence to commercial production (Use attributes of millets, pseducereals and pulses)

Common and scientific name	Plant characteristics	Traditional use	Nutraceutial and commercial interest
Finger millet (Mandua) *Elusine coracana*	Herbaceous crop (seed-propagated)	Flour is used for making chapati & badi in Uttatakhand	High protein, Iron content, Gluten free
Amaranth (Cholai) *Amaranthus caudatus*	Herbaceous crop (seed-propagated)	The grain is roasted eaten, and flour is used as chapati	Rich source of Vitamins & Minerals
Buckwheat (Fafar) *Fagopyrum tataricum*	Herbaceous crop (seed-propagated)	The flour is used for chapati.	Good source of rutine used as medicine & highly nutritious.
Horse gram (Gahat) *Macrotyloma uniflorum*	Herbaceous crop (seed-propagated, legume crop)	Highly nutritious pulse consumed in winter and also cooked for a variety of dishes	The grain soup is used as a cure for kidney stones & rich in minerals.

Local value addition in agro-based products for entrepreneurship development

Maikhuri et al., 2001, The Environmentalist.
Saxena et al., 2005, Journal of Mountain Science.

Area-specific approaches based on socio-agro-ecological potential and access to markets, information, and institutional services

Agro-ecological potential and suitability	Access to markets, information, and institutional services	
	Good	**Poor**
High	**Areas with high potential and good access to markets and services** • Promote large scale food production (where possible mixed cropping), horticulture, poultry farming, etc,. • Enhance support for high value cash crops, MAPs and vegetables • Integrate traditional food crops in cropping system in all agro-zones • Promote climate resilient crop varieties and adaptation measures • Establish agro- processing and storage facilities • Climate resilient technology and water management • Encourage woman as entrepreneurs/managers in agriculture business	**Areas with high potential but poor access to markets and services** • Improve marketing, storage and transport facilities, information systems, and extension services for fruit/ vegetable/livestock products • Strengthen local food systems with a focus on traditional crops and support value chain development • Promote high-value non-perishable agricultural products such as pulses, medicinal plants, and honey • Promote livestock and livestock products and by products • Improve credit, extension, and insurance facilities for crops and livestock
Low	**Areas with low potential but good access to markets and services** • Promote local products such as crafts (e.g. woodcarving, shawls, carpets) and services for markets • Promote agro- technologies that enhance agricultural potential and utilize local niches • Encourage agroforestry, NTFPs, and medicinal plants • Develop local off-farm employment opportunities • Encourage local breeds of livestock such as yak, goats, and sheep (mainly pastoralism) in high mountain ranges	**Areas with low potential and poor access to markets and services** • Provide incentives for conservation and sustainable use of bio-resources for livelihood and income generation • Encourage non-farm activities, e.g., tourist guides, homestay, local handicrafts • Promote subsistence agriculture with zero-tillage, mixed cropping, and livestock production • Promote rural, ecotourism and recreation • Develop and harness environmental services

Wild bio-resources

- Medicinal and aromatic plants and traditional health care systems(THCS).

- Wild edibles/Non timber forest product (NTFPs); Fruits, green leafy vegetables, etc.,

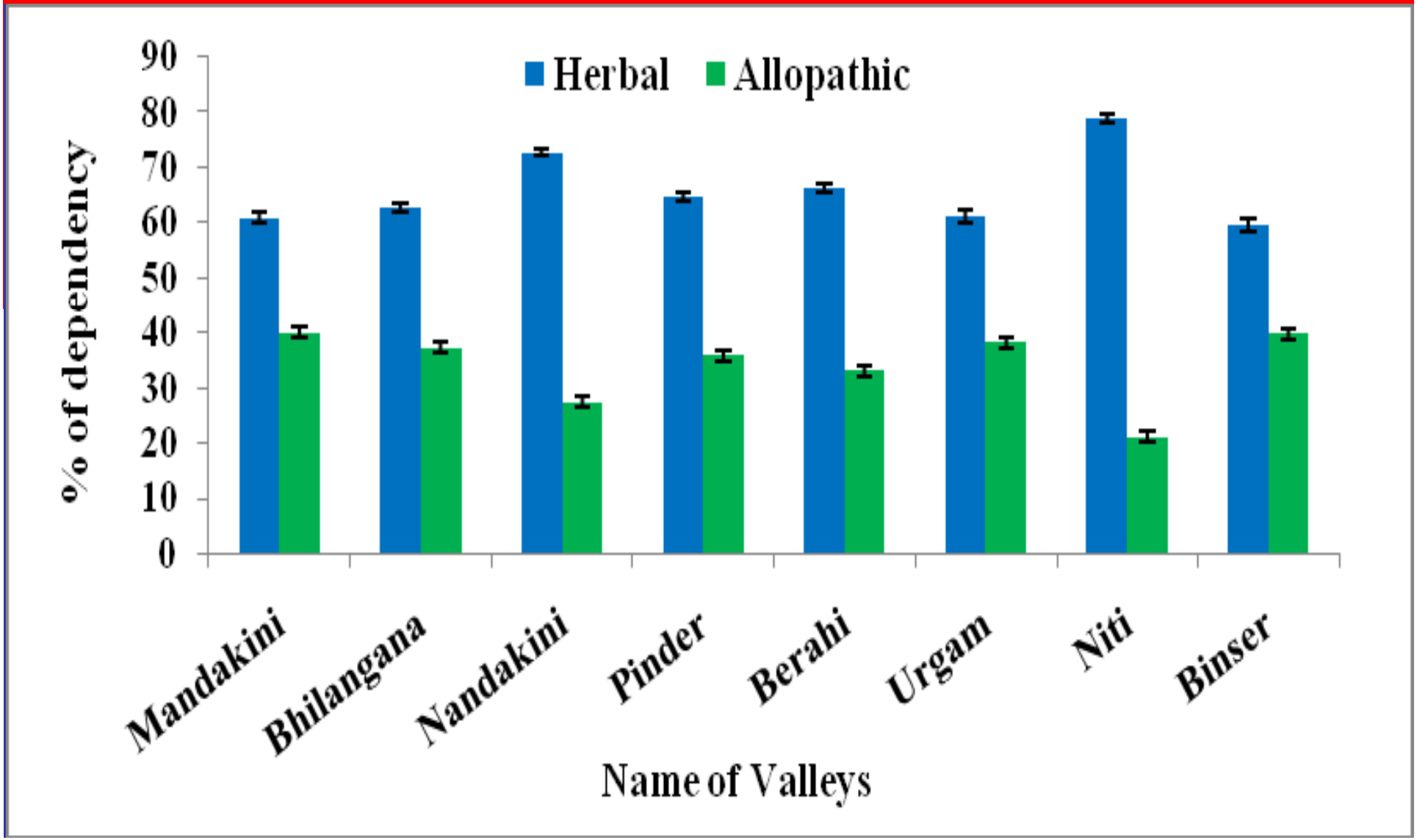
Traditional uses of medicinal plants for curing ailments in Alaknanda catchment of Uttarakhand (Phoondani and Maikhuri,2o1o).

Name of plant species	Vernacular name	Ailments	Traditional uses
Picrorhiza kurrooa	Kutaki	Fever	50 gm.of dried roots milled along with 2 spoons sugar and taken with water.
Angelica glauca	Choru	Cold and cough	1 gm. root powder mixed with 1 cup tea as a cure for common cold.
Saussurea costus	Kuth	Tooth ache	100 ml decoction of the Saussurea costus tuber mixed with 4-5 drops of Prunus armenica oil and ½ spoon of salt.
Podophyllum hexandrum	Bankakri	Cancer	Root paste is applied
Arnebia benthami	Balchari	Baldness	5gm root milled and mix with 50ml mustard oil for applying on hair.
Aconitum hetrophyllum	Atis	Stomach ache	Root paste applied on the fore head to cure headache.
Dactylorhiza hatagirea	Hatajari	Wounds and cuts	Root paste is applied for treating cuts.
Swertia chirayita	Chirayata	Fever	.Fresh leaves and stem milled juice and taken with water.

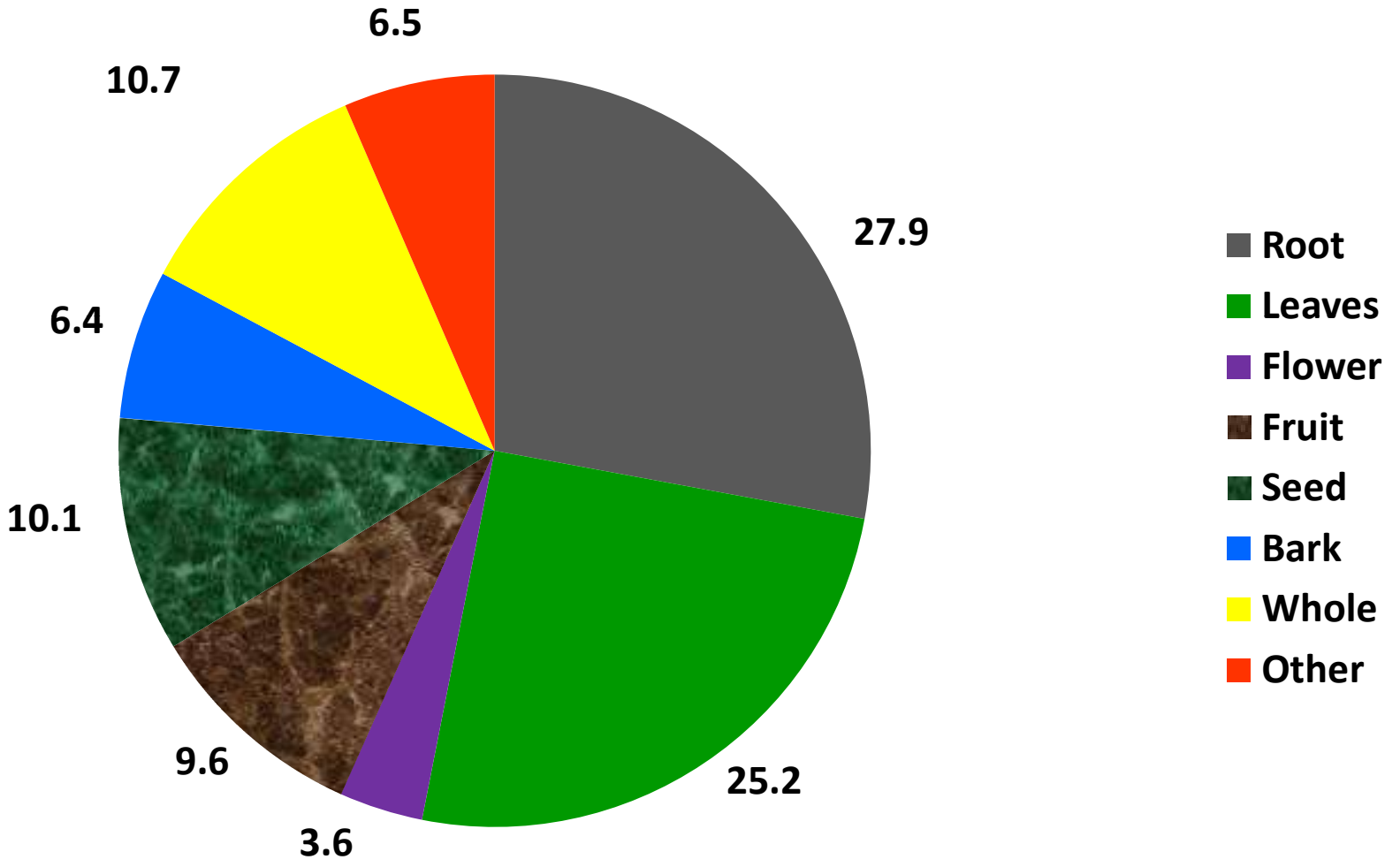
Collection period of some high value medicinal plants for curing various ailments in different communities/valleys of Alaknanda Catchment in Uttarakhand

Name of plants	Part used	Medicinal uses	Collection period
Saussurea costus	Root	Toothache	Autumn season (September-October)
Delphinium denudatum	Root	Snakebite	Autumn season (September-October)
Saussurea ovallata	Flower	Leucorrhea, Mental disorder	Rainy season (August) When the flower is mature
Polygonatum verticillatum	Root	Anemia, Leucorrhea	Autumn season (September-October)
Podophyllum hexandrum	Root	Cancer	Autumn season (September-October)
Arnebia benthami	Root	Hair disease	When the above ground part is dry
Aconitum heterophyllum	Root	Fever, Stomachache	Autumn season (September-October)
Picrorhiza kurrooa	Root/Leaf	Typhoid fever, Jaundice	Autumn season (September-October)
Dactylorhiza hatagirea	Root	Cuts, Wounds	Autumn season (September-October)
Taxus baccata	Bark	Anti- cancer, Bone fracture	Winter season (November-December)

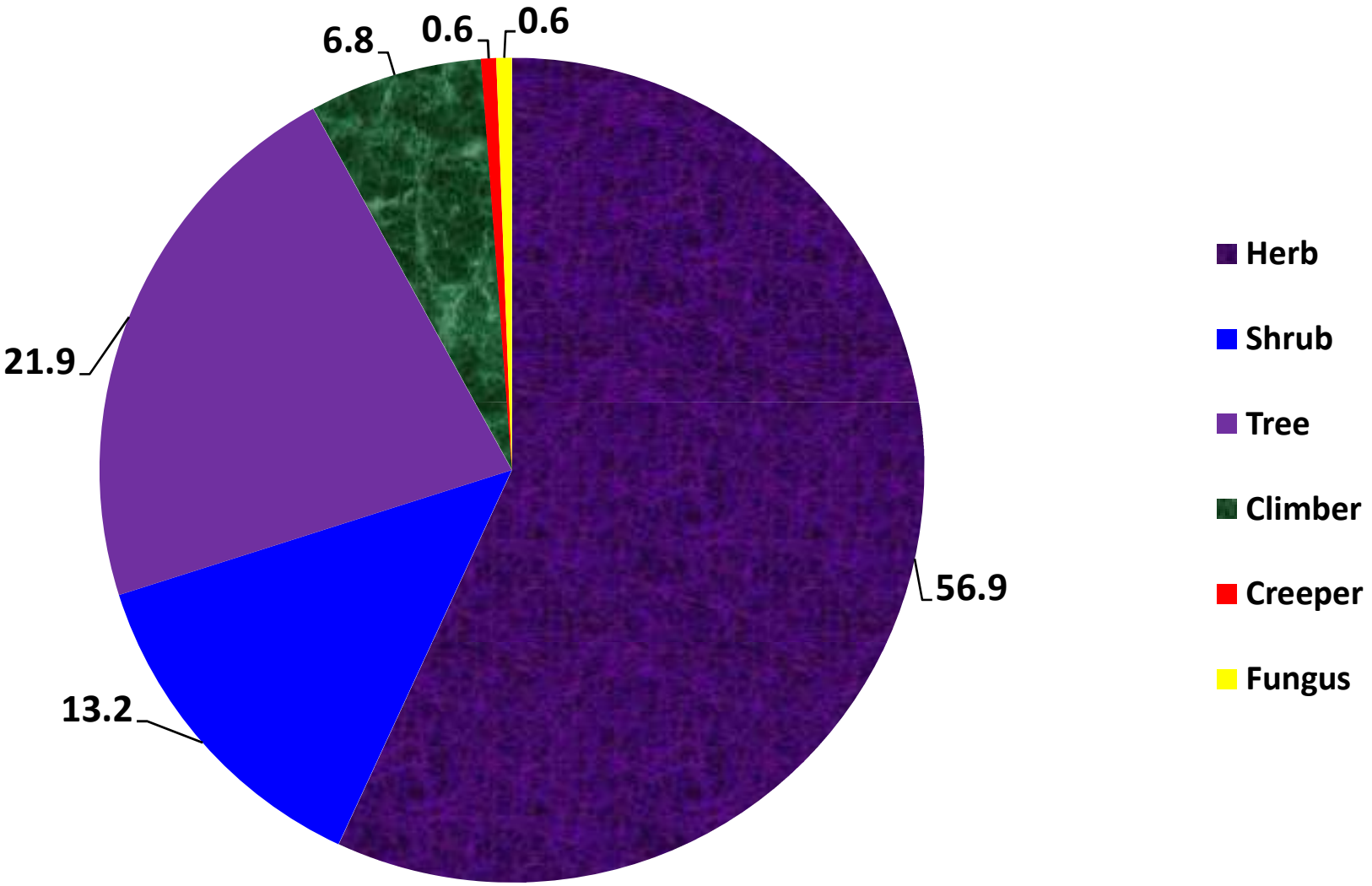
Total dependency of herbal and allopathic system of treatments for curing ailments in Alaknanda catchment of Uttarakhand



Medicinal plants and their parts utilized by the tribal and non-tribal communities of Alaknanda catchment on traditional health care system.



Proportion of different category of medicinal plants (%) used for curing ailments in Alaknanda Catchment



Central Himalayan forests and alpine meadows safety nets mechanism as household livelihood coping strategies

Coping with adversities	Function	Description
Safety net	Insurance	Food and cash income in periods of unexpected food and income shortfalls
Support current consumption	Gap-filling	Regular and irregular food and income shortfall such as crop failures and seasonal shortages
Occupational activities	Source of employment and livelihood diversification	Unemployed youth/low income group people, off-cropping seasonal activities

Three critical functional categories – are major assets in responding food and nutritional security. As a source of livelihood security, these functions need to be included in planning for poverty reduction, nutritional security and climate adoption strategies, as well as forest and alpine management.

The main reasons for the lack of attention given to underutilize or wild gathered Species include

- A lack of information and reliable methods for measuring their contribution to farm households and the rural economy;
- The lack of guaranteed markets, except for a small number of products;
- The irregularity of supply of wild plant products;
- The lack of quality standards;
- Lack of standardization of the product;
- The lack of storage and processing technology for many of the products;
- The availability of substitutes;

Contribution of agro and wild bio resources in developing immune defenses to counter the impact of Covid-19 in central Himalayan rural landscapes

- Traditional mountain crops
- Medicinal plants of wild origin
- Wild fruits/edibles
- Spices/condiments of wild origin
- Wild greens used as a food/vegetables
- Wild and cultivated plants used as a Hot beverages (teas)

Traditional mountain crops used as major food by the local people during COVID-19 (as prescribed by local Vaidya's/herbalists) to increase immune defenses in Central Himalaya, Uttarakhand

Botanical name	Local name	Uses and medicinal properties
Amaranthus causdatus	Amaranth (Kedar-chua)	The grain is considered very healthy and keeps body warm during winter season. Rich source of vitamins and minerals.
Fagopyrum esculentum	Buck wheat (Oggal)	The grains are rich source of vitamins and strengthen immune systems. High Medicinal use.
Fagopyrum tataricum	Buck wheat (Fafar)	It is a good source of rutine, healthy and improves immune defenses.
Macrotyloma uniflorum	Horse gram (Gahat)	A highly nutritious pulse , the grain soup is used as a cure for kidney stones.
Elusine coracana	Finger Millet (Manuduwa)	The grain considered rich source of vitamins and healthy food.
Setaria italica	Foxtail Millet (Koni)	Substitute of rice, be good for patients suffering from typhoid fever, pneumonia etc.
Echinochloa frumentacea	Barnyard millet (Jhangora)	The cooked grains when mixed with curd given for patients suffering from jaundice and also considered good for diabetic patient.
Parilla frutescense	Perilla (Bhangjeera)	Oil is edible and also used as a medicine and improve immune system,.
Vigna radiata	Green gram (Mung)	Soup of the grains are very nutritious, strengthens immune defenses.

Medicinal plants consumed /used by the local people to increase immune defenses during COVID-19 (as prescribed by local Vaidya's/herbalists) in Central Himalaya, Uttarakhand

Botanical Name of Medicinal Plants	Local Name	Uses
Origanum vulgare	Wild leaf Basil (Van tulsi)	Whole plant is used as an immunity booster by the local communities. Highly medicinal
Ocimum sanactum	Basil (Tulsi)	Whole plant parts are used to increase immunity and also used to cure colds and cough
Allium sativum	Garlic	Fresh bulb chewed which provide immunity to the body, and prevent pulmonary problems
Mentha arvensis	Mint (Podina)	Fresh leaves provide resistance against fever and very refreshing
Tinospora sinensis	Giloy	Whole plant used to cure fever, reduce body temperature and improve immune systems
Vibernum mullaha	Indian craneberry (Bhatmoliya)	Fruit juice used to provide strength, nutritious, rich in vitamin C and is very refreshing
Zingiber officinalis	Ginger (Adrak)	Rhizome used to cure cough and good immunity booster
Hippophae salicifolia	Sea-Buckthorn (Amesh)	Fruit juice is rich in vitamin C, provide strength to body and also used to treat colds and coughs
Phyllanthus emblica	Indian gooseberry (Amla)	Fruit is rich source of vitamin C and also used as blood purifier
Rhododendron arboreum	Rhodadendron (Burans)	Juice used to cure cardiac and respiratory disorder and very refreshing.

Wild fruits/edibles consumed /used by the local people to increase immune defenses during COVID-19 (as prescribed by local Vaidya's/herbalists) in Central Himalaya, Uttarakhand

Plant species	Local name	Part used/mode of application	Medicinal and other uses
Aegle marmelos	Stone apple (Bel)	Fruits used for juice and squash	The fruit is aromatic and is used in curing of peptic ulcer, constipation, scurvy and dysentery and is said to act as a tonic for the heart and brain.
Berberis asiatica	Indian barberry (Kingore)	Fruits used for juice and squash	It is good remedy for stomachache, diabetes, cold and cough fever.
Elaeagnus latifolia	Bastard Oleaster (Gewain)	Fruits used for juice, squash and sauce	Believed to be good in cough and bronchitis. It is capable of reducing the incidence of cancer.
Embilica officinalis	Indian gooseberry (Amla)	Fruits used for pickle and juice	The fruit juice is used to cure cough, anemia, piles and diabetic.
Spondias pinnata	Hog plum (Amara)	Fruits used for juice, squash and sauce	The fruit is good source of vitamin `C' and used to cure diabetes, heart ailment, urinary troubles etc.

Spices/condiments of wild origin consumed /used by the local people to increase immune defenses during COVID-19 (as prescribed by local Vaidya's/herbalists) in Central Himalaya, Uttarakhand

Plant species & part used	Traditional and medicinal use
1. *Allium humile* (Small alpine onion) Local name: Ladum	Traditionally fried paste is added to meat & culinary purposes, Medicinally it is useful to cure jaundice, cough and cold.
2. *Alium rubellium* (Purple flowered garlic) Local name: Doodhu	Traditionally used for flavoring as condiments, and is reported to be good for the patients suffering from jaundice and also useful in cold and cough.
3. *Angelica glauca* (Angelica) Local name: Choru	Traditionally the aromatic root is a flavoring agent and is commonly used as spice and condiment.. Leaves and stem of the plant are useful to cure dysentery and provide relieve from body pain caused due to extreme cold.
4. *Pleurospermum angelicoides* Local name: Chhipi	Roots are used as spices and condiments. The decoction of the roots is used to cure typhoid fever, stomach pain, body pain, etc.
5. *Carum Carvi* (Caraway) Local Name: Kala Jeera	The seeds are used as spice or condiments and also it is used to cure dyspepsia, cold and cough, an appetizer.
6. *Cinnamomum tamala* (Indian bay leaf) Local name: Tejpata, dalchini	Leaves of C. tamala (tejpata) are widely used as a spice and condiments to improve the appetite and digestion.

Wild greens used as a food/vegetables by the local people to increase immune defenses during COVID-19 (as prescribed by local Vaidya's/herbalists) in Central Himalaya, Uttarakhand

Botanical Name	Local Name	Traditional/local knowledge of collection, preservation, cooking and use
Amaranthus bilatum	Purple Amaranth (Jungli chaulai)	Leaves are boiled or cut leaves are fried in cooking oil with spices and is considered highly nutritious
Chenopodium foliolosum	Goosefoot (Bethua)	Leaves are boiled and fried in cooking oil with spices and is believed to prevent cold and is a good appetite stimulant
Diplazium esculentum	Vegetable Fern (Lingra)	Boiled fronds are cut and fried in cooking oil with spices such as seeds of Cleome viscose and is considered healthy, rich in vitamins and also to improve immune system.
Girardinia diversifolia	Himalayan nettle (Dholkanali)	Fresh leaves are boiled and mashed and fried in cooking oil with spices and improve immune system
Paeonia emodi	Himalayan peony (Chandra)	Fresh leaves are boiled with spices as vegetable provide vitamins and energy
Rumex nepalensis	Nepal dock (Payoom)	Fresh young leaves are boiled or fried in cooking oil with spices and improve growth and good physical development and fattens.

Wild and cultivated plants and quantity of different ingredients (gm/liter) used in preparation of hot beverages (teas) by the traditional mountain communities to boost the immune system in treating corona disease

Name of plant and Ingredient used	Combination (gm/litre)
1. *Taxusbaccata* bark	1.00 gm
2. Common Salt	25gm
3. Purified butter (Ghee)	1-2 tea spoon (10-20 gm)
4. Pinna (dry mixture of walnut and apricot kernels, flour of fried wheat/barley/buckwheat is locally called pinna)	20-30 gm
5. *Bergenia ligulata* leaves	20gm
6. *Betula utilis*gum (resin)	10gm
7. *Origanum vulgare* leaves	30gm
*8. Cinnamomum tamala (*Tejpataa leaf+ bark)	Tejpataa leaf 5 gm and bark 20gm
9. Kadha (mixture of four different plant products such as ginger (*Zinger officinale*), black pepper (*Piper nigram*), cardamom (*Cardamom Elettaria*) and clove (*Syzygium aromaticum*) in different proportions)	Ginger (50 gm) Black pepper (5 gm) clove (2 gm) cardamom (2gm)

Success stories linked to Bio cultural Conservation & Sustainable Development

Garhwal Regional Centre

- Unique model for livelihood enhancement and biodiversity conservation through participatory action research for resolving policy-people conflicts in Nanda Devi Biosphere Reserve (NDBR).

- In-situ conservation of traditional mountain agrobiodiversity through village community participation in Urgam valley, Chamoli (a joint initiative of GBPIHED-GRC, NBPGR, New Delhi and village community).

Cont..

- Established long term model demonstration on rehabilitation of degraded land using agro-forestry and eco-restoration approaches and assessment of growth and carbon stock of 20 years mixed species plantations established on degraded land (14 ha) at Bansbara and is the first attempt in the Himalaya based on repeated measurements of the same sites over 20 year period.

- Wild bio-resource utilization (38 potential wild spices) for livelihood enhancement, income generation and conservation.

- Promotion of medical plants sector through improvement of cultivation/ conservation practices and value addition of high value species.

Indicators of SD are varied:- therefore, monitoring & evaluation has to be done using a number of currencies.

✓Sustainable growth

✓Capital efficiency

Economic

(Cost- benefit analysis, capital saving, asset accumulation , Gross National happiness (GNH, Bhutan))

Social

Ecological

✓Equity

✓Social mobility

✓Participation

✓Employment

(quality of life, health, food security, nutrition etc.)

Sustainable development

✓Environmental

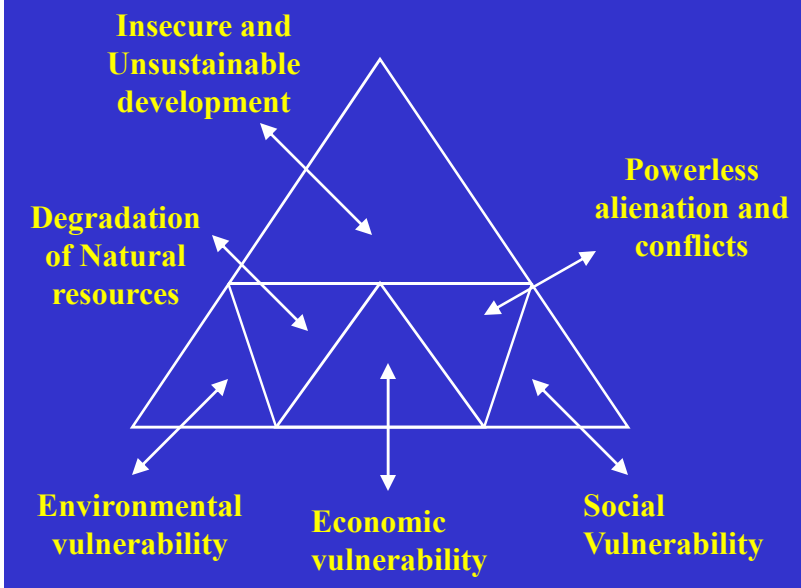
✓Natural

✓Biodiversity

✓Carrying capacity

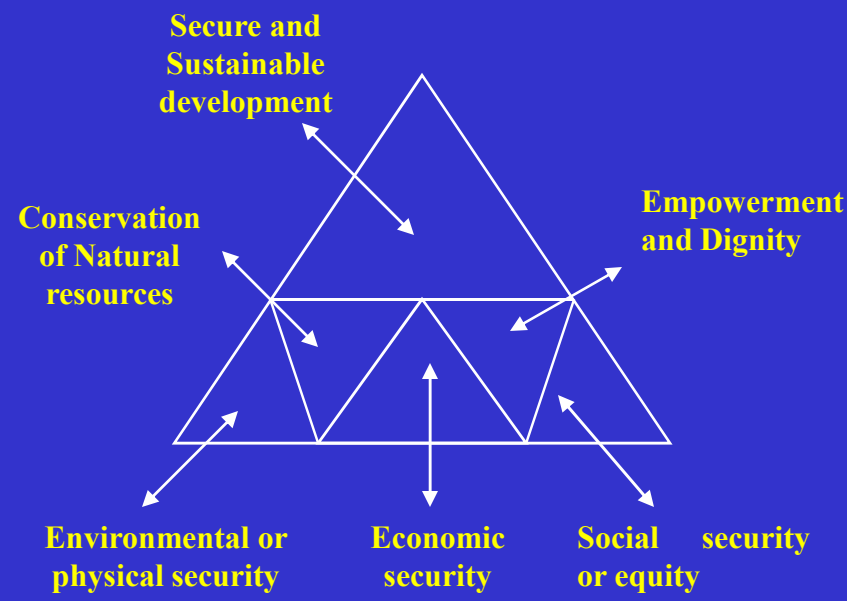
(LUCC, biomass quality & quantity, soil fertility, energy efficiency)

Unsustainable development



- Himalayan ecosystem and people inhabited there are subject to intense economic, social and physical/environmental vulnerabilities.
- Don't have access to the pathways of economic growth
- Victims of natural calamities
- Marginalized by most social and political resources
- Outsiders have control over their natural resources
- Poverty, hopelessness resulted into conflicts – which leads unsustainable development.

Sustainable development



Need for:

- Decentralizing governance to local level
- Developing policies and programmes which support sustainable use and environmentally sound management of natural resources
- Need for equal social rights and opportunities for participation in governance by all sections of the societies including women
- Involvement of diverse civil society and especially grassroots networks and associations to achieve more voice and influence in policy and public action choices.

Rural landscape Traditional agriculture (Food and Nutrition Security) in the CHR and the Sustainable Development Goals

- Goal 1- End poverty in all its forms everywhere
- Goal 2- End hunger, achieve food security and improved nutrition , and promote sustainable agriculture.
- Goal 3- Ensure healthy lives and promote well-being for all at all ages.
- Goal 5- Achieve gender equalities & empower all woman & girls.
- Goal 6- Ensure availability and sustainable management of water and sanitation for all.
- Goal 8- Promote sustained economic growth, full and productive employment & decent work for all.
- Goal 12- Ensure sustainable consumption and production patterns.
- Goal 13- Take urgent action to combat climate change and its impacts.
- Goal 15- Protect, restore & promote sustainable use of ecosystem, combat desertification and halt and reverse land degradation & halt biodiversity loss.

Priority action points for policy planning towards the sustainable development of hill agriculture of the central Himalayan region

- Develop decentralised approaches for the mobilisation and strengthening of formal and informal decision-making institutional mechanisms
- Redefi-ne research and development (R&D) priorities with a regional focus
- Develop strong linkages between R&D institutions, agricultural universities/NGOs and the private sector
- Improve integration of cross-sectoral linkages and interdependencies between different policies.
- Replicate success stories and identify lessons from failures
- Transfer appropriate hill-specific agro-technology to user groups
- Address human resource development issues in policies
- Properly implement extension and support services systems
- Ensure conservation of traditional agrobiodiversity and associated traditional knowledge
- Improve effectiveness of existing agricultural institutions, their arrangements and capabilities
- Promote organic cultivation, emphasising traditional hill crops and value addition

Priority interventions for conservation and management of bio-resources of wild origin of the Central Himalaya

- Strengthen research and development into indigenous knowledge of medicinal and aromatic plants used in THCSs.
- Increase the quality and quantity of clinical trials and certification.
- Promote networking to facilitate communication and collaboration with traditional communities and researchers/experts.
- Establish appropriate and suitable frameworks and approaches for intellectual property rights, benefit sharing and to provide due recognition to the traditional societies for their creation of the indigenous knowledge system.
- Develop appropriate mechanisms of sustainable harvesting of medicinal and aromatic plants with the conservation and management of natural resources and promote cultivation of those plant species that are mostly used in the THCS.
- Develop a holistic policy to address conservation, cultivation, utilization, traditional knowledge, trade, intellectual property rights and research in Himalayan states.
- Create awareness of conservation and management of threatened medicinal and aromatic plants through training, workshops, publications, and school curricula.

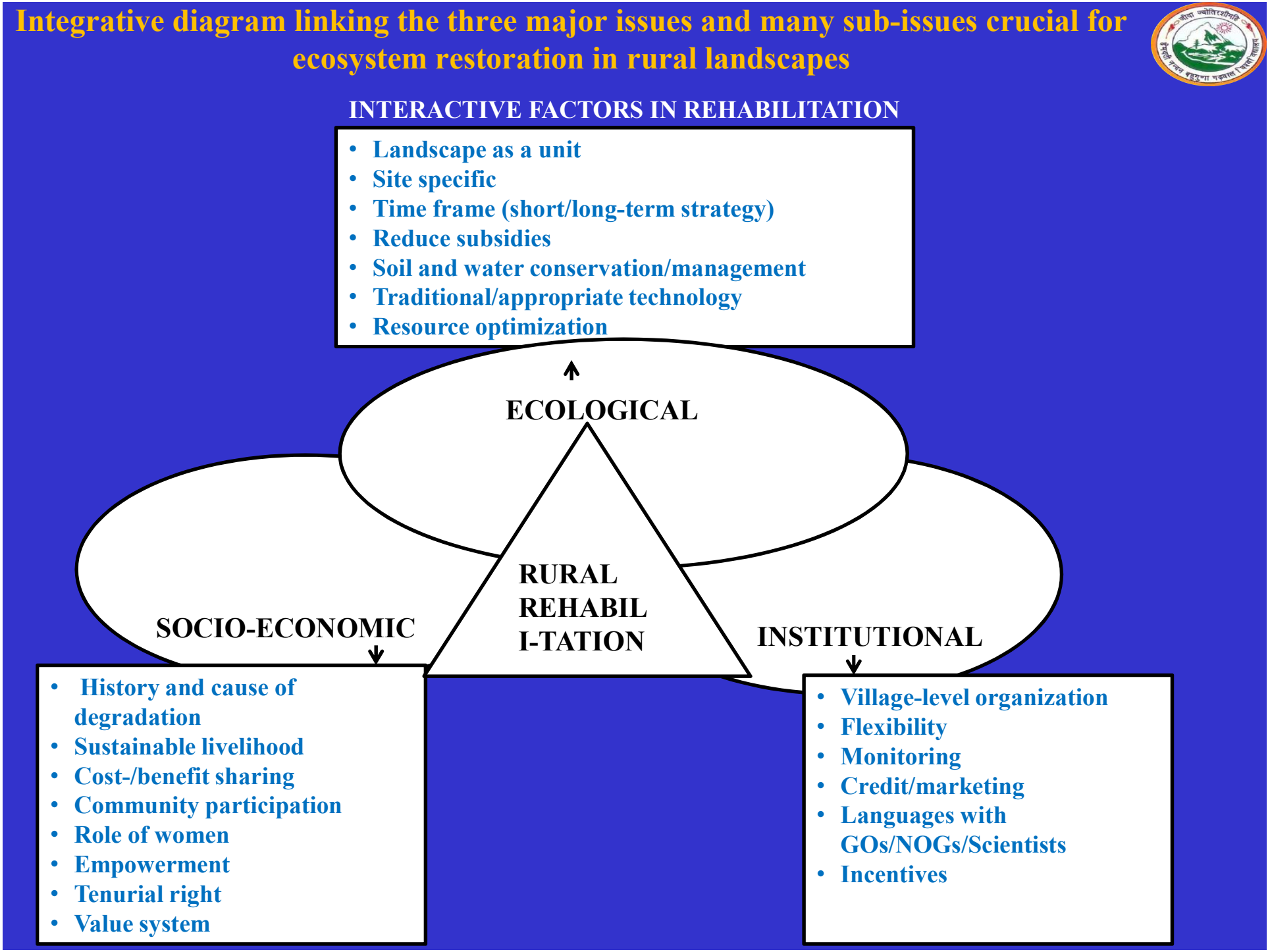
Conclusion

- In this context, Mahatma Gandhi can be quoted, who aptly said.
- Earth provides enough to satisfy every man's need, but not every man's greed. If this mantra (statement/or principle or hymn) were adhered to, it would definitely make a significant contribution in augmenting the natural resource base of the Indian Himalayan Region.

The Isa Upanishad says. The whole universe is pervade by God' Nature has spiritual significance. It has implications for the survival of humanity as well. Protection of nature is protection of self.


Thank You

Integrative diagram linking the three major issues and many sub-issues crucial for ecosystem restoration in rural landscapes

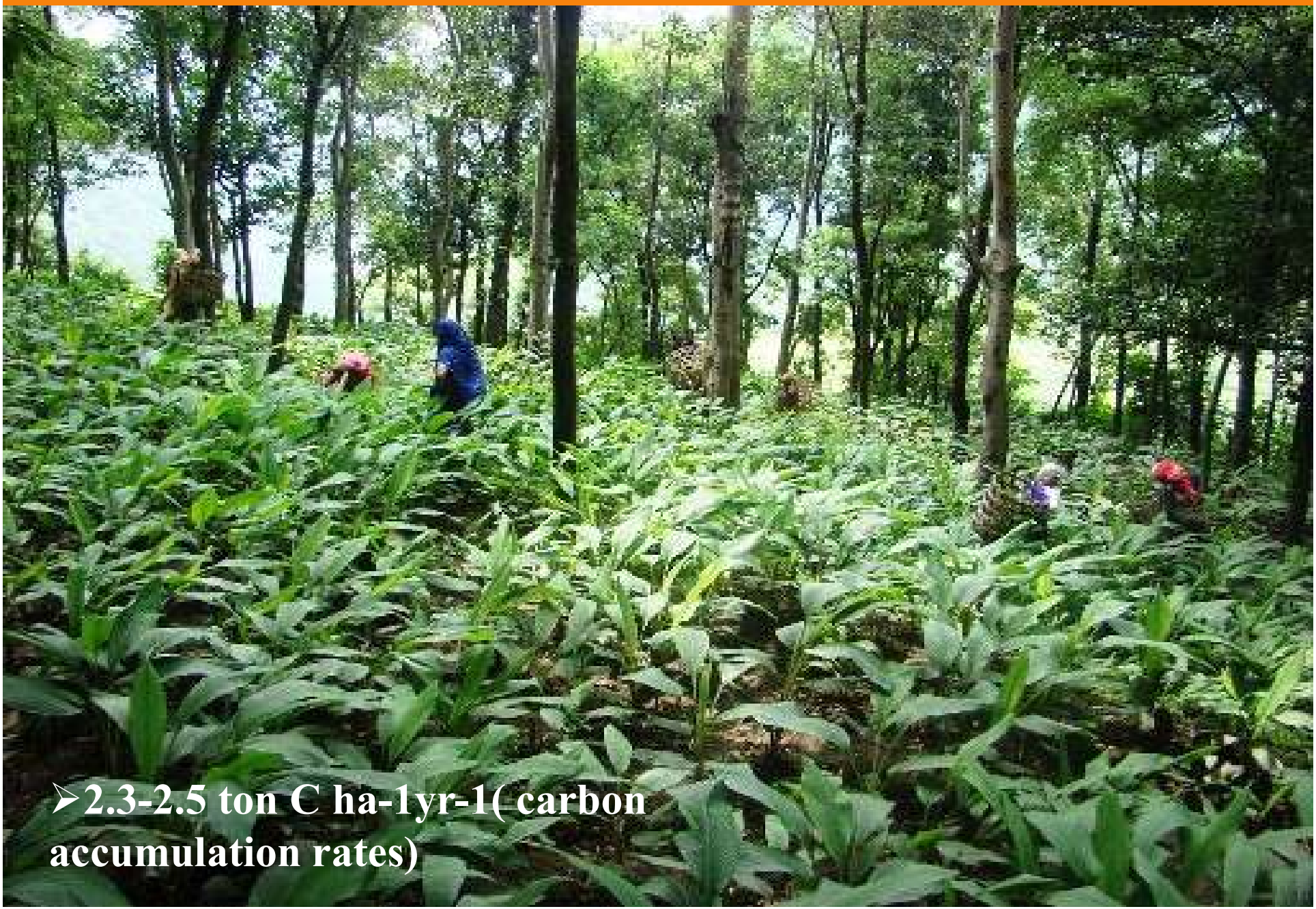


Priority R&D – Approaches for ecosystem restoration in the Himalayas

- **Ecological restoration of degraded forest land**
- **Abandoned agriculture land restoration through Agroforestry**
- **Sylvi-pasture**
- **Agri-horticulture**
- **MAPs cultivation**
- **Environmental education (School Children –primary and secondary level)**

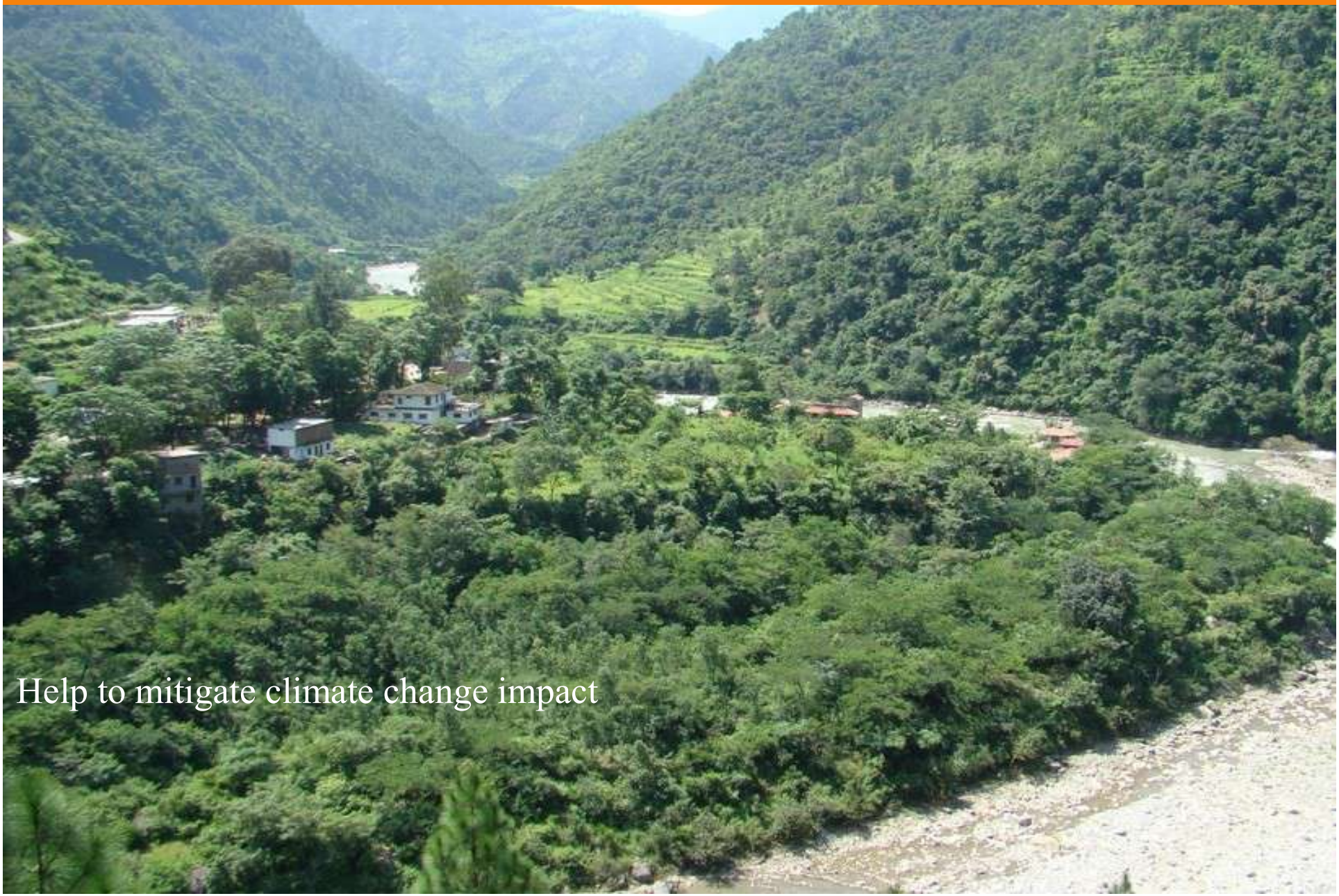
Banswara before Plantation

Integrated agro-forestry with MAPs cultivation



- 2.3-2.5 ton C ha-1yr-1(carbon accumulation rates)

Land rehabilitation through Restoration ecology approach (6ha)



The ecosystem restoration models demonstrated contributes in following major areas

- Reducing drudgery of women and reduce pressure on forests.
- Reduce crop damage by wildlife (turmeric cultivation).
- Improve carbon sequestration – climate change mitigation.
- Improve economy and livelihoods

Need to tap the wisdom of traditional practices

There is a need to tap the wisdom of traditional practices as well as the best of modern technology. Many traditional environmental practices are still relevant today.

- Dig wells
- Excavates water tanks
- Plants trees: whenever a body is cremated, plant a tree
- Don't cut green trees
- Create parks and flower garden (don't pick flowers at night)
- Don't disturb water at night (allow pollution to settle)
- Don't pollute (defecate on) river banks
- Adopt a simple , non-violent life style
- Reduce consumption and harm to the environment
- Recycle a reuse

The Isa Upanishad says. The whole universe is pervade by God' Nature has spiritual significance. It has implications for the survival of humanity as well. Protection of nature is protection of self.

SS-5.Nanda Devi Biosphere Reserve: Resolving Policy Conflicts through Participatory Action Research and Model Demonstration

- Establishment of biosphere reserve resulted in curtailment of rights of local people, nor are they provided with adequate alternatives for meeting their resources.

Achievement and knowledge products

- Assessment of policy-People Conflicts

➢ The main reasons/causes of the conflict was that ban of expedition on Nanda Devi Peak, restriction on grazing in core zone, ban on NTFPs collection and crop and livestock depredation by wildlife.

- Scientific and participatory Action Research

➢ An integrated study was undertaken between 1992 to 2007 in 10 buffer zone villages considering people's perceptions, attitudes towards the reserve establishment and assessment of ecosystem function of buffer zone villages using ecological and economic currencies.

➢ The results of the altitudinal survey indicated that, majority of the respondents (75%) had negative attitude, about 15% were found neutral and 10% have positive attitude, despite the fact, that all respondents were receiving some benefits from eco-development programs implemented by NDBR authorities.

➢ The impacts on people of establishment of biosphere reserve were studied. More than 95% of respondent expressed that agriculture and horticulture productivity is getting reduced, to a large extent, for reasons related to conservation policies.

Priority interventions for socio-economic development, conflict resolution and biodiversity conservation

Agriculture and Horticulture

➢ **Based on the eco-energetic studies in agro-ecosystem suggested that mixed cropping of *Solanum tuberosum* + *Phaseolus vulgaris* + *Amaranthus* spp. Or *Solanum* + *Phaseolus are* ecologically and economically viable.**

➢ **Vegetable cultivation under protected condition.**

- **Value Addition in Wild Edibles and other Forest Products**
- **Promoting cultivation of medicinal plants those have local market**
- **Degraded land rehabilitation through linking appropriate cost-effective technologies**
- **Developed guidelines, strategies and action plan for ecotourism promotion and management: moving towards a community- centered approach**
- **Through our in-depth action research in the field of eco-tourism helped policy–planners to revisit the issues related to mountaineering/expedition in the core zone. Finally in 2003 the core zone of BR has been opened to regulated tourism with restrictions on tourist numbers (around 500 tourists per year).**

- **Conservation education and awareness**
- **In-depth study over last 25 years on various aspects changed the mindset of the people and now over 70% people have positive attitude towards biosphere reserve.**
  - **Developed strategies and action plan on "Promoting Eco-tourism in Nanda Devi Biosphere Reserve.**
  - **The wide scientific coverage on NDBR motivated UNSECO South Asia to document the outcome which was brought in the form of the film "*Invocations to the Mountain Goddess*".**
  - **The action and participatory research work carried out in the reserve on various aspects is given due consideration by various line departments/agencies at district and state levels and most of our findings has been incorporated in the action plant of Forest and Tourism departments.**

SS-3. Conservation and Sustainable Use of Medicinal Plants through Field based Model Demonstration, Cultivation and Outreach Programme

- **The medicinal and aromatic plants (MAPs) have huge economic potential**
- **Programme initiatives:**
  - Sharing of indigenous knowledge of agronomic practices and use of MAPs.
  - Promoting farmers for nursery raising and large scale cultivation of potential species.

- **Achievements & Knowledge Products**
  - Documented traditional agronomic practices, wild collection and uses of 18 MAPs species**.**
  - Promoting domestication/cultivation, sustainable use/value addition and conservation of high value low volume MAP species (*Picrorriiza kurooa, Saussurea costus, Vallenriana wallichii, Inula racemosa, Angelica glauca, Allium stracheyi, etc.)*.
  - Developed linkages of MAPs growers with value chain, marketing and buy back systems (Emami Pvt. Ltd., Kolkota).
- Skill development of local people through on-site training and field demonstration and organized 35 farmers training programme between 1996 to March 2015 in 9 hilly districts of Uttarakhand and trained about 889 participants.
- **Established 5 medicinal plants model demonstration sites covering 4 ha. of village common land in four districts (i.e., Tehri, Uttarakashi, Chamoli and Rudraprayag).**
- Raised about 5.0 lakhs seedlings of 8 MAPs species and about 3.25 lakhs seedlings distributed among the farmers and NGOs. As a result 94 farmers started cultivation of MAPs.
- The findings of this long term action research programme helped institutions involved in medicinal plant sector to develop enabling policy environment regarding cultivation/collection and marketing of MAPs for economic development.

SS-2. Bio-resource (wild origin) utilization and conservation for Livelihood Enhancement and enterprise development

- **Forest bioresources constitute an important source of livelihood of millions of people across the Himalaya**
  - Of the nearly 800 species of wild edibles reported from India, 344 species are found in central Himalaya.

Achievements and knowledge products

- **Potential bioresources and availability for enterprise development**
  - More than 35 plant species having high economic value screened for value added product development (i.e., juice, squash, jelly, pickle, spice, condiments and medicines).
  - Information and database on distribution, traditional uses, phenophases, fruit yield, sustainable harvesting, conservation and cost-benefit analysis
  - Assessment of nutraceutical potential (food, vitamins, minerals, macro and micro nutrients, etc.) of 35 species.
  - Developed the package of practices for sustainable use of 35 wild bioresources for value addition and enterprise development.

- **Capacity and skill development programme organized 18 trainings (each of 2 days) between 2008 – 2017 and trained about 662 people.**

- **Impact and replicability:** About 525 households adopted value addition of wild bioresources as an off-farm activity and average additional income earned through this venture was estimated Rs. 11,700/HH/yr.
  - The approach and action research frame work for bioresources utilization has been included in the policy and action plan of the Uttarakhand government particularly livelihood extensions programme/activities.

Some barriers to the promotion and mainstreaming of agro-biodiversity for improved diets and nutrition

•Disconnect between the biodiversity, agriculture and health sectors and other sectors (including education)

• Continued neglect by the international and national research and extension systems

• Biodiverse food-based approaches all too often fall outside the traditional scope of clinical nutrition and public health

• Lack of skills and institutional capacity necessary to promote multi sector approaches to fully exploit biodiversity, agriculture and health linkages

• Lack of data linking biodiversity to dietary diversity and improved nutrition outcomes

• Lack of evidence demonstrating or comparing the most (cost-) effective methods and approaches for delivering or mobilizing biodiversity for dietary and nutrition outcomes

• Poorly developed infrastructure and markets for the majority of biodiversity for food and nutrition

• Inadequate agricultural and food security policies and strategies that promote major cereal staples have often diminished the dietary role of more nutritious species such as millets, indigenous fruits and vegetables and roots and tubers

• Negative perceptions and attitudes to local, nutritionally-rich traditional biodiverse foods

• Non-tariff barriers and strict food safety assessment regulations such as the European Union's Novel Foods Regulation (NFR) which places a considerable burden of proof on those attempting to bring traditional biodiverse foods and their products to markets

• The 'artificial' cheap cost of exotic or imported foods which externalize their health and environmental costs.

Challenges to traditional food dietary diversity and nutrition security

Challenge	Consequences	Dimension of food and nutrition security likely to be affected negatively
Deterioration of local food system	•Reduced food production & diversity	•Food availability utilization
Changing diets	• Reduced dietary diversity	•Food utilization
Climate change	•Risks to agriculture production, Diversity & Farm income	•Food availability, Stability, Utilization & Accessibility
Lingering poverty	•Reduced food intake & Dietary Diversity	•Food accessibility & utilization
Increased outmigration	•Labour shortages in agriculture leading to reduced production	•Food availability
Abandonment of cultivable land	•Low returns, land abandonment and loss of production	•Food availability
Rapid urbanization	•Encroachment of agriculture land leading to reduced agricultural production	•Food availability
Inadequate infrastructure and market centers	•Inadequate food distribution & post-harvest losses , Higher prices external food items	•Food accessibility & availability
Depletion of natural resources	•Loss to water resources & biomass manure form forests •Reduced supply of wild edible, and reduced livestock production and income	•Food availability, availability, utilization, accessibility
Constraints to internal food movement	•Reduced food supply to mountains , Higher prices of available food	•Food availability & accessibility
Inadequate access to improved drinking water, sanitation, and hygiene	•Higher prevalence of disease	•Health status

The major causes which are directly and indirectly responsible for this genetic erosion and creating imbalance in traditional agro-ecosystem are:

1. Infra-structural development, roads and consequent exposure;
2. Illusions about quality of coarse and fine grains;
3. Aspirations for off-farm employment;
4. Lack of specified programmes and incentives;
5. Abandonment of traditional agro-ecosystem by indigenous population;
6. Socio-economic and cultural change;
7. Migration of hill population to the plains in search of employment;
8. Deterioration of traditional agro-ecosystem caused by introduction of modern high-yielding crops and crop varieties;
9. Replacement of mixed cropping by mono-cropping;
10. Deterioration of natural habitat caused by man induced environmental changes;
11. Lack of scientific interest in these crops.

C. Cultivation and conservation of medicinal and aromatic plants (MAPs)

Large scale cultivation of *Picrorrhiza kurrooa*

Large scale cultivation of *Arnebia benthamii*


An International Workshop on
Sustainability and Culture in Himalayan Societies
University of Haifa (13-15 March 2022)
University of Haifa
Territorial Jurisdiction and interrelation among Gods and Goddess
in Kinnaur, Himachal Pradesh,
And Garhwal Central Himalaya, India
Prof. R.C. Bhatt and Dr. Nagendra Rawat
Department of History, AIHC and Archaeology


Location of Chunukot fort and its remains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בית מגורים מפואר מהתקופה הרומית

Mansion from the Roman Period

בית המגורים המפואר נבנה לפי מתכונת אדריכלית, שהייתה רווחת בעולם הרומי במאה השלישית לסה"נ. במרכז הבית טרקלין, שהיה חדר אוכל ואירוח. יתר חדרי הבית, הבנויים רובם בשתי קומות, הקיפו את הטרקלין ואת חצר העמודים הסמוכה לו.

בחדרים רבים נחשפו רצפות פסיפס, מהן לבנות ומהן מעוטרות. המפוארת שבכולן היא רצפת הטרקלין, ובה תיאורים מחיי האל דיוניסוס ועיטורים נוספים.

The mansion was built according to a plan that was popular in the Roman world in the third century CE. In the center of the house was a traclinium (living-dining room) and colonnaded courtyard. Surrounding them were other rooms.

Many of the rooms had mosaic floors, some white and others with colorful patterns. The most ornate of them all is the floor of the traclinium, containing scenes from the life of the god Dionysus.


Deities and their subordinates
Name of Figurine
Responsible for
Form

ONE HIMALAYA ONE POLICY

INDIA'S G20 PRESIDENCY AND SUSTAINABLE DEVELOPMENT IN THE HIMALAYA:

OPPORTUNITIES, STRATEGIES AND POLICY RECOMMENDATIONS

SUBMITTED TO

NITI AAYOG, New Delhi, Government of India
and
PMO, Government of India, New Delhi

PREPARED BY

HNB Garhwal University, Srinagar, Garhwal, Uttarakhand (HNBGU)
GB Pant National Institute of Himalayan Environment, Kosi Katarmal, Uttarakhand (NIHE)
Research and Information System for Developing Countries (RIS)
Indian Himalayan Central Universities' Consortium (IHCUC)
Kalinga Institute of Indo Pacific Studies (KIIPS)

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2023

Structure and Main Institutional Coordinators of IHCUC

Name	(IHCUC)	Designation	Institution Represented
Professor Annpurna Nautiyal	Convener &Chief Coordinator of IHCUC	Vice Chancellor	H.N.B. Garhwal University, Uttarakhand
Professor Avinash Khare	Coordinator	Vice Chancellor	Sikkim University, Sikkim
Professor Shambhu Nath Singh	Coordinator	Vice Chancellor	Tezpur University
Professor Saket Kushwaha	Coordinator	Vice Chancellor	Rajiv Gandhi University Arunachal Pradesh
Professor Jagadish Kumar Patnaik	Coordinator	Vice Chancellor	Nagaland University
Professor G.P. Parasin	Coordinator	Vice Chancellor	Tripura University
Professor K.R.S. Sambasiva Rao	Coordinator	Former Vice Chancellor	Mizoram University
Professor Dibakar Chnadra Deka		Present Vice Chancellor	
Professor S.K. Srivastava	Coordinator	Former Vice Chancellor	North-Eastern Hill University, Meghalaya
Professor Prabha Shankar Shukla		Present Vice Chancellor	
Professor Mehraj-ud-Din Mir	Coordinator	Former Vice Chancellor	Central University of Kashmir
Professor Farooq A. Shah		Former Incharge Vice Chancellor	
Prof. A Ravinder Nath		Present Vice Chancellor	
Professor Ashok Aima	Coordinator	Former Vice Chancellor	Central University of Jammu
Professor Sanjiv Jain		Present Vice Chancellor	
Prof. Kuldeep Agnihotri	Coordinator	Former Vice Chancellor	Central University of Himachal Pradesh, Dharmshala
Professor Sat Prakash Bansal		Present Vice Chancellor	
Professor D.C Nath	Coordinator	Former Vice Chancellor	Assam University Silchar
Professor R.M. Pant		Present Vice Chancellor	
Shri Jarnail Singh		Former Vice Chancellor	Manipur University
Professor N. Lokendra Singh	Coordinator	Present Vice Chancellor	
Dr. Sanjay Kumar	Coordinator	Former Director	CSIR-IHBT- Palampur, Himachal Pradesh
			GBPNIHE, Kosi Katarmal, Almora

NITI Aayog

(Thematic Study-I)

Enumeration and Valuation of the Economic Impact of Female Labour in the Hills

A Study of **Indian Himalayan Region (IHR)**

assigned by

NITI AAYOG, New Delhi

funded by

UGC, New Delhi

Submitted by

Indian Himalayan Central Universities Consortium (IHCUC)

February, 2022

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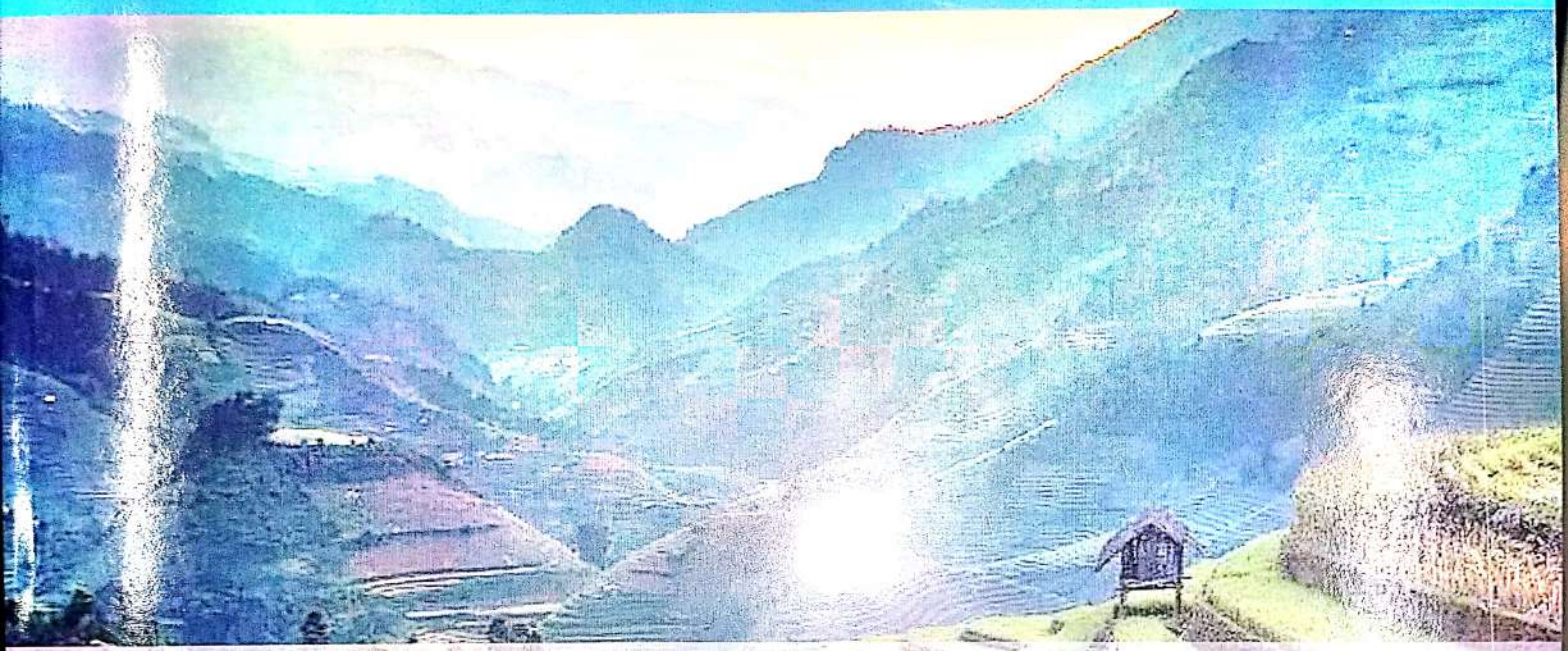
Dr. Sanjay Kumar	Coordinator	Director	CSIR-IHBT- Palampur, Himachal Pradesh

NITI Aayog

(Thematic Study-II)

Agro-Ecology in Himalayan States with special emphasis on marketing



A Study of Indian Himalayan Region (IHR)

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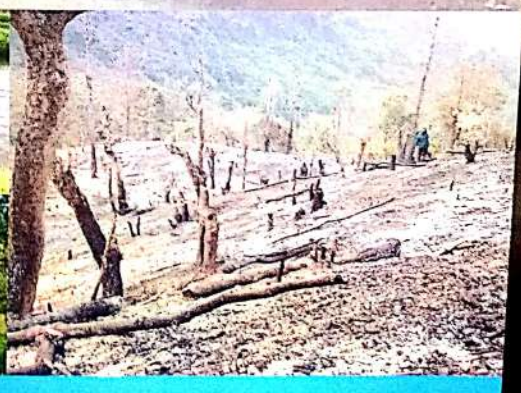

Submitted by

Indian Himalayan Central Universities Consortium (IHCUC)

February, 2022

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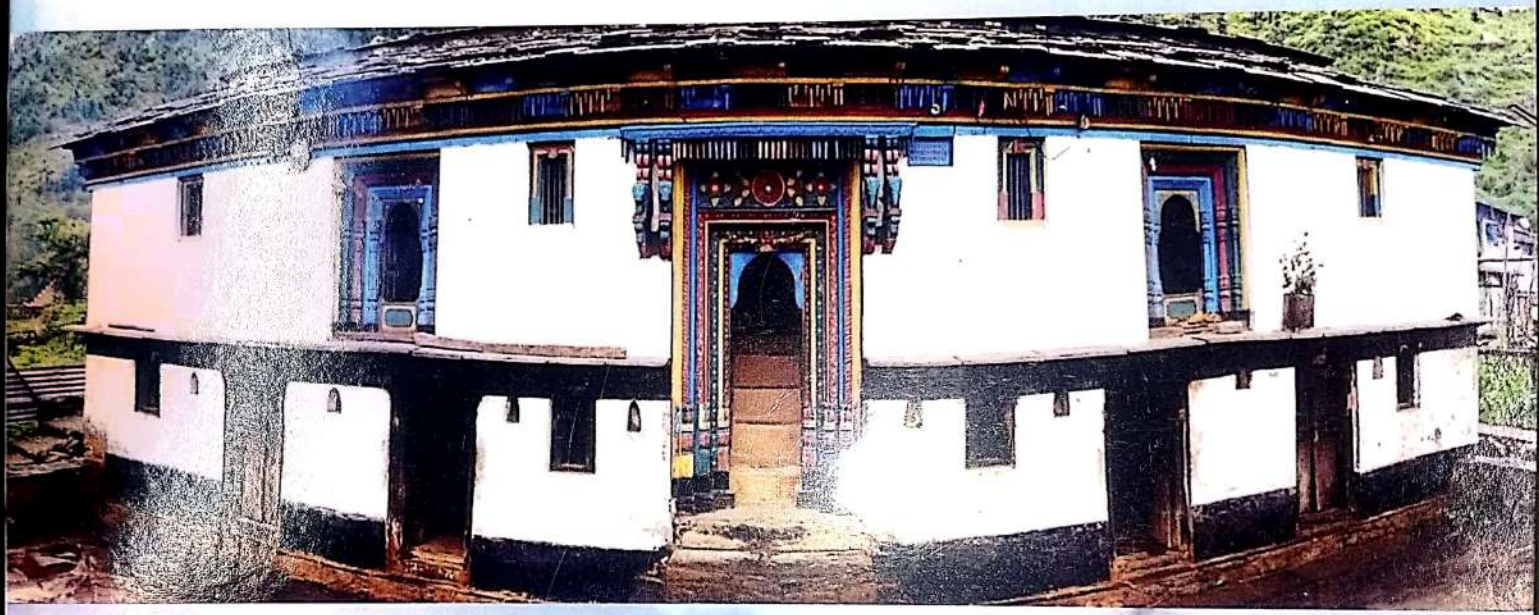
NITI Aayog

(Thematic Study-III)

ज्ञान–विज्ञान विमुक्तये

Development of Eco-friendly and Cost-effective Tourism in Hills



A Study of Indian Himalayan Region (IHR)

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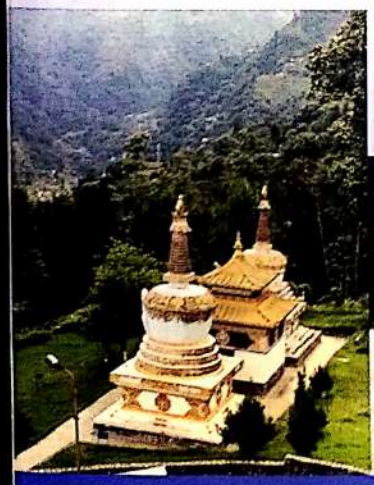

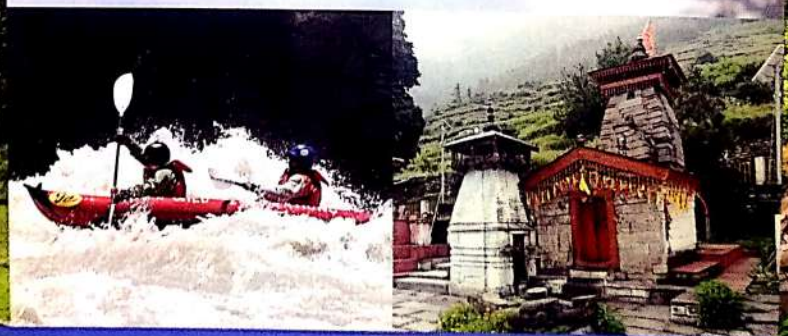

Submitted by

Indian Himalayan Central Universities Consortium (IHCUC)

February, 2022

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(Thematic Study-IV)

Opportunities of Livelihood to Check Migration From The Hills

A Study of Indian Himalayan Region (IHR)

assigned by

NITI AAYOG, New Delhi

funded by

UGC, New Delhi

Submitted by

Indian Himalayan Central Universities Consortium (IHCUC)

Feb, 2022

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(Thematic Study - V)

Water Conservation and Harvesting Strategies

A Study of Indian Himalayan Region (IHR)

assigned by

NITI AAYOG, New Delhi

funded by

ज्ञान-विज्ञान विमुक्तये

UGC, New Delhi

February, 2022

Submitted by

Indian Himalayan Central Universities Consortium (IHCUC)

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Central University of Jammu, Jammu and Kashmir

MoU with IIT Kanpur signed in 2021

CHARACTERIZATION OF GROUNDWATER IN SEISMICALLY ACTIVE REGIONS OF UTTARAKHAND, INDIA: IMPLICATIONS FOR EARTHQUAKE INDUCED VARIATIONS

In this project we are collecting the water samples from 7 different sites of Himalayan region. We have selected two Groundwater Monitoring Stations in proximity of MCT, one is Agyasthamuni (Lat: 30.390725, Long: 79.026365), and another is Gopeshwar (Lat:30.409526, Long:79.319797). We have installed sophisticated monitoring instruments such as multiparameter water quality sensors with high frequency data transmission capabilities for analysis of pH, EC, ORP, Alkalinity, Water level, major anions (HCO_3, CO_3, SO_4, NO_3, Cl, F) and cations (Ca, Mg, Na, K, Fe, Al, Si) and stable isotopes ratios of Hydrogen (^2H) and Oxygen (^{18}O). We are collecting samples from 2 hot springs located in Gauri Kund (Rudraprayag) and Tapovan (Chamoli) for analysis of pH, EC, ORP, major anions (HCO_3, CO_3, SO_4, NO_3, Cl, F) and cations (Ca, Mg, Na, K, Fe, Al, Si) and stable isotopes ratios (Hydrogen (^2H), Tritium and Oxygen (^{18}O). Apart from it we are collecting 3 surface water samples near the monitoring stations, 2 samples of Mandakini River and 1 sample from Alakananda River for analysis of pH, EC, ORP, major anions (HCO_3, CO_3, SO_4, NO_3, Cl, F) and cations (Ca, Mg, Na, K, Fe, Al, Si) and stable isotopes ratios of Hydrogen (^2H) and Oxygen (^{18}O). All the samples are collected at a monthly interval and analysed in laboratory of National Institute of Hydrology, Roorkee. For the analysis advanced instruments such as Inductively Coupled Plasma Optical Emission Spectrometer, Ion chromatograph and Mass Spectrophotometer have been used. These instruments provide a full spectrum analysis of water chemistry in a cost and time effective manner.

Groundwater monitoring station at Gopeshwar.

Groundwater monitoring station at Agasthyamuni.

Objectives:

(1)Monitoring groundwater level and groundwater quality in the active seismic belt of Uttarakhand in 2 sites.

(2) Analyse and characterize space-time variations in groundwater with respect to contemporary seismic events.

(3) Develop a process-based understanding of the observed anomalies and the mechanisms triggering them.

(4) Explore the potential to utilize groundwater anomalies for the development of precursor for Earthquakes.

Activity Report: MoU with IIT Kanpur, 2017

Himalayan Cloud observatory (HCO) BadshahiThaul, Tehri Garhwal

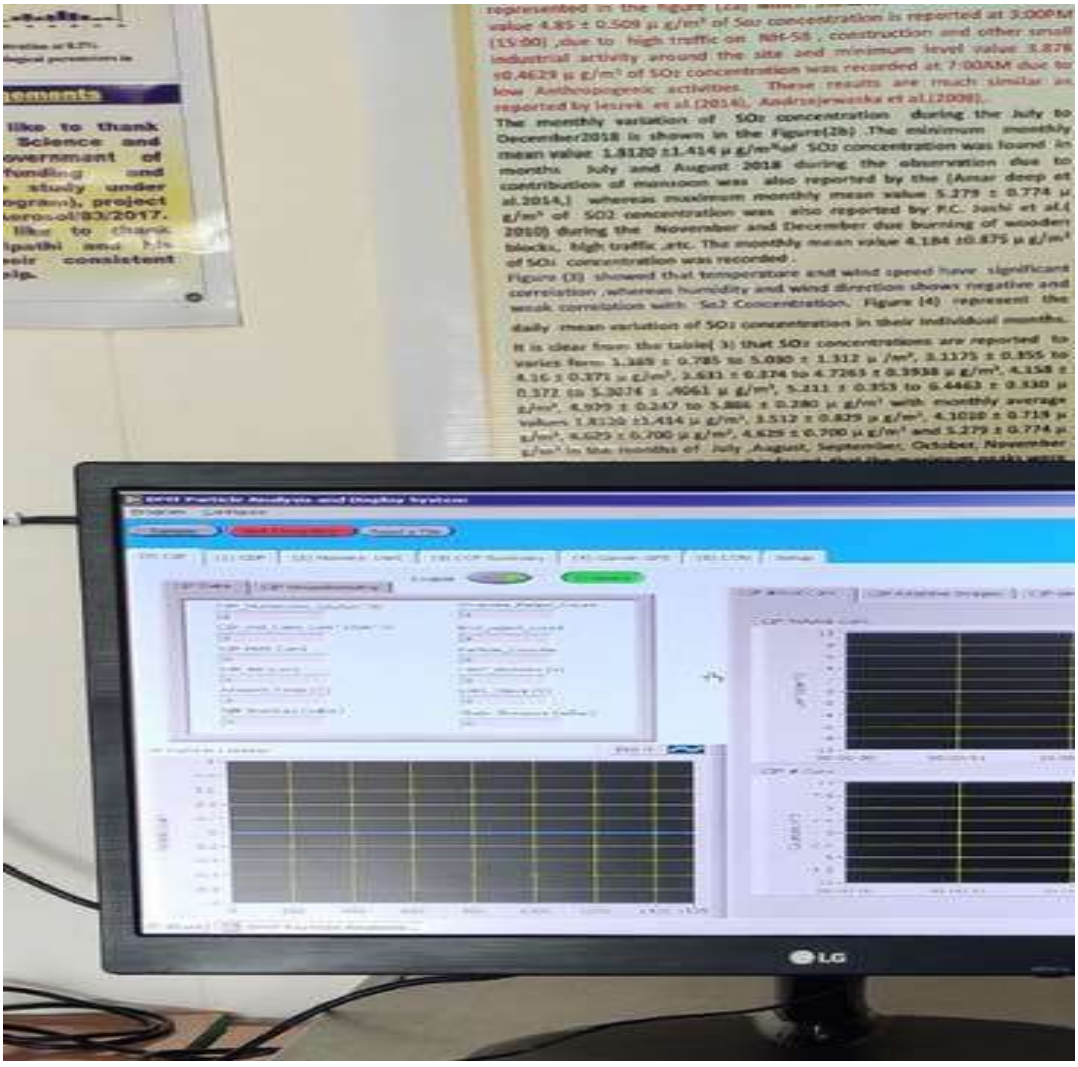
Joint Collaboration with Department of Physics, Srinagar and Tehri Campus, Hemvati Nandan Bahuguna Garhwal University Srinagar Garhwal & Department of Civil Engineering, Indian Institute of Technology Kanpur

Funded by Government of India, Department of Science &Technology (DST)Strategic Programmes, Large Initiatives andCoordinated Action Enabler (SPLICE)CLIMATE CHANGE PROGRAMME

DST Funded project (SPLICE –Climate Change Program) research project entitled "What impacts do aerosols have on cloud condensation nuclei, clouds and rainfall over a pristine Himalayan region"

The Himalayan cloud observatory (HCO) is located on the slope of enchanted lesser Himalayan Mountain range surrounded by the dense forest of Alpine, Oak and Deodar trees. The site is situated in Department of physics HNB Garhwal University, SRT Campus Badshahithaul ($30^0$34' N and $78^0$41'E) Tehri Garhwal District of Uttarakhand at altitude of 1725 m above mean sea level (ASL). The Himalayan cloud observatory (HCO) is situated on outskirts of new Tehri and Chamba cites (8 km and 3 km away from city center to the North East and Northwest respectively) with the population of 6.19Lakh and population Density of 170 km^{-2} as per 2011 census report. The residential area is about 300 m apart from the HCO. The NH-34 passes with moderate traffic on other side of hill to the West direction. The site has no major industrial activities in Radius of 10 km, but Tehri Dam Hydro project is in the Range of 25 Km. The Himalayan cloud observatory is establishing to take ground-based observation for the study Aerosols, Cloud condensation nuclei (CCN) particles and meteorological Parameters over the large region of Uttarakhand to understand the complex mechanism of cloud bust and climate change in sensitive Himalayan region in all-weather condition.

Collaborating Team:
Prof R C Ramola, Director, SRT Campus Badshahithaul
Dr Alok Sagar Gautam, Srinagar Campus, HNB Garhwal University
Prof S N Tripathi, IIT Kanpur
Dr U C Dumka, Aries Nainital
Dr Vijay Kanwade, University of Hyderabad
Mr Anil Mandaria
Mr Gaurav Mishara
Mr Akash Rathi
Mr Sanjeev Kumar
Mr Karan Singh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www.jagran.com

गढ़वाल जागरण

बादल बनने की प्रक्रिया पर

जागरण संवाददाता, श्रीनगर गढ़वाल : उत्तराखंड के पर्वतीय क्षेत्रों में मौसम में होने वाले बदलाव और बादल बनने की प्रक्रिया को समझने के लिए गढ़वाल केंद्रीय विश्वविद्यालय श्रीनगर के भौतिक विज्ञानियों ने शोध कार्य आरंभ किया है। विवि के चौरास परिसर में भौतिक विज्ञान विभाग की वातावरणीय भौतिकी प्रयोगशाला में यह शोध कार्य संचालित किया जा रहा है। वैज्ञानिक एक रिपोर्ट तैयार कर प्रदेश सरकार से शोध के आंकड़ों का विश्लेषण और अध्ययन के निष्कर्ष को साझा करेंगे।

विश्वविद्यालय के शोध

गढ़वाल केंद्रीय विवि के भौतिक विज्ञान विभाग की हि
साइजर यंत्र लगाते विवि भौतिक विज्ञान विभाग की
डॉ. आलोक सागर गौतम व प्रो. आरसी रमोला ● ज

भी काफी मदद मिलेगी जिससे शोध में
कार्य भी आगे बढ़ेगा। क

उन्होंने कहा कि पर्वतीय धु

एसआरटी कैंपस में
एसएमपीएस यंत्र

● पहाड़ों के वातावरण, मौसम व जलवायु को समझने में मदद मिलेगी

शाह टाइम्स संवाददाता

श्रीनगर। हेमवती नंदन बहुगुणा गढ़वाल विवि श्रीनगर की ओर से एसआरटी कैंपस बादशाहीथौल में स्थापित हिमालयन क्लाउड आण्जरबैटरी में नैनो स्कैन स्कैनिंग मोबिलिटी पार्टिकल साइजर यंत्र का सफलतापूर्वक स्थापित किया गया। परियोजना विज्ञान एवं तकनीकी मंत्रालय भारत सरकार के निदेशक एंव भौतिक विभाग में सहायक

प्रक्रिया को
मिलेगी। पी
आरसी रमो
से शोध का
और यह य
साबित होग
विज्ञान और
मदद मिलेग
विज्ञान एवं
सरकार द्व
परियोजना
जलवायु क
मददगार स
बताया कि
विश्लेषण

Published Papers (Joint Colloborations)

In the ecologically sensitive regions of Himalayas there are very few measurementsof cloud properties. This study provides crucial data of cloud condensationnuclei (particles on which cloud droplet form) that will help understand and model cloud properties in central Himalayas.

https://www.sciencedirect.com/science/article/abs/pii/S1352231020308554?fbclid=IwAR0TVyT_eoiwaVpavwbWm4Yl1gfKHOURm0t3TR_rLj0hEDwzPsgNFCbkheU

ESTD. 1984
ISFCP

AICTE Sponsored 6 Days Online STTP on

"TARGET BASED DRUG DESIGN STRATEGIES UTILISING CADD TOOLS AND ECOFRIENDLY MICROWAVE ASSISTED GREEN SYNTHESIS"

AICTE

27th April to 02nd May 2020

ORGANIZED BY

ISF COLLEGE OF PHARMACY, MOGA

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MOHIT KUMAR

Attended 6 Days Online STTP

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Dr. Pooja Chawla	Dr. R. K. Narang	Dr. G. D. Gupta	Parveen Garg
Professor	Vice- Principal	Director-cum-Principal	Chairman
ISF College of Pharmacy, Moga	ISF College of Pharmacy, Moga	ISF College of Pharmacy, Moga	ISF College of Pharmacy, Moga

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CERTIFICATE

This is to certify that

MEENAKSHI NEGI

Attended 6 Days Online STTP

Coordinator	Organizing Secretary	Convener	Patron
Dr. Pooja Chawla	**Dr. R. K. Narang**	**Dr. G. D. Gupta**	**Parveen Garg**
Professor	Vice- Principal	Director-cum-Principal	Chairman
ISF College of Pharmacy, Moga	ISF College of Pharmacy, Moga	ISF College of Pharmacy, Moga	ISF College of Pharmacy, Moga

Bioorganic Chemistry 104 (2020) 104315

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Review article

Role of heterocyclic compounds in SARS and SARS CoV-2 pandemic

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Coronaviruses

ABSTRACT

Coronaviruses have led to severe emergencies in the world since the outbreak of SARS CoV in 2002, followed by MERS CoV in 2012. SARS CoV-2, the novel pandemic caused by coronaviruses that began in December 2019 in China has led to a total of 24,066,076 confirmed cases and a death toll of 823,572 as reported by World Health Organisation on 26 August 2020, spreading to 213 countries and territories. However, there are still no vaccines or medications available till date against SARS coronaviruses which is an urgent requirement to control the current pandemic like situations. Since many decades, heterocyclic scaffolds have been explored exhaustively for their anticancer, antimalarial, anti-inflammatory, antitubercular, antimicrobial, antidiabetic, antiviral and many more treatment capabilities. Therefore, through this review, we have tried to emphasize on the anticipated role of heterocyclic scaffolds in the design and discovery of the much-awaited anti-SARS CoV-2 therapy, by exploring the research articles depicting different heterocyclic moieties as targeting SARS, MERS and SARS CoV-2 coronaviruses. The heterocyclic motifs mentioned in the review can serve as crucial resources for the development of SARS coronaviruses treatment strategies.

1. Introduction

Heterocyclic scaffolds play a pivotal role in drug discovery and development as they constitute the key structural component of a majority of biologically active moieties. Their ability to interact with almost every cellular mechanism in living organism has been responsible for their versatile nature. Their interaction with different mechanistic pathways in viruses has continuously been exploited by researches for the designing of heterocycle-based antiviral agents. Several FDA approved drugs currently in the market comprise of different

Abbreviations: 2019-nCoV-2, 2019-novel coronavirus; 3CLpro, 3chymotrypsin-like protease; 9-O-SIA, 9-O-acetyl-*N*-acetylneuraminic acid; ACE2, Angiotensin converting enzyme 2; COMFA, Comparative molecular field analysis; COMSIA, Comparative molecular similarity indices analysis; COVID 19, Corona virus disease 2019; CPE, Cytopathic effect inhibition assay; CRFK cells, Confluent crandel feline kidney cells; CVB3 3Cpro, Coxsackievirus B 3 cysteine protease; Dabcyl-KTSAVLQSGFRKME-Edans, Dabcyl-Lys-Thr-Ser-Ala-Val-Leu-Gln-Ser-Gly-Phe-Arg-Lys-Met-GluEdans, [4-(4-dimethylaminophenylazo) benzoic acid]-KTSAVLQSGFRKME-[5-[2′-(aminoethyl)amino]-naphthalenesulfonic acid]; DTT, 1,4-Dithio-D,L-threitol; E protein, Envelope protein; FDA, Food and Drug Administration; FIPV, Feline infectious peritonitis virus; FRET analysis, Fluorescence resonance energy transfer analysis; HBTU, Hexafluorophosphate benzotriazole tetramethyluronium; M protein, Membrane protein; MD simulation, Molecular dynamics simulation; MERS CoV, Middle east respiratory syndrome corona virus; MM-GBSA, Molecular Mechanics/Generalized Born Surface Area; MM-PBSA, Molecular mechanics Poisson–Boltzmann surface area; Mpro, Main protease; MTT, 3-(4,5-Dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide; N protein, Nucleocapsid protein; NFkB, Nuclear factor kappa-light-chain-enhancer of activated B cells; NIH (MLPCN) screening, National Institutes of Health (Molecular libraries probe production centers network) screening; nsp10, non-structural protein 10; nsp12, non-structural protein 12, *RNA dependent RNA polymerase*; nsp13, non-structural protein 13, helicase; nsp14, non-structural protein 14, *N-terminal exoribonuclease and C-terminal guanine-N7 methyl transferase*; nsp15, non-structural protein 15, *uridylate-specific endoribonuclease*; nsp16, non-structural protein 16, *2′-O-methyl transferase*; NTD, *N*-terminal domain; ORFs, open reading frames; PC 3Cpro, Picornavirus 3 cysteine protease; PDB, Protein data bank; PHEIC, Public Health Emergency of International Concern; PLpro, papain-like protease; PP1a, Polyprotein1a; PP1ab, Polyprotein1b; qRT-PCR, Quantitative reverse transcription polymerase chain reaction; QSAR, Quantitative structure-activity relationship; RASPD, Rapid Screening with Physicochemical Descriptors; RdRp, RNA dependent RNA polymerase; S protein, Spike protein; SARS CoV, Severe acute respiratory syndrome corona virus; WHO, World Health Organisation; Z-RLRGG-AMC, Z-Arg-Leu-Arg-Gly-Gly-7-amido-4-methylcoumarin.

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0045-2068/

heterocyclic scaffolds [1].

Coronaviruses (CoV) are a family of viruses capable of causing mild to severe symptoms of respiratory distress. In the last two decades, the outbreak of two of the coronaviruses, Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS), have emerged as epidemics with severe mortality. Both epidemics were of zoonotic origin, with SARS CoV transmission from civet cats to humans in 2002 in China and MERS CoV transmission from dromedary camels to humans in 2012 in Saudi Arabia [2]. There was emergence of cluster of pneumonia cases of unknown etiology in Wuhan city, Hubei province, China on 31 December 2019 and later declared by China that the outbreak is associated with a seafood market in Wuhan. China shared the genetic sequence of novel coronavirus responsible for the outbreak for diagnostic purposes on 12 January 2020 [3].

On 30 January 2020, World Health Organisation (WHO) declared this 2019-nCoV outbreak as a PHEIC (Public Health Emergency of International Concern) which was declared pandemic on 11 March 2020 [4]. On 11 February 2020, WHO named this novel coronavirus as COVID-19 (corona virus disease 2019) and later International Committee on Taxonomy of viruses renamed it as SARS CoV-2 [5]. There were 24,066,076 confirmed cases of COVID-19 and 823,572 deaths, globally as on 26 August 2020 [6].

Coronaviruses are single stranded positive sense RNA viruses. COVID-19 is caused by seventh of known coronaviruses which have infected humans, in the sequence: 229E, NL63, OC43, KKU1, MERS-CoV, SARS-CoV, and 2019-nCoV-2. The latter is a betacoronavirus of subgenus sarbecovirus, and is a severe acute respiratory syndrome coronavirus 2 with 96% genome similarity to other bat coronaviruses [7,8]. Among other coronaviruses, virus causing COVID-19 has an advantage of the presence of a unique polybasic cleavage site leading to its increased pathogenicity [9]. It has the largest RNA genome (30 kb) among all other RNA viruses with six to ten open reading frames (ORFs). It consists of some structural and some non-structural proteins. The structural proteins include: spike (S protein), envelope (E protein), membrane (M protein), nucleocapsid (N protein) while the non-structural proteins include: main protease (M^{pro}), papain-like protease (PL^{pro}), non-structural protein 13 (nsp13, helicase), non-structural protein 12 (nsp12, RNA dependent RNA polymerase), N-terminal exoribonuclease and C-terminal guanine-N7 methyl transferase (nsp14), uridylate-specific endoribonuclease (nsp15), 2′-O-methyl transferase (nsp16) and nsp10 [10]. The N protein consists of viral genome while the other three proteins, S, E and M, make the viral envelope. The processing of two viral replicase polyproteins produced by ORF1a/b of COVID-19, PP1a and PP1ab, leads to the production of sixteen non-structural proteins while the mRNA encodes for the formation of structural proteins [11]. The spike protein is responsible for attachment to the host cell membrane using the host cell's angiotensin converting enzyme-2 receptor thus initiating the infection process. Upon entering the host cells, the viral genome undergoes translation into viral polyproteins. The viral $3CL^{pro}$ and PL^{pro} then cleave these translated proteins into effector proteins. PL^{pro} has the capability to deubiquinate host's NFkB and interferon factor 3, resulting in suppression of host cell immunity. The binding of SARS-CoV-2 and ACE-2 has been found to be 10–20 times greater than that of SARS-CoV and ACE-2, favouring the higher transmissibility of SARS-CoV-2 [12].

Like other betacoronaviruses, SARS-CoV and MERS-CoV, SARS-CoV-2 also attacks the lower respiratory system of the patient, release the nucleocapsid in host cellular machinery and further undergoes replication in host cytoplasm leading to viral pneumonia. It can also lead to multiple organ damage affecting heart, kidney, gastrointestinal tract, liver and central nervous system of the patient [4,12].

The RNA genome sequence of SARS CoV-2 (GenBank ID: MN908947.3) has shown to exhibit 82% similarity with SARS CoV (GenBank ID: NC_004718.3) and also it is often seen that the key target enzymes in coronaviruses reveal some sequence similarities, like RdRp of SARS CoV-2 shows 96% identity with SARS CoVRdRp, 3CLpro of SARS CoV-2 revealed 96.08% and 87.00% similarity with that of SARS CoV and MERS CoV, respectively, and though only 83% sequence similarity is seen between PLpro of SARS CoV-2 and SARS CoV but the active site of both the proteins do not show much variation, therefore the heterocyclic scaffolds showing effectiveness against these targets in SARS CoV and MERS CoV might also be repurposed and modified for healthcare emergencies like SARS CoV-2 and other such outbreaks of coronaviruses in future [13–15].

As the heterocyclic compounds have been rigorously involved in the ailments including viral infections, AIDS, cancer, there exists a profound scope of exploring these multiple nuclei to curb coronaviruses. Therefore, through this review we have tried to summarise some of the treatment options based on the heterocyclic nuclei researched and developed against SARS CoV, MERS-CoV and SARS-CoV-2 epidemics using in vitro, in vivo and in silico approaches, which may be of immense value at this hour of global emergency and in future.

2. Isatin and indole-based derivatives

As some isatin based compounds have shown potent activity against 3C protease of rhinoviruses and the cysteine proteases of both rhinovirus and SARS CoV possessed structural similarity at the active site, some isatin derivatives were designed and assayed for inhibitory activity against SARS CoV 3CLpro by fluorescence resonance energy transfer FRET analysis. The assay revealed the higher potency of 5-iodo or 7-bromo isatin derivatives with benzothiophenemethyl side chain rather than with benzyl or alkyl side chains. The IC_{50} value of the most potent inhibitor **1** came to be 0.95 μM. The compound exhibited efficient binding within the active site of the enzyme. The carbonyl and amine groups of isatin scaffold were involved in forming hydrogen bond with Gly-143, Ser-144 and Cys-145 as shown by the docking analysis. The authors reported that the bulky nature of side chain on isatin derivatives decreased the inhibitory activity due to steric hinderance of the side chain with His-164 and Met-165 of 3CLpro [16]. After a year, *N*-substituted-5-carboxamide derivatives of isatin scaffold were designed and compared with 5-iodo substituted analogues using *in vitro* and computational approaches. The colorimetric inhibition assay results reported **2** as the potent inhibitor with lowest IC_{50}value of 0.37 μM. The hydrophobic naphthyl group at N-1 of isatin moiety was found to be well fitted in hydrophobic pocket, thus increasing the activity. Also the C-5 carboxamide substitution imparted 3 to 4 times higher potential compared to the 5-iodo derivatives while the C-5 ester and carboxylic analogues did not display any inhibitory activity which was explained to be due to their poor binding at P1 site of 3CLpro as a result of strong charge repulsion from Glu-166. In addition, the carboxamide group successfully formed two hydrogen bonds with His 163 and Phe 140. The synthesized derivatives possessed noncovalent reversible binding with 3CLpro of SARS CoV [17]. Other group of scientists synthesized 5-sulfonamide derivatives of isatin and docked within SARS CoV 3CLpro active pocket with an improvement in inhibitory potential. The results of FRET inhibition assay suggested a better activity of 5-substituted analogues compared to substitutions at other positions of isatin scaffold. The 5-(piperazin-1-ylsulfonyl)isatin analogues displayed the higher potential than the 5-halogen substituted derivatives. Replacing the 5-piperazinyl moiety with 5-piperidinyl substitution further enhanced the antiviral potency with an IC_{50} of <5 μM. The effect of substitutions at N1 of isatin moiety revealed the most promising activity of compound **3** ($IC_{50} = 1.04$ μM) having an *N*-benzyl group which was further confirmed by docking analysis using Glide 5.5 software. Compound **3** extended hydrogen bonds with residues Gly143 and Cys145 of 3CLpro (PDB ID: 1UK4), with a dock score of 8.70. The docking results unleashed the crucial role of N-1 and C═O at position 2 of isatin nucleus in hydrogen bond formation. The 5-sulfonyl and N1-benzyl substituents fitted well into the S2 and S1 hydrophobic pockets of 3CLpro, respectively, thus improving the inhibitory potential of the derivatives [18]. Reports are also available with tripeptidic inhibitors of SARS CoV 3CL protease. The

dipeptide-type analogues with position-3 *N*-arylglycyl moiety were developed resulting in enhanced activity due to the hydrogen bond formation between amine of glycyl and Glu166 residue of 3CL pro. The fluorometric inhibition assay showed that the presence of DL-pyroglutamyl or pyrrole-2-carbonyl in place of N-(3-methoxyphenyl) glycyl moiety as rigid position-3 analogue, decreased the inhibitory potential dramatically while the indole-2-carbonyl group as rigid position-3 moiety remarkably improved the potential. Compound **4** with substitutions on position-3 indole nucleus with a 4-methoxy substituent was reported as the most potent derivative (IC_{50} value = 0.74 μM) when compared to 5- or 6-methoxy or 4-hydroxyl/4-isopropoxyl/4-isobutyloxyl derivatives. Replacing the rigid position-3 indole scaffold with other heterocycles like benzothiazole or benzofuran greatly reduced the activity suggesting the crucial role of amine of indole nucleus in hydrogen bond formation. The docking analysis of compound **4** (K_i = 0.0063 μM) with SARS CoVMpro (PDB ID: 1WOF) highlighted a favourable conformation of the rigid P3 4-methoxyindole moiety in the active site, compared to the flexible N-(3-methoxyphenyl)glycyl unit providing a 65-fold greater potential to the indole derivative [19]. Two series of pyrazole and pyrimidine fused indole derivatives were designed and analysed for their antiviral activity against SARS CoV 3CLpro, biosterically replacing isatin with indole. The FRET inhibition assay results revealed compound **5** as the most potent derivative with an IC_{50} value of 0.12lM. It was concluded that 2,3-dihydroinden-1-one was a required for anti-SARS CoV activity whereas it's clubbing with pyrimidine nucleus provided greater enhancement in potency compared to that with pyrazole moiety and at the same time, isoxazole fusion lead to compounds with lesser potency [20]. The SARS CoV-2 helicase was homology modelled using 2019-nCoV/USA-WA1-F6/2020 (Gen Bank: QHU79203.1) helicase amino acid sequence against SARS CoV helicase (PDB: 6jyt.2.A) as template due to a 99.78% sequence similarity between the two and the modelled protein was analysed for antiviral properties of 23 clinically approved antiviral drug candidates using MOE software. The docking study revealed the highest binding affinity of compound **6** with a dock score of −9.84 kcal/mol involving a hydrogen bond formation with Gly79 of SARS CoV-2 helicase thus enabling the compound to be an efficient inhibitor of SARS CoV-2 helicase, thus interfering with the viral replication potential of helicase [21]. The disruption of the trimerization of SARS CoV-2 spike protein which is reported to be involved in host cell membrane fusion, can lead to antiviral activity. A portion of spike protein trimer S2 domain (947–1027 residues) was found to be structurally similar to influenza virus H3N2 haemagglutinin by comparative analysis, to which Arbidol**7** binds for its anti-influenza action. The binding mode and mechanism of action of compound**7**, against SARS CoV-2 spike protein trimer (PDB: 6VSB), was analysed using HADDOCK2.2 and SWISS-DOCK molecular docking servers. The results of docking analysis revealed the potential interaction of compound **7** with the SARS CoV-2 spike protein S2 domain residues (K776, K780, K947, E1017, R1019, S1021, N1023, L1024, T1027) in the same way as with H3N2 HA protein (PDB: 5T6N), thus interfering with SARS CoV-2 trimerization and suggesting a potential role of compound **7** in the treatment of SARS CoV- 2 infection [22]. The homology modelling of SARS CoV-2 RdRp structure using SWISS-MODEL server revealed its 97.05% sequence similarity with the template, SARS CoVRdRp (PDB: 6NUR). The modelled structure was then docked against 74 antiviral drugs using Autodock Vina and the binding interactions were analysed by PyMol and Chimera. Delavirdine **8**, an anti-HIV drug, exhibited pronounced inhibitory activity against SARS CoV-2 RdRp forming hydrogen bonds with Ala576 and Asn 582, with a dock score of −8.5, thus emphasizing the imperative role of **8** in SARS CoV-2 treatment therapy by interfering with RdRp dependant viral replication [23]. Novel inhibitors of SARS CoV-2 Mpro (PDB: 2H2Z) were designed by analyzing the active site, which basically comprise of S1′, S1, S2 and S4 subunits. In the newly synthesized compounds, aldehyde was taken as a warhead required to form covalent bond with the thiol of cysteine which keeps the inhibitor anchored at S1′ site of the protein. The FRET inhibition assay displayed a high potential of compound **9** with an IC_{50} value of 0.053 μM with no cytotoxicity. The electron density map examination of the crystal structure of SARS CoV-2 Mpro (PDB: 6LZE) in complex with compound **9** revealed a favourable conformation of compound **9** in the active site, involving a hydrogen bond of its indole moiety with Glu166 and hydrophobic interactions with Pro168 and Gln189. *In vivo* pharmacokinetic study in mice with 5 mg/kg i.p and 5 mg/kg i.v administration, demonstrated 87.8% bioavailability value while *in vivo* toxicity analysis in SD rats and beagle dogs indicated no toxicity and mortality at a dose of 40 mg/kg. Therefore, the results of analysis suggested a promising role of compound **9** for SARS CoV-2 clinical trial studies [24]. Six anti-influenza drugs namely arbidol, oseltamivir, baloxavir, zanamivir, peramivir and laninamivir were evaluated for their antiviral potential against SARS CoV-2. The cell counting kit-8 (CCK-8) assay demonstratedarbidol**7** as a potent inhibitor with an EC_{50} value of 4.11 μM while a CC_{50} value of 31.79 μM. A sharp decline in the SARS CoV-2 induced cytopathic effect and viral NP expression by compound **7** was also observed using immunofluorescence staining assay. The qRT-PCR examination displayed an efficient inhibition of viral replication stages with more pronounced effect at entry (41%) compared to post-entry stage (61%) using viral multiplicity of infection (MOI) of 0.05. Arbidol **7** lowered the binding efficiency of virions, in virus infected Vero E6 cells (MOI of 0.05) upto 67%. The result of viral intracellular trafficking analysis by immunofluorescence microscopy revealed a decrease in release of SARS CoV-2 from endo lysosomes. Since no neuraminidase analogue was found in SARS CoV-2, therefore the neuraminidase inhibitors tested in this study failed to show any result. Also, since the cap snatching effect of endonuclease of viral polymerases is absent in coronaviruses, as a result of this, baloxavir which acts by inhibiting this particular mechanism of endonuclease, also failed in SARS CoV-2 infection [25]. Fig. 1 outlines various indole and isatin derivatives.

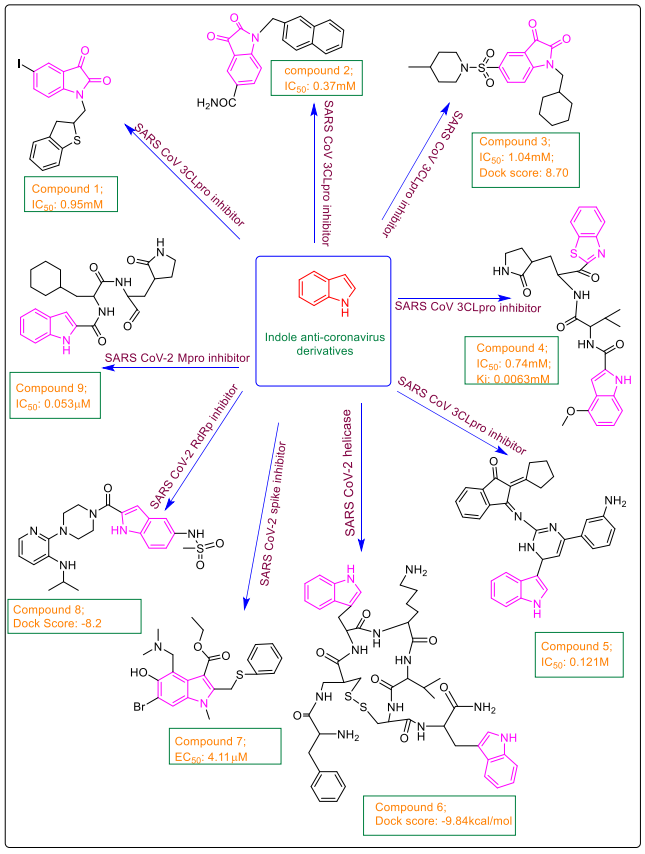

Fig. 1. Isatin and indole-based derivatives.

3. Quinoline and isoquinoline derivatives

In 2003, with the outbreak of SARS CoV epidemic, several drugs were repurposed against it. One such anti-malarial drug, chloroquine **10**, was also evaluated for its antiviral potential against SARS CoV infection. The results of MTT assay in Vero E6 cells revealed a good potency with an IC_{50} value of 8.8 μM while a CC_{50} value of 261.3 μM, suggesting the use of chloroquine in SARS CoV like infections. The drug proved to be more effective in later stages of viral replication rather than effecting viral attachment or penetration [26]. Almost a year later, chloroquine **10** was further reported for its prophylactic and therapeutic use against SARS CoV activity by treating Vero E6 cells at a concentration of 0.1–10 μM, both 20–24 h prior and 3–5 h after the viral infection. Immunofluorescence assay results indicated a 100% viral inhibition chloroquine pre-treated cells at 10 μM concentration while a 90–94% decrease in virus antigen-positive cells at 33–100 μM in post-treated cells with an ED_{50} of 4.4 μM. The mechanism of action for antiviral action was depicted as the abrogation of terminal glycosylation of ACE-2 receptor thus interfering with SARS CoV spike-ACE-2 receptor binding necessary for viral entry in host cells by flow cytometry and immunoprecipitation analysis. As chloroquine is basic in nature, the inhibition of virus-endosome fusion due to increase in endosomal pH was presumed to be responsible for post-treatment anti-SARS CoV effects [27]. Keeping in view the antimalarial potential of ferroquine, even on chloroquine resistant strains and the antiviral efficacy of chloroquine was well established against SARS CoV, some ferroquine derivatives have been reported for their antimalarial and antiviral potential. The analysis results revealed a high anti-malarial potency of compound **11**, a hydroxyferroquine analogue, with high lipophilicity and lesser toxicity than ferroquine. From the *in vitro* study results of ferroquine showing the good potency of its metabolites against chloroquine resistant *Plasmodium falciparum* strain, it was suggested that the de-alkylated metabolite of the metallocene **11** namely mono-*N*-desethyl-ferroquine, facilitated the activity of parent molecule. The compound **11** exhibited good anti-HIV and anti-SARS CoV activity with an EC_{50} value of 3.6 μM in SARS CoV infected Vero cells, compared to the standard chloroquine showing an EC_{50} value of 6.5 μM though it exhibited poor potential against other viruses like reovirus-1 and HSV-2, herpes simplex virus-1, sindbis virus, influenza A virus, vesicular stomatitis virus and vaccinia virus, thus revealing its high selectivity towards HIV and SARS CoV infections [28]. From the virtual screening of over six lakh compounds in a database, a quinolinone derivative was selected for its promising anti-SARS CoV 3CLpro activity, for which the *in vitro* SARS CoV inhibition analysis revealed an IC_{50} value of 0.44 μM/L. Therefore, taking it as lead, based on its structure and activity, 23 novel 4-quinolinone ester derivatives were synthesized and *in vitro* and *in silico* studies were conducted to evaluate their SARS CoV 3CLpro inhibition potential. Compound **12** with a methyl substitution at NH moiety of the quinolinone lead compound, demonstrated nearly 12-fold greater anti-SARS CoV 3CLpro activity using FRET analysis, with an IC_{50} of 36.86 nM/L in comparison to lead. The docking analysis with SARS CoV 3CLpro (PDB: 3SN8) via Discovery Studio 3.0, indicated a more favourable binding of **12** in the active site of SARS CoV 3CLpro compared to the lead molecule which is proposed to be due to a hydrogen bond of amide oxygen with His 163 which remains conserved in both molecules and hydrogen bonds of ester carbonyl oxygen of **12** with Cys 145 and His 41 (the catalytic enzymes in SARS CoV 3CLpro active site necessary for proteolytic function). The structure activity relationship study of synthesized derivatives displayed a decrease in anti SARS CoV potential with the replacement of thiophene moiety of lead molecule with benzene, substituted benzene or alkyl carbon chains which is considered to be due to large size of these substituents which failed to fit within small S1′ pocket of the protease [29]. With the outbreak of MERS CoV infection in 2012, some FDA approved drugs which have shown activity against other coronaviruses, were repurposed against MERS CoV infection also. One such drug namely chloroquine **10** from a database of 348 FDA approved compounds, was also investigated for its *in vitro* potential against MERS CoV infected Vero and Huh7 cells using a colorimetric cell viability assay. The results unleashed the inhibition of MERS CoV mediated cytopathic effect by chloroquine with an EC_{50} value of 3 μM while it exhibited an EC_{50} value of 4.1 μM in SARS CoV infected Vero E6 cells. To determine the pre- and post- treatment effects of chloroquine, the time-of-addition experiment using plaque assay was conducted by adding the drug both 1 h prior and 1 h post viral infection (multiplicity of infection, 1) which revealed an approximate decrease of 2-log in viral production in chloroquine pre-treated Vero cells with no effect in post-treated cells, thus suggesting an early stage inhibition of MERS CoV infection via inhibition of clathrin mediated endocytosis [30]. The catalytic site of SARS CoV at Arg188/Gln189, was reported to be degradation sensitive while its mutant strain with isoleucine residue at 188 in place of arginine renders the protease highly stable and catalytically more efficient. At the same time, a peptide-mimetic substrate-based inhibitor with an aldehyde group at C-terminal demonstrated a potent competitive inhibition of the mutant R188I SARS CoV 3CLpro strain.

Novel decahydroisoquinoline based non-peptide derivatives were designed taking the above peptide mimetic inhibitor as lead and evaluated for their anti-R188I SARS CoV 3CLpro activity. The compound **13**, a (4aR,8aS) isomer of trans-decahydroquinoline diastereomers with *N*-p-bromo-benzoyl substitution, displayed a high potential with an IC_{50} value of 63 μM. The X-ray crystallographic study of compound **13** in complex with 3CLpro (PDB: 4TWW), revealed a compact fitting of compound **13** within the active site of SARS CoV 3CLpro comparable to the active lead molecule. The S2 pocket was largely covered with decahydroisoquinoline fused ring while the hydrogen bond between the N atom of imidazole ring of compound **13** and His163 of 3CLpro provided it a favourable conformation at the S1 site of protease. Also, the *N*-*p*-bromobenzoyl moiety lies outward from 3CLpro where hydrophobic interactions might be possible [31]. From a dataset of FDA approved drugs, a set of 1528 compounds were screened and evaluated for their anti-SARS CoV-2 activity by combining cell viability assay and SARS CoV-2 ELISA. The Cell Titer Glo assay and cytopathic effect (CPE) inhibition assay (MOI: 0.01) in Vero E6 cells revealed promising effects of compound diiodohydroxyquinoline **14**, (a quinoline derivative) used as a luminal amebicide, with a CC_{50} value of >100 μM and approximately 70% CPE inhibition, respectively. Compound **14** also showed an EC_{90} value of 4.50 μM in viral load assay using MOI of 0.01 in Vero E6 cells while an EC_{50} value of 1.38 μM through plaque reduction assay. It was also observed that treatment with compound **14** greatly reduced the SARS CoV-2 N antigen expression at a non-toxic concentration of <10 μM just like remdesivir which was taken as reference. The replication of SARS CoV-2 was also inhibited effectively at post entry. The *in vivo* studies revealed that compound **14** could be used as a potent luminal antiviral agent [32]. As it has been already reported that apart from using ACE-2 receptor, coronaviruses use sialic acid-containing glycoproteins and glycosides also as a source for entry into the host cell membrane and also that MERS CoV entry can be inhibited by depleting these sialic acids content. The efficiency of chloroquine **10** and hydroxychloroquine **15** against SARS CoV-2 was studied *in silico* (Hyperchem and Molegrow molecular viewer) using the mechanism of depletion of cell surface sialic acids containing gangliosides. Merging chloroquine with Neu5Ac depicted a good fit between the two, through interaction between negatively charged carboxylate of Neu5Ac and a cationic charge of chloroquine. The molecular modelling of 9-O-SIA (9-O-acetyl-*N*-acetylneuraminic acid), the preferable sialic acid for interaction with coronaviruses, also demonstrated a favourable fit among the two via interaction of nitrogen containing cationic ring of chloroquine with carboxylate of 9-O-SIA (interaction energy: −47 kJ/mol). Compound **15** showed a similar interaction with 9-O-SIA with enhanced binding owing to a hydrogen bond formation (interaction energy: −46 kJ/mol). The interaction affinities of the two drugs with ganglioside sialic acids, as sialic acid mostly forms a part of human respiratory tract gangliosides and glycoproteins was studied through molecular

modelling using ganglioside GM1. The results revealed good interaction of both the drugs within the two drug-binding sites in GM1, showing a high interaction energy of −108 kJ/mol and −120 kJ/mol, respectively. Finally to determine the ability of both the drugs to prevent the binding of SARS CoV-2 spike NTD with cell surface ganglioside, the NTD-GM1 complex was superposed with drug-GM1 complex, which indicated that both NTD and the drug binds at the same position in GM1 and with the same mechanism involving a hydrogen bond and a CHπ interaction, thus unleashing the anti-SARS CoV-2 potential of the drugs [33]. Some active quinoline and isoquinoline derivatives are shown Fig. 2.

4. Pyridine derivatives

A library of 50,000 compounds was screened for their activity against SARS CoV 3CLpro using FRET analysis. The non-specific compounds were further screened by examining their activity against SARS CoV 3CLpro in the presence of BSA (bovine serum albumin) and out of the screened compounds, 69 compounds show specificity against SARS CoV 3CLpro. All of these screened compounds showed potential electrophilic centres like amides, nitriles which may be capable of forming covalent bond with the nucleophilic thiol of Cys 145 at the active site of 3CLpro. Therefore, they were further analysed in the presence of DTT (1,4-dithio-D,L-threitol) for their specificity against SARS CoV 3CLpro which depicted 5 inhibitors whose activities were least affected by DTT. Finally, the selected compounds were evaluated against other coronaviruses also namely hepatitis A virus 3Cpro, chymotrypsin, hepatitis C NS3pro and papain, to test their selectivity for SARS CoV 3CLpro. Compound **16** displayed the highest selectivity and potency against SARS CoV 3CLpro with an IC_{50} value of 0.5 μM, thus emphasizing on the role of 5-chloropyridine derivatives as anti-SARS CoV agents [34]. The derivatives were evaluated for their activities against SARS CoV (Frankfurt-1 strain) and FIPV (feline infectious peritonitis virus) infections by MTT assay in Vero E6 cells and CRFK (confluent crandel feline kidney) cells infected with 100 $CCID_{50}$ (50% cell culture infective dose) SARS CoV and FIPV, respectively. The highest potency was revealed by compound **17**, with an EC_{50} of 17 mg/L against SARS CoV and with almost no cytotoxic effect in Vero cells (MIC > 100 mg/L). The compound showed post entry inhibition of viral infection in time of addition experiment in FIPV infected CRFK cells. The structure activity relationship study revealed that the sulphide and sulphoxide analogues displayed poor activity against both viruses. The reduced pyridine-*N*-oxide analogues exhibited a complete loss of antiviral potential against both SARS CoV and FIPV, at their subtoxic concentrations, thus emphasizing on the imperative role of *N*-oxide in pyridine nucleus [35]. The 5-chloropyridinyl indolecarboxylate analogues were synthesized as anti-SARS CoV evaluated for their *in vitro* and *in silico* anti-SARS CoV 3CLpro inhibitory activity [36]. The FRET inhibition assay demonstrated compound **18**, as the most active analogue having a 4-carboxylate indole substitution, with an IC_{50} value 0.03 μM. The analysis results indicated a decrease in potential with the shift of carboxylate moiety on positions other than 4 in indole nucleus. The acylation of indole N also resulted in loss of anti-viral potency. *In silico* study was also conducted by docking of compound **18** within the binding pocket of SARS CoV 3CLpro (PDB: 2HOB) using GOLD 3.2 program which further confirmed its promising role as an anti-SARS CoV agent. The results of docking analysis revealed a good fit of compound **18** within the active site of protease due to the formation of three hydrogen bonds by carbonyl oxygen with Cys 145, Ser 144 and Gly 143 while the indole moiety fits into the hydrophobic S2 site involving the interaction of imidazole N with His 41 [37]. Two series of derivatives of 5 chloropyridine were synthesized using MAC-5576 **16** (a potent anti-SARS CoV agent) as lead. *In vitro* SARS CoVMpro inhibition assay showed the derivatives of series 1 (derivatized benzene substituted furan fused to chloropyridyl ester) to be possessing higher inhibitory potential than those of series 2 (derivatized, six membered cyclic aromatic moiety clubbed with chloropyridyl ester) with compound **19** as the most promising inhibitor exhibiting an IC_{50} value of 60 nM. The analysis results revealed a decrease in anti-SARS CoV potential with a change in the position of nitro group in compound **19** from *para* position to *ortho* or *meta* position of benzene ring. The molecular docking study using AutoDock depicted the binding of chloropyridine group within the S1 pocket of SARS CoV 3CLpro, with N of pyridine forming a hydrogen bond with N of His 163 while the furan moiety fits into the space between S1 and S2 subsites involving van der Waals interaction with Met 165. The *p*-substituted benzene moiety (ΔG: −9.34 kcal/mol) fitted well into the S2 pocket while the *o*- or *m*-substituted benzene rings in other derivatives were forced to move outside from S2 pocket due to steric hinderance with SARS CoVMpro residues, His 41 and Met 49 [38]. Fig. 3. shows various pyridine derivatives.

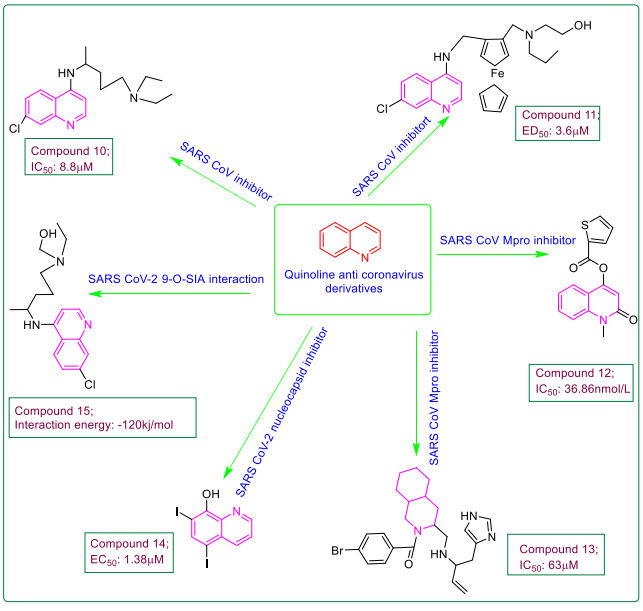

Fig. 2. Some of the promising Quinoline and Isoquinoline derivatives.

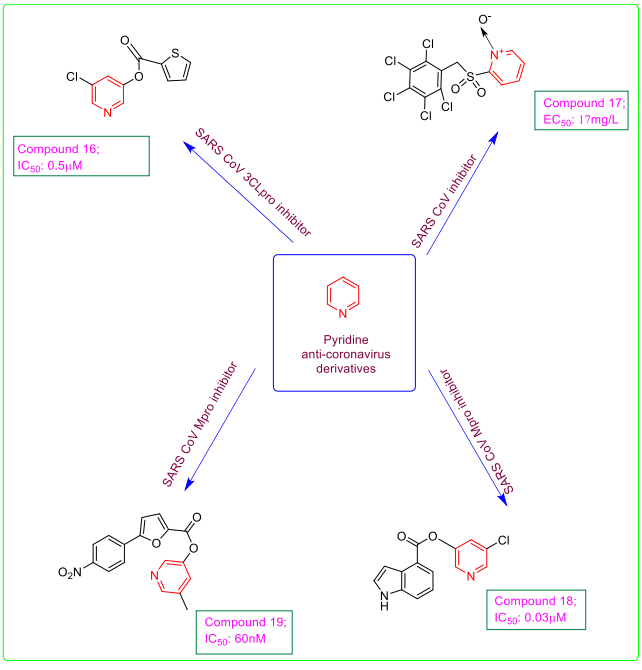

Fig. 3. Potential Pyridine derivatives.

5. Purine and pyrimidine derivatives

The Maybridge compound database, was virtually screened for a set of anti-SARSCoV 3CLpro (PDB: 1UK4) inhibitors within the binding site containing the catalytic dyad Cys 145 and His 41 which forms a part of subsites S1, S2 and S3, using DOCK 4.0.2 server. The top 93 compounds involving more than two hydrogen bonds with Mpro, were further analysed by SARS CoVMpro inhibition assay, among which 21 derivatives were found active exhibiting an IC_{50} value of <30 μM. Three of these 21 compounds shared a similar core structure, *N*-phenyl-2-(2-pyrimidinylthio)acetamide, using which 25 more structural analogues were screened from Maybridge, SPECS_SC and ChemBridge databases and a total of 28 analogues were analysed for anti-SARS CoV inhibitory potential which displayed compound **20** as the most promising analogue with an IC_{50} value of 3 μM. The results furnished from 3D-QSAR modelling using COMFA and COMSIA analysis completely matched with those from experimental analysis. The MM/GBSA analysis results also revealed the best fit of compound **20** within the binding pocket of SARS CoV 3CLpro with a binding free energy of –23.17 kcal/mol, due to the strong interactions formed by its thiazole and benzene moieties with protease residues namely, Gln 192, Leu 167, Glu 166 and Pro 168 [39]. 6-Chloropurine derivatives have been reported to exhibit potent antiviral activity against many viruses. Nucleoside analogues based on 6-chloropurine moiety were designed and analysed for their activity against SARS CoV using plaque reduction assay in SARS CoV Frankfurt-1 strain infected Vero E6 cells. Compound **21** exhibited promising activity with an IC_{50} value of 48.7 μM and a decrease in virus yield to less than one-hundredth of the control, at 20 μM concentration. The structure activity relationship study showed the importance of chlorine atom at position-6 of purine nucleus and a loss of anti-SARS CoV activity with the 2-amino group substitution in 6-chloropurine moiety. The replacement of chlorine group with weaker leaving groups like —SMe or —OMe, led to a decrease in anti-SARS CoV potential which is attributed to be due to lack of formation of an irreversible covalent bond which 6-chloropurine can form with the active site of SARS CoV owing to its electrophilic nature. The unprotected 5′-hydroxyl substitution in ribofuranosyl moiety is also imperative as it gets converted to the active triphosphate form leading to the antiviral activity. Also, the replacement of ribofuranosyl moiety with 2′-deoxy- or 3′-deoxyribonucleoside analogues led to a detrimental effect on the anti-SARS CoV potential of compound **21** [40]. From the compound library, Genesis plus collection, 960 compounds were screened against SARS CoVPLpro using *in vitro* and *in silico* approaches. The results of deubiquitination assay demonstrated that out of the screened compounds, only two derivatives, 6-Mercaptopurine **22**, (IC_{50} value: 21.60 μM) and 6-Thioguanine **23** (IC_{50} value 5 μM) exhibited pronounced SARS CoVPLpro inhibition. The thiocarbonyl group of **22** and **23** was found to be crucial for SARS CoVPLpro inhibition using structure function relationship study by ISIS, as replacing it with hydroxyl or methylthio moiety led to loss of inhibition. The docking analysis confirmed the inhibition inhibition mechanism within the active sites of SARS CoVPLpro (PDB:2FE8) and 3CLpro (PDB: 1UK2) using DS modelling 1.7 program. The docking result suggested a good fit of both the compounds with a dock score for **22** (23.9) and **23** (24.4) within the active site of PLpro with the probability of formation of a hydrogen bond between sulphur atom of the compounds and Cys 1651 residue of SARS CoVPLpro resulting in reversible competitive inhibition. While the dock scores with SARS CoV 3CLpro were found to be 17.8 for **22** and 18.4 for **23**, much lower than with SARS COV PLpro, thus emphasizing on the selectivity of both the compounds towards PLpro [41]. Another series of pyrimidine derivatives was synthesized and evaluated for their SARS CoV 3CLpro inhibitory potential. The FRET analysis using Dabcyl-KTSAVLQSGFRKME-Edans as fluoregenic substrate demonstrated compound **24** to be endowed with marked SARS CoV 3CLpro inhibitory potential exhibiting an IC_{50} value of 6.1 μM, with no cytotoxicity as depicted by MTT assay. The molecular docking analysis of compound **24** with SARS CoV 3CLpro (PDB: 1UK4) using Discovery studio modelling 1.2 SBD program unleashed a good fit of phenylnitro group within the S1 pocket with O atom of nitro group forming a hydrogen bond with Cys 145 and Gly 143 at the binding site of 3CLpro. The lack of nitro group led to a loss of inhibitory potential, emphasizing on the imperative role of nitro substituent. Moreover, electron withdrawing groups like chloro in phenyl ring favoured the inhibitory potential more than the electron releasing groups like methoxy or methyl [42]. The antineoplastic drug carmofur **25**, a pyrimidine analogue was analysed for SARS CoV-2 Mpro inhibitory potential using the X-ray crystallographic study. The electron density map of the **25**-SARS CoV-2 Mpro complex indicated a favourable conformation of the drug within the active site of protease with its fatty acid moiety forming a covalent bond with Cys 145 of the catalytic dyad leading to the release of 5-fluorouracil. The carbonyl O of **25** was observed to be involved in hydrogen bond formation with Cys 145 and Gly 143 while the fatty acid tail showed hydrophobic interaction with His 41, Met 165 and Met 49 at the S2 subsite of the protease. The *in vitro* inhibition assay in SARS CoV-2 infected Vero E6 cells revealed an EC_{50} value of 24.30 μM while the cytotoxicity study indicated the selectivity of compound **25** with a CC_{50} value of 133.4 μM [43]. A set of 6799 compounds from Pubchem and Asinex library were virtually screened and analysed by molecular docking against SARS CoV-2 nucleocapsid RNA binding domain (PDB: 6VYO). The high throughput virtual screening with docking was done using Schrodinger's molecular docking module at the active sites 1, 2 and 3 of the protein. From the screened ligands, compound zidovudine **26**, a thymidine analogue, demonstrated the highest potential with a dock score of −9.75 while a binding free energy of −59.43 kcal/mol at site 3, as depicted by MM-GBSA approach. The molecular dynamic simulation study also revealed a stable interaction of **26**-SARS CoV-2 N protein complex, thus suggesting the exploration of this potential nucleus as anti-SARS CoV-2 agent [44]. A series of diaryl pyrimidine derivatives were evaluated for their SARS CoV-2 inhibitory potential using *in silico* approaches. The molecular docking analysis of the derivatives with the SARS CoV-2 spike glycoprotein-human ACE-2 complex (PDB: 6VW1) was carried out using AutoDock Vina while the results were analysed by MGL tools and PyMol. The pyrimidine derivative **27** showed best binding affinity at the interface of the complex with a binding energy of −8.95 kcal/mol which was attributed to be due to formation of a hydrogen bond with ASP 350, Arg 393 and Asn 394 residues and hydrophobic interactions of its naphthyl and phenyl moieties with Phe 40, Trp 69, Leu 73, Phe 390 and Leu 391 amino acid residues. The molecular dynamic simulation study with GROMACS v5.1.4 biomolecular simulation package demonstrated a stable conformation of **27** within the spike glucoprotein-ACE2 complex throughout the simulation. Its high binding affinity of with the complex was further confirmed by binding free energy calculation using MM-PBSA, the results of which came out to be lowest (ΔG: −30.89 kcal/mol), thus suggesting further evaluation of diaryl pyrimidines as effective anti-SARS CoV-2 agents [45]. Fig. 4 highlights some of the purine and pyrimidine derivatives active against coronaviruses.

6. Pyrazole derivatives

Pyrazolones have been exploited for activity against viruses. A set of 6800 compounds from Korea chemical bank database underwent high throughput screening to obtain the most potent compound against SARS CoV 3CLpro. After primary screening using Dabcyl-KTSAVLQSGFRKME-Edans as fluoregenic substrate, the compounds that showed > 50% inhibition of protease activity at 50 μM further undergo secondary screening at 10 μM. The inhibition assay revealed compound **28** as the most potent inhibitor of SARS CoV 3CLpro with an IC_{50} value of 2.5 μM. The docking analysis of compound **28** within the active site of SARS CoV 3CLpro (PDB: 1UK4) using Discovery studio modelling 1.2 SBD program, depicted a good fit of the molecule with its 4,5-dihydro-1H-pyrazole moiety occupying S1′ and S2 sites and remaining part resting at S3 site of the protease [46]. Another series of pyrazolone analogues were

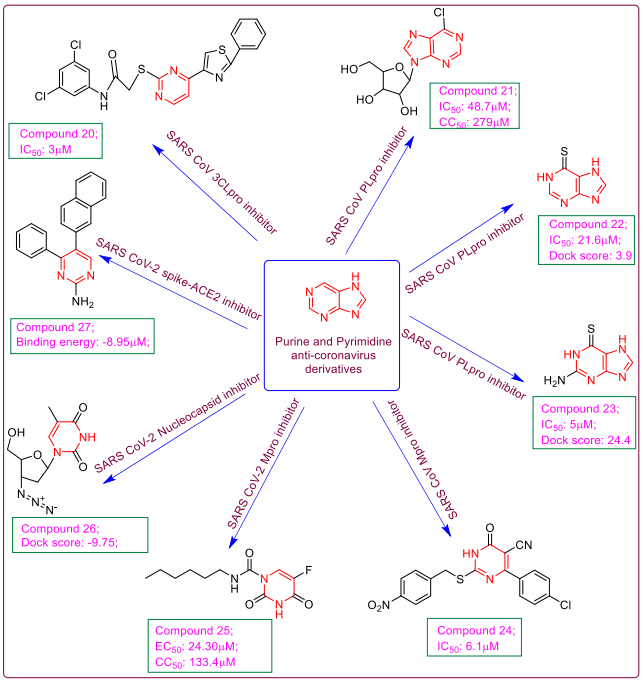

Fig. 4. Purine and Pyrimidine derivatives acting on coronaviruses.

reported for the antiviral potential against SARS CoV 3CLpro and CVB3 3Cpro. As a result of *in vitro* FRET analysis, compound **29**, with a *p*-benzylidene aryl ring substitution at C4 of pyrazolone moiety, was observed to be endowed with marked activity against both 3CLpro and 3Cpro with IC_{50} values of 8.4 μM and 9.6 μM, respectively. The MTT cytotoxicity assay results revealed no cytotoxicity of the target compounds at 200 μM. To further confirm the inhibitory potential of the target compounds, molecular docking analysis via Discovery studio modelling 1.2 SBD program of Accelrys, of the derivatives within the binding site of SARS CoV 3CLpro (PDB: 1UK4) was performed which unleashed a favourable conformation of compound **29** with its N1 phenyl substituent fitted well in S1′ pocket while the O of nitro group formed a hydrogen bond with Gly 143. The carbonyl oxygen of pyrazolone moiety was involves in H-bond formation with Glu 166. The phenyl ring at C3 of pyrazolone fitted well in hydrophobic S2 site while the p-carboxybenzylidene substituent at C4 of pyrazolone nucleus fitted easily in S3 pocket with carboxyl oxygen forming a hydrogen bond to Gln 192. The *in vitro* and *in silico* study results emphasized on the imperative role of carboxyl group in benzylidene ring as pyrazolone derivatives lacking this substituent lost their inhibitory potential. It was found that the presence of electron withdrawing substituents like nitro, cyano or fluoro at N1 phenyl ring led to an increase in inhibitory potential [47]. Some 5-pyrazolone derivatives were designed and evaluated for their inhibitory potential against SARS CoV and MERS CoV 3CLpro. The *in vitro* fluorometric analysis using Dabcyl-KTSAVLQSGFRKME-Edans as peptide substrate for 50 nM SARS CoV 3CLpro or 300 nM MERS CoV 3CLpro, unleashed the highest potential of compound **30** with IC_{50} values of 5.8 μM and 7.4 μM, respectively. The structure activity relationship study proved that the replacement of bulky phenyl substituent from position 3 of pyrazolone moiety with smaller groups like methyl or CF_3 will led to loss of inhibitory potential. Also, the removal of carboxylate group from compound **30** resulted in derivatives with no inhibitory activity. The substitution with lipophilic group at p-position of phenyl ring at N1 of pyrazolone also led to a marked increase in activity. The *in vitro* assay results were further confirmed by docking analysis of the ligand within the active site of SARS CoV 3CLpro (PDB: 2ALV) using iGemdock v2.1 program. The docking results revealed a good fit of compound **30** within the active site with carboxylate moiety resting in S1 site forming hydrogen bonds to Gly 143, Ser 144 and Cys 145 while furan moiety interacting with hydrophobic S1′ site. The lipophilic tert-butyl group of compound **30** showed good interaction with hydrophobic S2 site, thus enhancing its inhibitory potential. Also, the carbonyl group of pyrazolone moiety is involved in hydrogen bond formation with His 41, thus destabilizing the catalytic dyad at the active site of SARS CoV 3CLpro [48]. The ZINC database was screened using RASPD web server with the aim of searching for potent SARS CoV-2 main protease inhibitors. The best two hit molecules selected as a result of RASPD score, were screened for their drug likeness using SwissADME and Molinspiration servers which revealed a good bioactive score and pharmacokinetics of both the ligands. Therefore, these two ligands were analysed for their binding affinities with SARS CoV-2 main protease (PDB: 6LU7) using ParDOCK server. The docking study results showed a good fit of both the ligands within the active site of protease with a higher binding affinity of compound **31** (Binding energy: −6.20 kcal/mol) comparable to ligand N3 (Binding energy: −6.43 kcal/mol), involving π-alkyl interactions with histidine residue of main protease [49]. Fig. 5 depicts pyrazole derivatives.

7. Thiazole derivatives

Thiazoles and their derivatives have been explored for activity against corona viruses. A series of trifluoromethyl ketone peptide derivatives were designed and evaluated for their activity against SARS CoV 3CLpro. The inhibition assay results revealed low inhibition potential of these derivatives with a minimum K_i value of 21 μM. Regnier *et al.* designed another series of derivatives by replacing the trifluoromethyl ketone group with electron withdrawing thiazolyl or benzothiazolyl ketone moieties, with the objective of improving the covalent bond formation with Cys 145 of catalytic dyad at the active site of 3CLpro. The inhibition assay results proved the highest potency of compound **32**, a thiazolyl ketone peptide derivative, possessing a K_i value of 2.2 μM. This inhibitory potential was further confirmed by computational docking study of **32** with SARS CoV 3CLpro (PDB: 1WOF) using MOE 2007.09 modelling package which demonstrated a good fit of ligand within the active site of protease with N of thiazole forming a

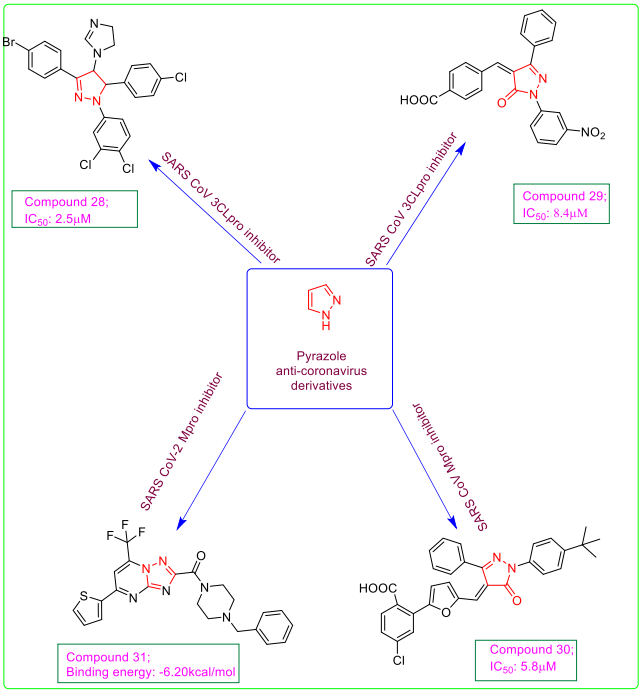

Fig. 5. Pyrazole derivatives acting as inhibitors of SARS CoV or SARS-CoV-2.

hydrogen bond to His 41 while the benzyloxycarbonyl and thiazolyl ketone groups involved in interaction with Cys 145 of the catalytic dyad [50]. The 5-arylidene-4-thiazolidinones were considered less selective towards biological targets because of the high reactivity of exocyclic double bond with the nucleophilic protein residues favouring the Michael addition reaction. Therefore, isosteric thiopyrano[2,3-d][1,3] thiazole derivatives were synthesized taking 5-substituted-4-thioxo-2-thiazolidinone as precursors. Compound **33** displayed the highest anticancer potential with GI_{50} value of 0.309 μM against MCF-7 breast cancer cell lines while it demonstrated a moderate potency against SARS CoV with IC_{50} value of 23 μM (visual assessment) and IC_{50} value of 14 μM (neutral red dye assessment) [51]. Konno *et al.* took compound **32** as lead and carried out the molecular modelling with 3CLpro (PDB: 1WOF) and found a vacant space in S1′ pocket carrying the thiazolyl group of compound **32** and a protruding benzyloxycarbonyl (P4) moiety from the active site while cyclic amide (P1) and electron withdrawing thiazolyl (P1′) moieties were observed to be crucial for inhibitory activity. The authors carried out optimization of P1′ and P4 moieties to get more efficient anti-SARS CoV 3CLpro inhibitors. The fluorescence-based peptide cleavage assay results of the newly optimized derivatives using Dabcyl-KTSAVLQSGFRKME-Edans as fluorogenic substrate, indicated the pronounced inhibition effect of compound **34** (against SARS CoV 3CLpro possessing K_i value of 0.003 μM. The authors reported that a benzothiazolyl moiety led to enhancement of activity owing to its good fit in the large S1′ pocket. Also the presence of 4-N,N'-dimethylaminophenoxy acetyl moiety resulted in favourable hydrophobic interactions with Ala 191 at S4 pocket, with a unique folding conformation for improved anti-SARS CoV potential [52]. As 4-thiazolidinone and pyrazoline analogues exhibit potent antiviral activity, 2-pyrazoline-4-thiazolidinone hybrid derivatives were designed and evaluated *in vitro* for their anticancer and antiviral potential. Compound **35** emerged as the most potent anticancer and antiviral agent based on AACF (antimicrobial acquisition coordinating facility) programme, against Tacaribe TRVL 11,753 strain (EC_{50}: 0.71 μg/mL) but showed mild activity towards SARS CoV urbani strain (EC_{50}: 49 μg/mL) [53]. The same group (Havrylyuk *et al.*, 2013) synthesized, another series of 5-pyrazoline conjugated 4-thiazolidinones analogues to get more active anticancer and antiviral agents. The evaluation of antiviral potency of compound **36** exhibited an EC_{50} value of 21.46 μM and a CC_{50} value of 34.67 μM against SARS CoV urbani strain [54]. A set of 5-ylidene-4-thiazolidinone-3-carboxylic acid derivatives were synthesized and found to have low or moderate inhibitory potential of the target compounds where compound **37** displayed marked anti-SARS CoV activity with an EC_{50} value of 27 μM and a selectivity index of >3.7 against SARS CoV urbani strain in Vero 76 cells [55]. A commercial database was screened to identify the novel inhibitors of SARS CoVMpro. Using the 3D structure of transmissible gastroenteritis Mpro (PDB: 1LVO) as template, the structure of SARS CoVMpro was simulated and its active site predicted owing to the sequence similarity between the two proteases. The molecular docking analysis result revealed the analogues bearing the core nucleus as compound **38** as inhibitors of SARS CoVMpro had the potential to inhibit Mpro infected Vero-E6 cells [56]. Some of such derivatives are depicted in Fig. 6.

8. Triazole derivatives

Triazoles have been reported in literature to possess remarkable antimicrobial activity. A series of benzotriazole esters was prepared by condensing (HBTU Hexafluorophosphate benzotriazole tetramethyluronium) with carboxylic acids and the target compounds were evaluated for their potential against SARS CoV 3CLpro using *in vitro* and *in silico* studies. The *in vitro* fluorometric assay revealed compound **39** to be highly active anti-viral agent (K_i value: 7.5 nM; CC_{50}: >100 μM) with an irreversible inhibition of SARS CoV 3CLpro. The *in silico* molecular docking exposed a favourable conformation of compound **39** within the active site of SARS CoV3CLpro (PDB: 1uk4) with benzotriazole scaffold

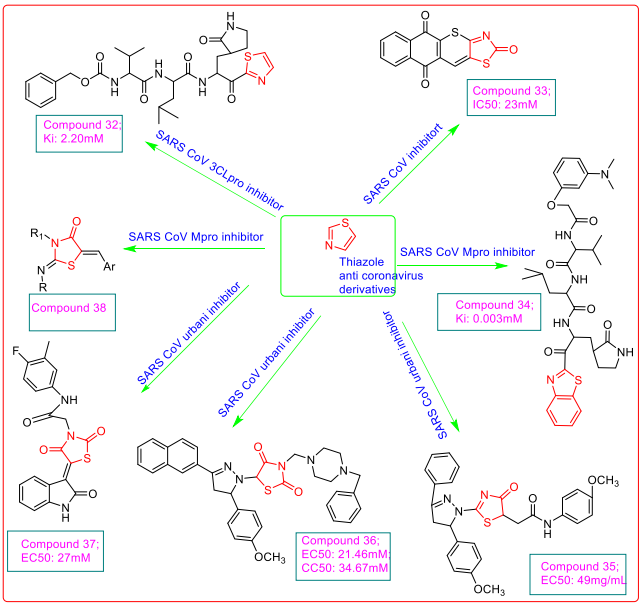

Fig. 6. Thiazole derivatives active against coronaviruses.

resting in pocket containing Gly 143, Ser 144 and Cys 145, facilitating a nucleophilic attack by the Cys 145 to the carbonyl group in benzotriazole ester. Also, the hydrogen bond formation between indole of **39** and —OH group of Thr 25 further stabilized the complex formation with SARS CoV 3CLpro. The benzotriazole ester derivatives exhibited a good inhibition of SARS CoV 3CLpro via acylation of Cys 145 in the catalytic dyad at active site [36]. Triazole based non-covalent inhibitors of SARS CoV 3CLpro were developed and analysed for their anti-SARS CoV 3CLpro inhibitory activity. Compound **40,** a biaryl substituted triazole derivative possessed a ligand efficiency of >0.3 which on analysis demonstrated the highest potency with an IC_{50} value of 0.051 μM [57]. Some 1,5-disubstituted tetrazole-1,2,3-triazole conjugates were screened via docking analysis against SARS CoV-2 main protease (PDB:6LU7) possessing the favourable interactions similar to the co-crystalized ligand with the active site catalytic triad, Gly 143, Ser 144 and Cys 145 residues involving the hydrogen bonds and hydrophobic interactions. Ten 1,5-disubstituted tetrazole-1,2,3-triazole hybrids as SARS CoV-2 Mpro inhibitors were generated. Among the proposed hybrids, compound **41** having an isatin moiety exhibited the highest interaction energy (E: −255.79 kcal/mol) within the active site of 6LU7 involving hydrogen bond formation of 1,2,3 triazole moiety with Ser 144 and Cys 145 and that of tetrazole moiety with Ser 1 and Asn 142 and also electrostatic interactions with His 41, His 172, Glu 166 and His 163 while the higher number of rings in its structure enhance the hydrophobic interactions [58]. Fig. 7 depicts some triazole derivatives active against corona viruses.

9. Miscellaneous heterocycles

Keeping in view the anti-SARS CoV activity of aryl diketo acids, a series of bioisosteric dihydroxy chromones were designed and examined for their SARS COV inhibitory potential against ATPase and helicase using phosphate release assay method and FRET-based analysis, respectively. The *in vitro* assay results revealed a good inhibitory potential of compound **42**, a flavonol analogue with free catechol group, with IC_{50} values of 25.4 μM and 2.7 μM against ATPase and helicase, respectively which proposed the involvement of two binding sites in Mpro i.e. one for hydrophobic interaction with arylmethyl moiety while other for hydrogen bond interaction with free catechol moiety [59]. Kim *et al.* developed a series of 2,6-bis-arylmethyloxy-5-hydroxychromones as anti-SARS CoV agents. The compounds displayed dual inhibitory

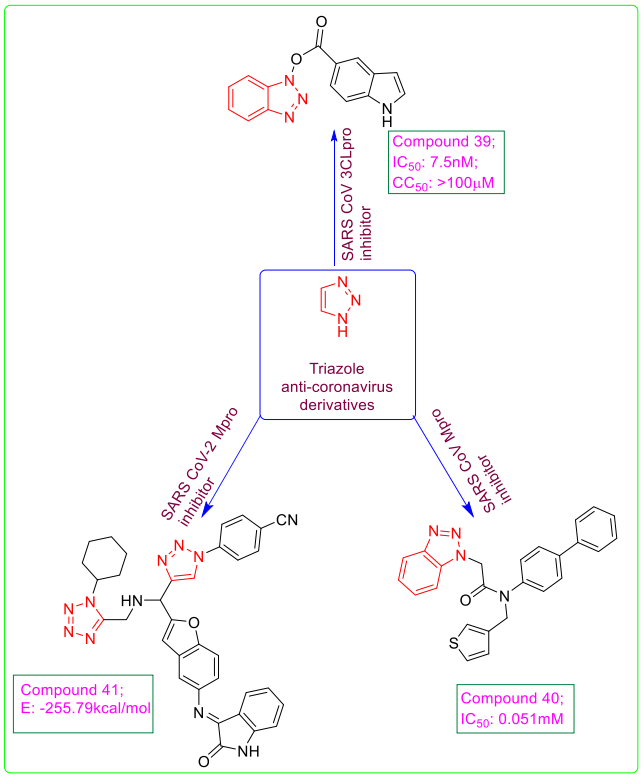

Fig. 7. Some active triazole anti-coronavirus derivatives.

activities against both nucleoside triphosphatases and helicases of SARS CoV. The compound **43** was found to be endowed with highest potential against both HCV (EC_{50}: 4 μM) and SARS CoV (IC_{50}: 4 μM for ATPase and 11 μM for helicase) with no cytotoxicity in HS27 (human normal fibroblast) cells (CC_{50} > 50 μM). According to structure activity relationship study, 3-iodo- or chloro-substituted benzyloxy moiety on 5-hydroxy chromone scaffold played a major role whereas derivatives with substitution at position 4 of benzyloxy ring displayed lower inhibition potential [60]. As nitric oxide (NO) derivatives have shown good antiviral effect against SARS CoV, hence phenyl furoxan derivatives, as NO donors, were evaluated by *in silico* approaches to test their potency against SARS CoV. The molecular docking analysis of some compounds with SARS CoVMpro (PDB: 6 W63) disclosed the best binding pose of compound **44** with binding affinity of −9.8 kcal/mol and dock score of −90.91. The docked conformation revealed hydrogen bond formation of **44** with Cys 145 and Ser 144 residues of the catalytic triad and also aromatic interactions involving His 41 and His 163. It was also concluded from docking results that spiroisoquinolino-piperidine substituted furoxan analogues exhibited better binding interactions compared to benzhydrylpiperazine substituted furoxan analogues. The molecular dynamic simulation demonstrated the stable complex formation between **44** and Mpro comparable to the co-crystalized ligand with ΔG value of −171.972 kj/mol [61]. A series of oxazine conjugate 9-anilinoacridine derivatives was designed using molecular docking approach of Schrodinger suite 2019. All the docked ligands represented favourable conformation within the active site of SARS CoV-2 Mpro (PDB: 5R82) while compound **45** exhibited the highest binding affinity with a Glide score of −7.829 greater than the standard hydroxychloroquine (Glide score: −5.47) which could be attributed to enhanced lipophilicity and hydrogen bonding of the ligand. The —OH group of phenyl ring was found to be involved in H-bond formation with Asn 119 residue of Mpro. The determination of ADMET properties of all the designed ligands were within the acceptable values. The molecular dynamic simulation study depicted a stabilized complex formation of A38-5R82, with —OCH_3 group of **45** forming a hydrogen bond with Asn 119 while N of acridine hydrogen bonded with Arg 188 and Ser 144 and acridine moiety also showed π-π interaction with His 41 [62]. With the help of computational methods, the CAS COVID-19 antiviral compound database was screened for nearly 50,000 compounds to examine their potencies against SARS CoV-2 Mpro and RdRp. The compounds were virtually screened by docking analysis using the crystal structures of main protease (PDB: 6LU7) and RdRp (PDB: 6LM7) proteins, by SMINA software. The selected hits were further analysed for their pharmacokinetic and pharmacodynamic parameters using pkCSM model. The best possible compounds were subjected to molecular dynamic simulation for stabilization of the complexes with the proteins via GROMACS 2018 program and compounds **46** (Binding affinity: −9.064 kcal/mol) and **47** (Binding affinity 8.816 kcal/mol) showed best binding poses and good ADMET against Mpro and RdRp, respectively. The compound **46** was stabilized well in the active site of Mpro forming hydrogen bonds with Gly 143, Ser 144 and Cys 145 while the morpholine moiety and 1,3,5-triazine group were involved in hydrophobic interactions with His 41 and Met 49 of catalytic dyad. The compound **47** also showed stable conformation within RdRp active site involving hydrogen bonds with Arg 553, Tyr 619 and Ser 682. There was formation of stable complexes **46** with 6LU7 and **47** with 6MU7 as per MD simulation studies [63]. Miscellaneous compounds are shown in Fig. 8.

10. Natural products

Natural products are being used as natural remedies for various ailments since time immemorial. Scientists have been actively involved in derivatization of these natural products to yield active compounds. A class of quinoid derivatives, tanshinones from *Salvia miltiorrhiza*, were evaluated for their antiviral potential against SARS CoV cystein proteases, 3CLpro and PLpro. The FRET based peptide cleavage assay results showed that compound **48**, a dihydrotanshinone I, was found to be endowed with highest competitive inhibition potential against both SARS CoVMpro (IC_{50}: 14.4 μM) and PLpro (IC_{50}: 4.9 μM) and a good inhibition of deubiquitination (IC_{50}: 1.2 μM). The structure activity relationship study revealed the presence of a naphthalene ring and a dihydrofuran moiety in tanshinone 1 analogues to be crucial for anti-SARS CoV activity [64]. Twelve geranylated flavonoids were isolated from *Paulownia tomentosa* fruit extract with the view to examine their anti-SARS CoV potential against PLpro. The FRET inhibition assay results demonstrated compound **49** possessing a 3,4-dihydro-2H-pyran

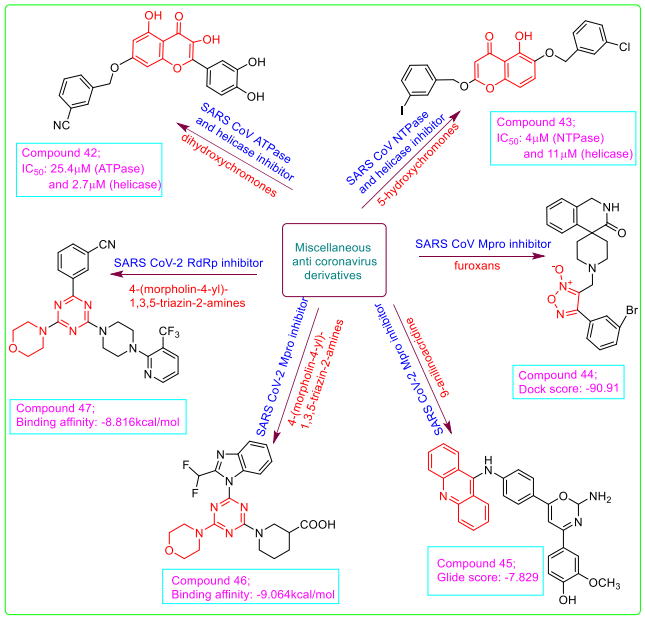

Fig. 8. Miscellaneous heterocyclic compounds with anti-coronavirus activity.

moiety, to be the most potent mixed type reversible inhibitor of SARS CoVPLpro exhibiting an IC_{50} value of 6.1 μM and K_i value of 3.5 μM [65]. Another library of 64 flavonoids was examined using FRET based inhibition assay and induced fit docking analysis, to determine the inhibitory potential of the target compounds against SARS CoV 3CLpro. Herbacetin **50**, a pentahydroxyflavone, showed good inhibitory activity with an IC_{50} value of 33.17 μM. It showed good inhibition even in the presence of 0.01% Triton X-100, which is used to avoid the false bioassay results owing to the aggregating tendency of flavonoids. The induced-fit docking analysis of compound **50** within the active site of SARS CoV 3CLpro (PDB: 4WY3) revealed its good binding interaction with a glide score of −9.263. The 8 —OH group of **50** formed hydrogen bonds with Glu 166 (S1 pocket) and Gln 189 (S2 pocket) which imparted additional binding affinity to **50** with the 4WY3 compared to other analogues, kaempferol and morin which lack the hydroxyl group at position 8 [66]. Some plant alkaloids and terpenoids of African origin were analysed by molecular docking studies, for their antiviral potential against SARS CoV-2 main protease (PDB: 6LU7). Among the alkaloids, 10-hydroxyusambarensine **(51)** an indole alkaloid from *Strychnos usambarensis* (Binding affinity: −10.0 kcal/mol) and among the terpenoids, compound 6-oxoisoiguesterin **(52)**, a bisnorterpene from *Bisnorterpenes* (Binding affinity: −9.1 kcal/mol) exhibited the highest binding potentials against SARS CoV-2 3CLpro even higher than the references taken, lopinavir (-8.3 kcal/mol) and ritonavir (−6.8 kcal/mol). There was hydrogen bond formation with Cys 145, Gln 166 and Gln 189 in **51** and in **52** with Thr 111 and Thr 292 leading to a favourable conformational fit within the active site of SARS CoV-2 Mpro. The ADMET study revealed good pharmacokinetics of both the ligands with a high gastrointestinal absorption index and no toxicity [67]. Fig. 9 highlights some natural products.

10.1. Authors' perspective

Based on the literature available, it was observed that some of the key enzymes of coronaviruses show high sequence similarity among themselves which can be exploited to target these coronaviruses by compounds with similar scaffolds and their bioisosteric analogues over a wide range. Therefore, keeping this in mind, this review gives an insight into the crucial role of heterocyclic moieties as anti-SARS CoV and anti-SARS Cov-2 agents. Isatin nucleus has shown tremendous effects against SARS CoV Mpro involving hydrogen bond formation by carbonyl and amine groups of isatin scaffold within the active site of protease as demonstrated by docking analysis [16]. 5-carboxamide and 5-sulfonamide analogues of isatin also revealed better inhibitory potential compared to 5-iodo analogues [17,18]. As hybrids of different heterocycles have often been used to increase potency, similarly, the pyrimidine fused indole derivatives demonstrated great potential against SARS CoVMpro [20]. Drugs like vapreotide, arbidol and delavirdine have also shown good inhibition activities against SARS CoV-2 helicase, spike and RdRp proteins, respectively [21–23]. Quinoline based heterocycles are in great demand with the researches on chloroquine and hydroxychloroquine as anti-SARS CoV-2 agents [33]. The quinolinone derivatives have also shown promise against SARS CoV Mpro, thus emphasizing the need to think of more such derivatives as anti-SARS CoV-2 agents [29]. The 5-chloropyridines like MAC-5576 and pyridine *N*-oxides also exhibited good inhibition of SARS CoVMpro [34,35]. Further, the docking analysis revealed a good fit of 4-indolecarboxylate fused 5-chloropyrine derivatives within the binding pocket of SARS CoV Mpro [37]. Therefore, 5-chloropyridine moiety proved to be effective against SARS CoVMpro and can be further exploited against SARS CoV-2 infections. Purine analogues, 6-mercaptopurine and 6-thioguanine demonstrated reversible competitive inhibition of SARS CoV PLpro through the formation of strong hydrogen bonds within the active site of protease [41]. The *in silico* analysis of pyrimidine based drugs, carmofur, zidovudine and AP-NP unleashed a potent inhibition of SARS CoV-2 Mpro, SARS CoV-2 nucleocapsid RNA binding domain and SARS CoV-2 spike-ACE-2 complex, respectively, thus providing an insight into the need for greater research on purine and pyrimidine analogues as SARS CoV-2 inhibitors [43–45]. The pyrazole and 5-pyrazolone derivatives underwent a favourable conformation within the active site of SARS CoV 3CLpro through hydrogen bonds and hydrophobic interactions with S1, S1′, S2 and S3 pockets of the protease, emphasizing on a crucial role of this moiety as SARS CoV inhibitory agent [46–48]. This review discloses a mild to moderate SARS CoV inhibitory potential of pyrazoline conjugated 4-thiazolidinones while 5-benzylidene-4-oxo-1,3-thiazolidine derivatives demonstrated good binding affinity with SARS CoV Mpro [havrylyuk; shen], thus asserting on a need for developing better 4-thiazolidinone derivatives as inhibitors of SARs coronaviruses. Some triazole derivatives also revealed potent inhibition of SARS CoV as indicated by docking analysis with SARS CoV Mpro active site [36]. Heterocyclic compounds of natural origin also play a crucial role in inhibiting the SARS CoV and SARS CoV-2 infections as depicted in this review [64–67].

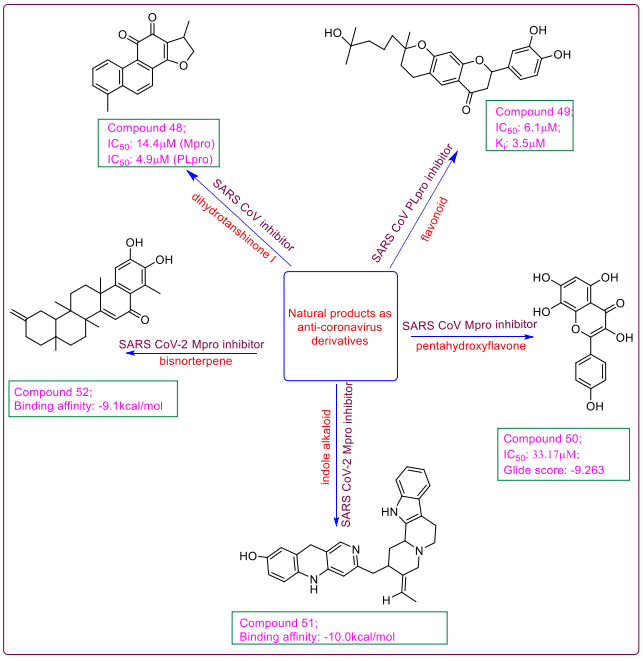

Fig. 9. Natural products as SARS CoV/CoV2 inhibitors.

11. Conclusion

With the emergence of SARS CoV-2 pandemic there is an urgent need for designing and developing safe, low-cost and potent anti-SARS CoV-2 agents and therapies with the aim to put an end to this global health crisis as early as possible. At present, a number of pharmaceutical industries and research centres throughout the world are working persistently to find a solution to the current pandemic situation. Some drugs are being repurposed based on their current therapeutic application while some are undergoing clinical trials to investigate their safety, efficacy and toxicity against SARs CoV-2 infections. Much focus has been given on pharmacotherapy, immunotherapy and plasma therapy as a means to combat SARS CoV-2 and other such life-threatening infections at present and in future. However, there is no vaccine or medication approved by FDA till date. Therefore, keeping in view the immense role of heterocyclic compounds as antiviral agents specially against coronaviruses, the better knowledge and understanding of the mechanism of heterocyclic scaffolds as anti-SARS CoV, anti-MERS CoV and anti-SARS CoV-2 agents may led to the discovery of an effective antiviral treatment thus minimizing the morbidity and mortality. As SARS CoV-2 show 82% sequence similarity with SARS CoV genome and also many target

enzymes in SARS CoV, MERS CoV and SARS CoV-2 also show similarity, therefore, many existing approved drugs and compounds revealing inhibitory potential against SARs CoV or MERS CoV can be exploited to analyse their potential against SARS CoV-2 pandemic. This review focuses on FDA approved or unapproved heterocyclic compounds involved in inhibiting SARS coronaviruses through *in vitro* or *in silico* approaches which may act as lead structures for the design and development of potent SARS CoV-2 inhibitors and other such pathogenic infections in future.

Consent for publication

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Review Article

Molnupiravir – A prospective silver bullet to mitigate severe acute respiratory syndrome corona virus-2

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ABSTRACT

The whole world is eagerly waiting for the unearthing of the best treatment strategy to put an end to the prevailing coronavirus disease-2019 pandemic. The pathogen responsible for this disease, that is, severe acute respiratory syndrome coronavirus-2 (SARS CoV-2) continues to be the most challenging issue that has kept the researchers and innovators all over the world in a dilemma of resolving it through finding the most efficacious, safe, and cost-effective therapy. A large number of drugs are under investigation as a part of drug repurposing approach for the treatment of SARS-CoV-2. One such drug, molnupiravir, is under Phase II/III clinical trials against SARS-CoV-2. Through this work, the authors will give an insight into the various aspects of molnupiravir as an antiviral agent including chemistry, pharmacokinetics, synthetic route, *in vitro, in vivo* studies, clinical trials, and probable mode of antiviral action of molnupiravir against SARS-CoV-2. The molecular docking approach has also been used to evaluate the binding interactions of the active form of molnupiravir, N-4-hydroxycytidine, with the RNA-dependent RNA polymerase of SARS-CoV-2 which emphasized on its good binding potential with the active site residues displaying a binding energy of −6.4 kcal per mol.

Keywords: Molnupiravir, severe acute respiratory syndrome coronavirus-2, clinical trials, docking studies

INTRODUCTION

Coronaviruses (CoV), a group of RNA viruses belonging to the family, Coronaviridae, are positive-sense single-strand RNA viruses having the potential to cause mild to fatal respiratory tract infections in mammals and birds.[1] The outbreak of CoV began with severe acute respiratory syndrome coronavirus-2 (SARS CoV) in 2002 in China spreading from civet cats to humans which was later observed in the form of Middle-East respiratory syndrome coronavirus (MERS CoV) in the year 2012, in Saudi Arabia, transmitting from dromedary cats to humans. Most recently emerged are the cluster of cases having symptoms like pneumonia in the Wuhan city of China, in December 2019 which was later named by the World Health Organization as coronavirus disease 2019 (COVID-19) and declared as pandemic in March 2020.[2] The CoVs comprise structural (spike, envelope, membrane, and nucleocapsid) and non-structural proteins (nsp) (main protease, RNA-dependent RNA polymerase [RdRp] [nsp 12], helicase, papain-like protease, N-terminal exoribonuclease, nsp 10, nsp 14, nsp 15, and nsp 16).[3] The SARS-CoV-2 exhibits approximately 80% sequence similarity with other bat CoVs.[4] It is more pathogenic than the other CoVs due to the presence of a unique polybasic cleavage site and has higher transmissibility due to the 10–20 times greater binding of SARS-CoV-2 with angiotensin-converting enzyme-2 (ACE-2) receptor compared to SARS-CoV with ACE-2.[5,6]

The SARS-CoV-2 releases its nucleocapsid into the patient's cells after attacking the host's lower respiratory tract, leading to viral replication responsible for the emanation of pneumonia-like symptoms.[7] In critical cases, SARS-CoV-2 infection can lead to multiple organ damage adversely affecting the heart, liver, lungs, kidney, gastrointestinal system, and central nervous system. The membrane protein has a role in virus humoral response together with neutralizing developed antibodies while spike protein assists the viral entry into host cellular machinery using host ACE-2 receptor. Transmembrane protease, serine 2 (TMPRSS2),

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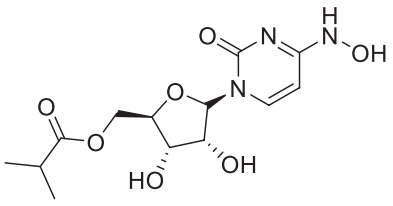
a transmembrane serine protease, cleaves the spike protein into S1 and S2 domain leading to its activation and viral entry into the host cell. The entry is followed by translocation which occurs through endocytic and non-endocytic pathways. Once the virus enters the host cell endosomes, the viral envelope protein supports the viral genome release into host cell as single-stranded positive RNA which further moves to transcription and translation processes using host cell machinery.

RdRp plays an important role in viral transcription and replication and has proved to be a crucial target in many antiviral therapies like remdesivir. RdRp shows high sequence similarity among the three CoVs while it is not expressed by the host cells, therefore, drugs targeting RdRp or RdRp inhibitors used against SARS-CoV and MERS-CoV can also be repurposed against SARS-CoV-2 with high potency and selectivity to viral entry.[2,8,9] RdRp catalyzes viral RNA genome synthesis using *de novo* (primer dependent) or primer independent molecular mechanisms. The *de novo* RNA synthesis involves the phosphodiester bond formation between 3'-hydroxyl end of one nucleotide and the 5'-phosphate moiety from next nucleotide. While in primer dependent mechanism, an oligonucleotide or a protein primer acts as a template for the development of a new complimentary RNA, through base pairing.[9]

Molnupiravir (MK-4482 and EIDD-2801) is an orally bioavailable 5'-isopropylester prodrug of β-D-N-hydroxycytidine (EIDD-1931, or N-hydroxycytidine, NHC), a ribonucleoside analog with potent anti-influenza activity. Molnupiravir was originally developed by Drug Innovation Ventures at Emory, a drug innovation company of Emory University, as an inhibitor of influenza viral replication. Later, the drug was acquired by Ridgeback Biotherapeutics which collaborated with Merck to develop it further.[10,11] Afterward, the drug was tested for its activity against SARS-CoV and MERS-CoV also. In March 2020, molnupiravir was found to be active against SARS-CoV-2 and thereafter it underwent randomized, double-blind, placebo-controlled, first-in-human study, in the US and UK, to test its safety, tolerability, and pharmacokinetics in healthy volunteers. In October 2020, a phase II/III randomized, placebo-controlled, double-blind clinical study of the drug was started by Merck on hospitalized patients to test its efficacy, safety, and pharmacokinetics.[12,13] Molnupiravir was found to be effective when given orally in SARS-CoV-2-infected ferrets blocking the viral transmission in them.[14]



Drug Name: Molnupiravir (MK-4482 and EIDD-2801)
IUPAC: ((2R,3S,4R,5R)-3,4-dihydroxy-5-(4-(hydroxyimino)-2-oxo-3,4-dihydropyrimidin-1(2H)-yl)tetrahydrofuran-2-yl)methyl isobutyrate
Formula: $C_{13}H_{19}N_3O_7$
Molecular mass: 329.31g/mol
Category: Antiviral, a ribonucleoside analogue inhibitor of RNA virus

PATHOPHYSIOLOGY

SARS-CoV-2 is a β-coronavirus showing genomic similarity of nearly 80% with SARS-CoV-1 and 96.2% with bat coronavirus $RaTG_{13}$ suggesting bats as the main source of its transmission.[15] It is a pleomorphic virus having a diameter of ~125 nm and the RNA genome of 30 kb(+) together with up to 10 open reading frames (ORFs). As per global initiative on sharing all influenza data database, three SARS-CoV-2 clades are identified as (a) G clade (spike S protein variant, D614G), (b) V clade (ORF3 variant, G251V), and (c) S clade (ORF8 variant, L84S). In India, A2a clade, S protein variant, D614G, was found to be the most prominent clade (48.6%). These clades show divergence in virulence thus affecting the effectiveness of repurposed drugs or of future vaccines and biologicals.[8,16,17]

SARS-CoV-2 viral infection is mostly found to be transmitted from person to person through respiratory droplets and aerosols through coughing and sneezing. The nasopharyngeal swab and feces have shown presence of the virus, and therefore, fecal-oral route transmission can also be a possibility.[18] It can also involve contact transmission that is by talking to the infected person or by inhaling the exhaled gas from infected person within a distance of about 6 feet and indirect transmission by coming in contact with contaminated droplets from mouth, nose, and eyes settled on different surfaces.[16]

The SARS-CoV-2 infection begins with the entry of virus into host cells by the attachment of its spike protein with the host cell's ACE-2 cell surface receptor on alveolar epithelial type II (AT 2) cells in respiratory tract. The S protein comprises S1 (N-terminal domain) and S2 (C-terminal domain) domains. The S1 domain is responsible for receptor binding and is also termed as receptor binding domain. SD1 and SD2 are the two subdomains of S1 domain and allow the conformational changes in S2 domain on binding to the receptor.[8] The life cycle of virus in host is believed to involve these major stages: Spike protein fusion with host ACE-2 receptor (attachment), spike protein cleavage by TMPRSS2 (activation), membrane fusion or endocytosis of virus by host cells (penetration), viral ssRNA entry into the host cell nucleus and synthesis of viral proteins by viral mRNA (biosynthesis), and maturation and release of new viral particles (maturation).[8,19]

TMPRSS2, a transmembrane serine protease (type II), cleaves the spike protein into S1 and S2 domains, thus making it possible for S1 domain to interact with host ACE-2 for entry into the host cells. After entering the host cells, the ss(+) RNA undergoes replication using viral RdRp forming complimentary ss(−) RNA which further leads to the formation of new positive mRNA strands suitable for synthesis of new viral proteins in host cells. The translation of viral genome leads to the formation of viral polyproteins which are cleaved by viral main protease and papain like proteases into effector proteins. The binding of nucleocapsid protein to positive strand RNA forms a nucleoprotein complex while the spike, envelope, and membrane proteins move to the endoplasmic reticulum. Thus, the virion assembly gets completed in Golgi apparatus and is now ready for its release from infected cells through exocytosis, as depicted in Figure 1. The viral main protease and papain-like protease have the ability to deubiquitinase NFkB and interferon factor 3 in host

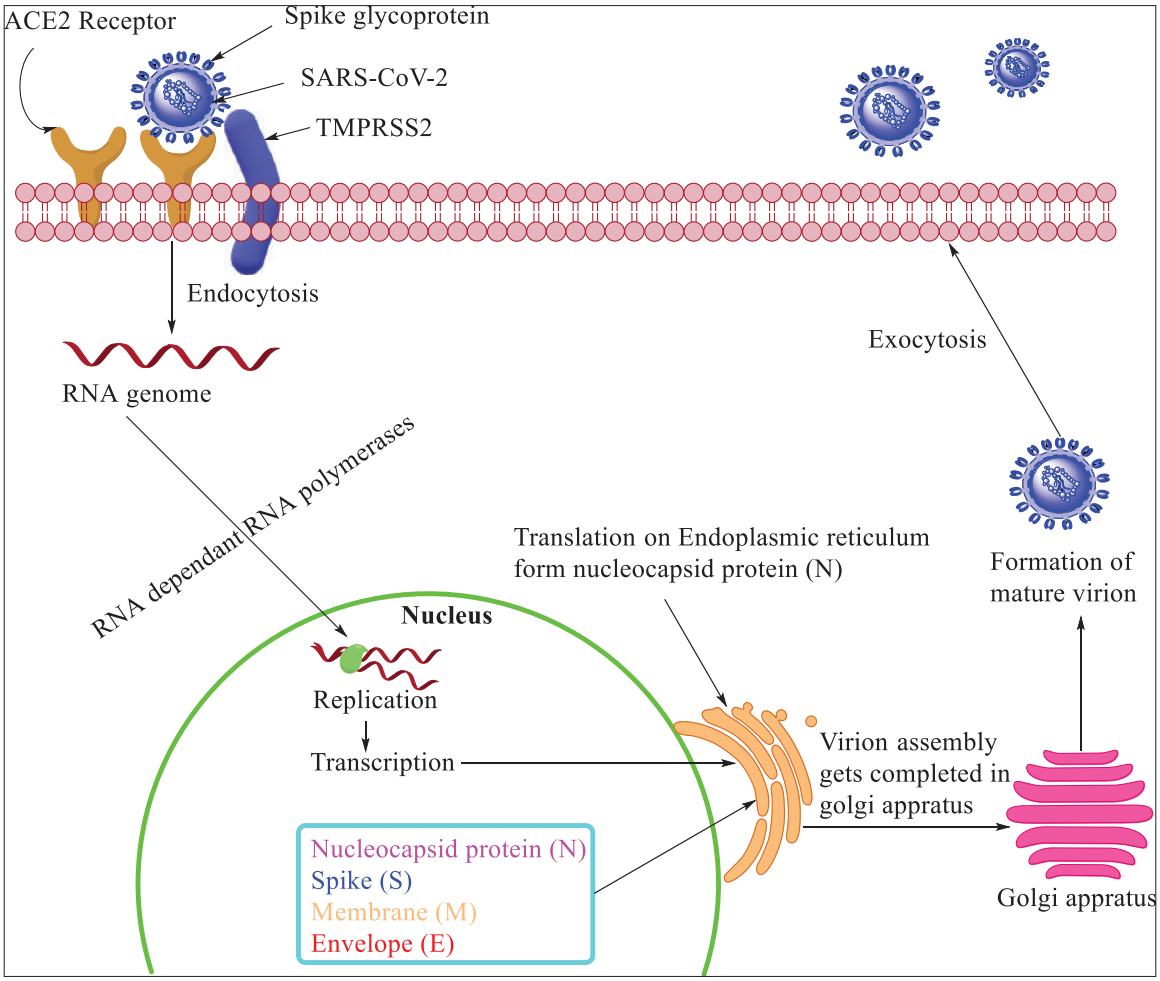


Figure 1: Pathophysiology of severe acute respivirus-2

cells, thus suppressing the host innate immunity.[2,8,16,20,21] Both lung inflammation and immune deficiency are the two interconnected processes involved in SARS-CoV-2 pathogenesis. ACE-2 is a metalloproteinase which is expressed in organs such as lungs, CNS, cardiovascular system, kidneys, gastrointestinal tract, and adipose tissues. The whole viral life cycle in the host cells leads to the release of cytokines and inflammatory markers such as interleukins, interferons, TNF-α, macrophage inflammatory protein 1α, monocyte chemoattractant protein-1, and chemokines like CXCL10 which results into vasodilation and an increase in capillary permeability. The "cytokine storm" causes the recruitment of CD4+ helper T cells, neutrophils, and CD8 cytotoxic T cells which results in further lung inflammation and injury. The resultant apoptosis of the host cells leads to new viral particle release and infection of surrounding type II alveolar epithelial cells, ultimately resulting in acute respiratory distress syndrome.[21,22]

MECHANISM OF ACTION

Molnupiravir is a prodrug of N-4-hydroxycytidine, therefore *in vivo,* it gets hydrolyzed to its active form which exists in two tautomeric forms: A cytidine mimic (pairs with guanosine) and a uridine mimic (pairs with adenosine) form. In the process of viral RNA replication using RdRp, switching between these two mimic forms led to mismatches causing catastrophic mutations in the newly generated viral RNA transcripts thus rendering them non-functional, as shown in Figure 2.[10,22]

METABOLISM

Molnupiravir gets hydrolyzed to β-D-N^4-hydroxycytidine (NHC, EIDD-1931) in host cells which further gets phosphorylated to its active 5'-triphosphate form in tissues as depicted in Figure 3.[10]

SYNTHETIC STRATEGY

Molnupiravir shows structural similarity with antiviral drug, remdesivir but both the drugs block RdRp in a different way and therefore can act complimentarily. Molnupiravir is an orally active drug and therefore can have an advantage of increased patient compliance in SARS-CoV-2 patients over remdesivir which is administered intravenously.

Molnupiravir was first developed by Emory University researchers through a five-step synthesis route using uridine as the precursor. In this patented route, initially, the protection of acetonide

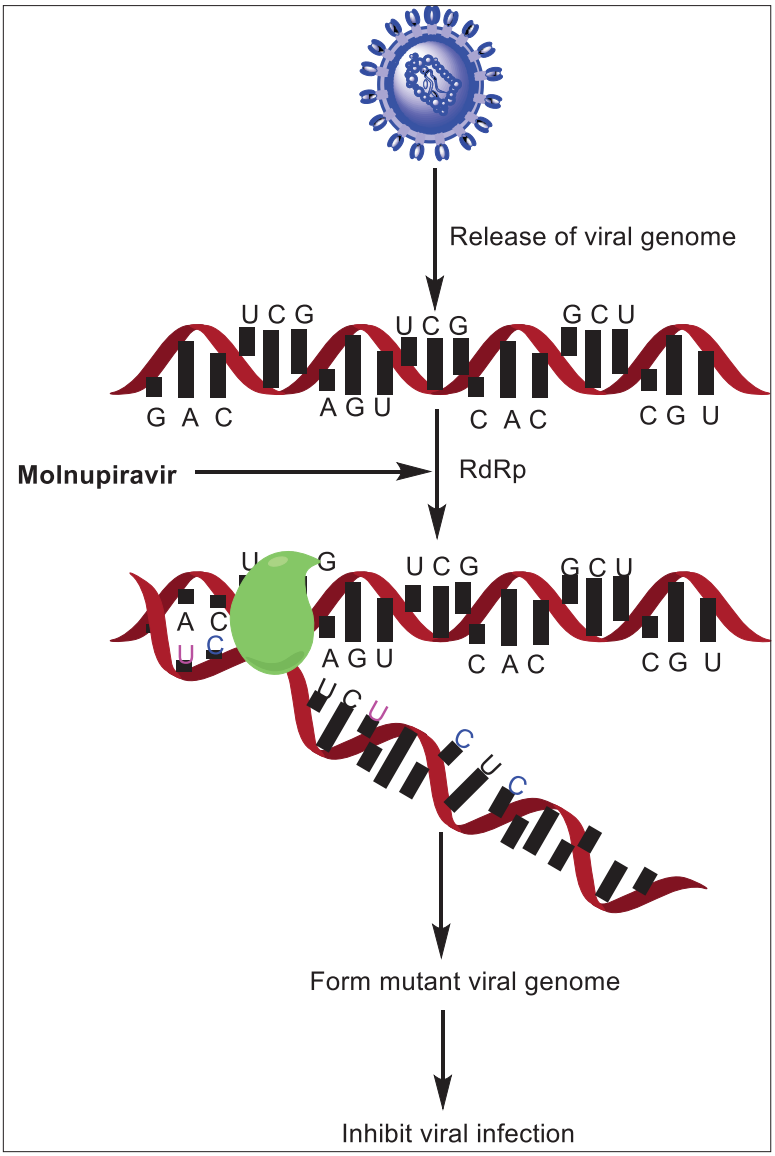


Figure 2: Mechanism of molnupiravir: U=Uridine, C=Cytidine

is done followed by selective esterification of the 5'-hydroxy group. Further, the activation of the molecule is performed by introduction of 1,2,4-triazole nucleus which gets replaced by hydroxylamine. This is followed by deprotection of the acetonide group yielding the final product, molnupiravir. This synthetic strategy has a disadvantage of very low yield at triazole coupling step (29%) [Scheme 1]. With an aim to improve the synthetic yield, a modification of the patented scheme was done. In this method, the triazole coupling was carried out in the first step using Et_3N as base, thus increasing the yield of this step from 29% to 88%. In the second step, the acetonide ester was obtained by stirring the triazole derivative with DMP and sulfuric acid in MeCN for 30 min. This was followed by conversion of acetonide ester to hydroxylamine by stirring it with hydroxylamine and iPrOH at room temperature. Finally, the deprotection of acetonide group was obtained by reaction with sulfuric acid and iPrOH as solvent at 60°C for 30 min resulting in the formation of title compound with 80% yield [Scheme 2].[23]

IN VITRO AND *IN VIVO* STUDY OF MOLNUPIRAVIR

Urakova *et al.* evaluated the role of NHC, a nucleoside analogue, as an anti-VEEV (Venezuelan equine encephalitis virus) agent. In the plaque assay, NHC revealed a strong anti-viral action in VEEV treated Vero cells, when applied before, at the time of or 4 h post infection (p.i.) at 1–2 μM concentration with an EC_{50} value of 1 μM. It was observed that NHC acts by inducing mutations in viral G RNA rendering them incapable of replication that is by causing viral lethal mutagenesis. The mutations acquired were mostly transition mutations like U-to-C or C-to-U transitions generated at the time of positive-strand RNA synthesis and A-to-G and G-to-A transitions occurring as a result of incorporation of NHC in negative-strand RNA.[24]

Due to the low oral bioavailability of NHC in cynomolgus macaques, a 5'-isopropyl ester of NHC, EIDD-2801, was synthesized with the aim to improve its oral bioavailability. EIDD-2801 showed similar

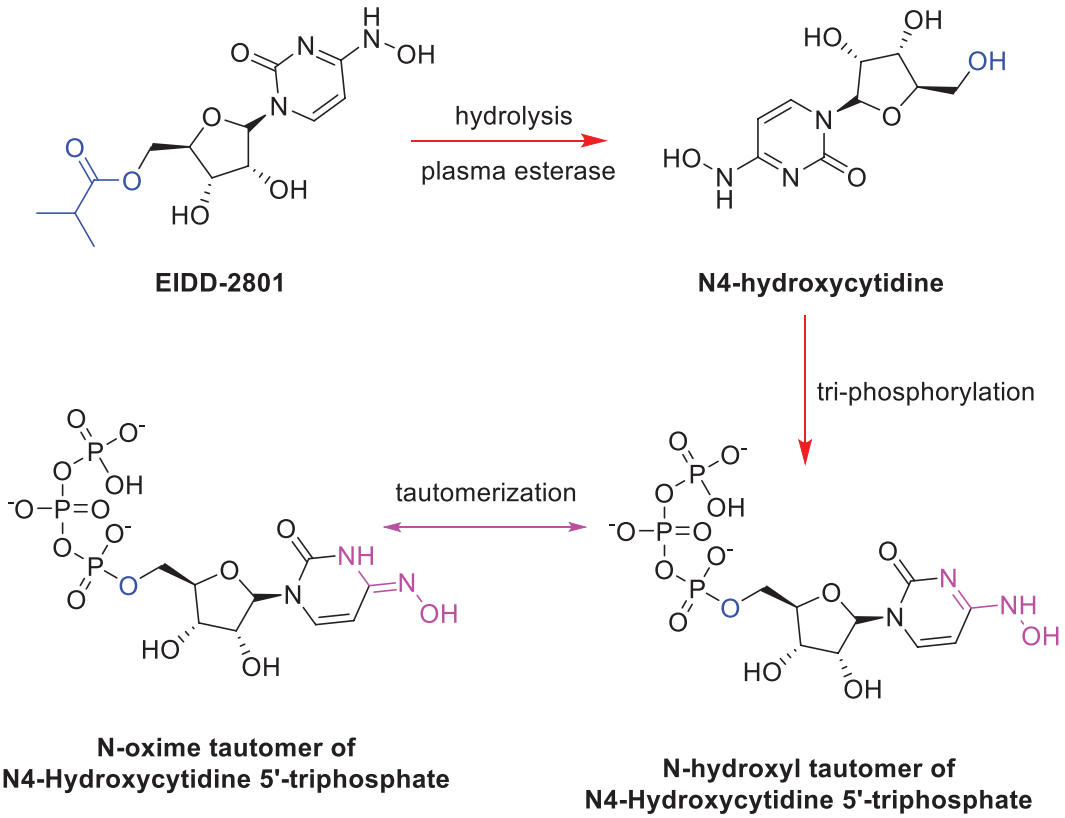
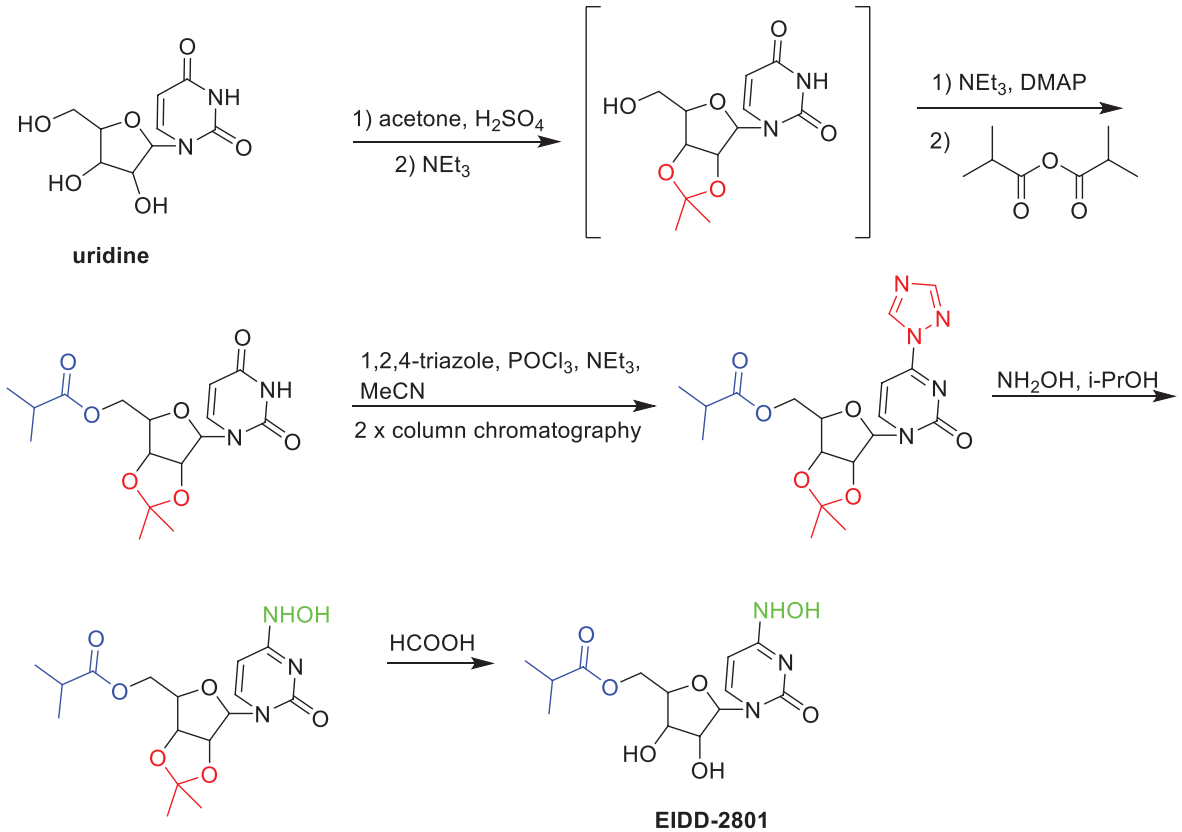
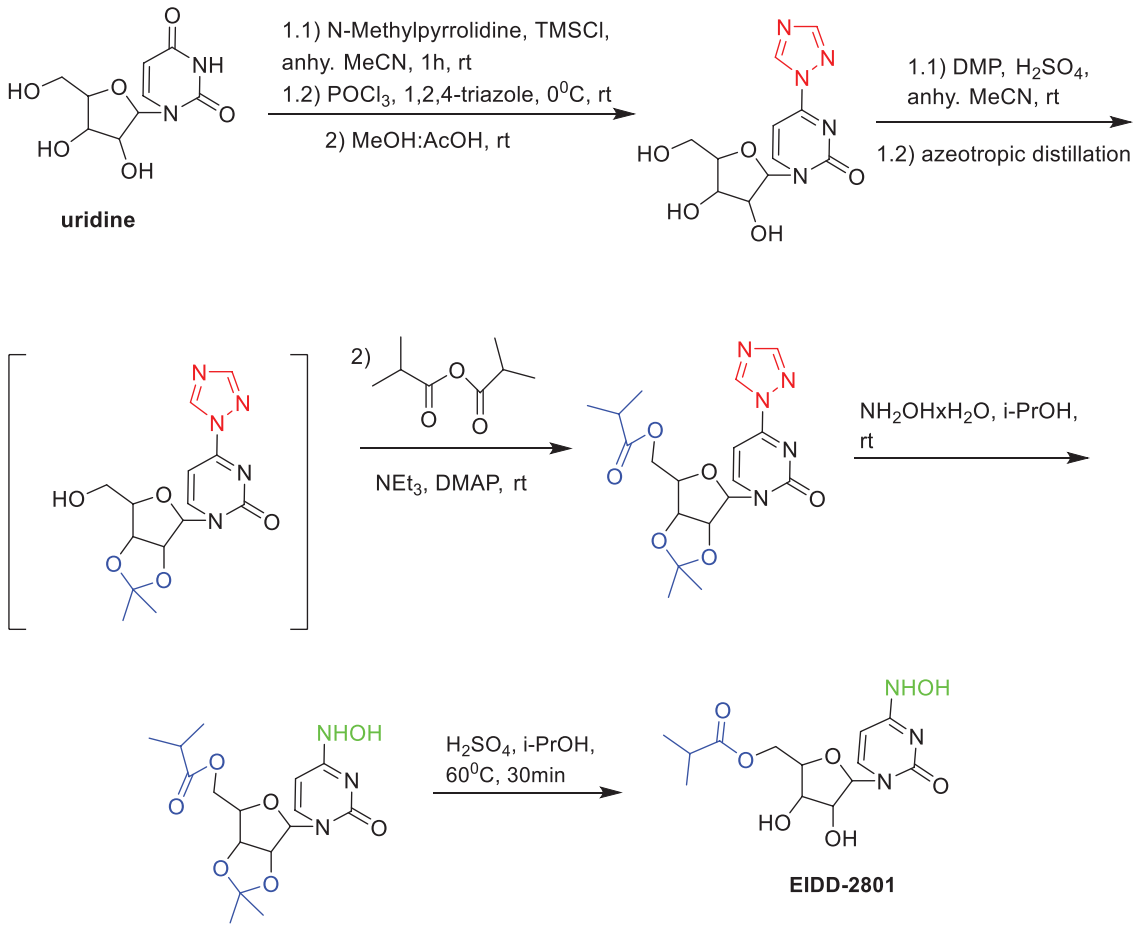


Figure 3: Metabolism of molnupiravir



Scheme 1: Patented route for synthesis of EIDD-2801



Scheme 2: New route for synthesis of EIDD-2801

bioavailability in mice as that of NHC but an improved bioavailability in nonhuman-primates and ferrets. It was observed that EIDD-2801 was hydrolyzed to NHC *in vivo*. A decrease in group pandemic 1 and group 2 seasonal influenza A shed virus load, inflammation, fever, and airway epithelium histopathology was observed in influenza virus infected ferrets, on oral therapeutic administration of EIDD-2801. Further, whole genome deep sequencing analysis revealed lethal mutagenesis as the mechanism involved in NHC influenza virus inhibition together with high barrier to viral resistance. Antiviral activity analysis in human airway epithelia (HAE) model revealed a CC_{50} value of 137 μM and a high therapeutic window of >1713 of NHC against different strains of influenza virus.[10]

Toots *et al*. conducted experiments in influenza infected ferret models to determine the quantitative efficacy parameters of EIDD-2801 like its minimum effective dose, latest onset of effective treatment together with the minimum doses required for maximum effect. The analysis results demonstrated 7 mg/kg of EIDD-2801 given by oral route, as the lowest efficacious dose following a b.i.d dosing regimen. Furthermore, a 36 h time window was found to exist for the initiation of effective treatment p.i. in ferrets. The administration of 7 mg/kg dose of EIDD-2801 at intervals of 12 h was observed to be sufficient to achieve maximum therapeutic effect against pandemic influenza A virus.[11]

Sheahan *et al*. demonstrated the anti-viral mechanism and efficacy of NHC, an active form of prodrug EIDD-2801, against coronavirus strains in mouse models. NHC showed potent anti-viral activity in MERS-CoV-infected Calu-3 2B4 human lung epithelial cell lines with an IC_{50} value of 0.15 μM and a CC_{50} value of >10 μM while an IC_{50} value of 0.3 μM and a CC_{50} value of >10 μM in SARS-CoV-2 (2019-nCoV/USA-WA1/2020) infected Vero cells. Furthermore, the anti-SARS CoV-2 assay in Calu-3 cells suggested a dose-dependent decrease in viral titers and vial genomic RNA (IC_{50} 0.09 μM). Further, antiviral assay study in HAE cells demonstrated no cytotoxicity up to a dose of 100 μM of NHC while at the same time, a dose-dependent decrease in SARS-CoV-2 replication was also observed in SARS-CoV-2-infected HAE cells. Similarly, a reduction in viral titer and genomic (ORF1) and subgenomic (ORFN) RNA was revealed in MERS-CoV- and SARS-CoV-infected HAE cells with IC_{50} values of 0.024 μM and 0.14 μM, respectively. The virus titer reduction assay in DBT cells unleashed an increased sensitivity to inhibition by NHC in coronavirus bearing resistance mutations to antiviral drug, remdesivir. NHC also displayed lethal mutagenicity and error catastrophe induction in RdRp, in MERS-CoV-infected HAE cells with A-to-G and U-to-C transitions in RNA. The *in vivo* study of EIDD-2801, an orally bioavailable form of NHC, in SARS-CoV- and MERS-CoV-infected C57BL/6 mice revealed a significant decrease in weight loss, lung titer, and hemorrhage at a dose of 500 mg/kg, both prophylactically and therapeutically.[25]

Due to the fact that ferrets transmit the SARS-CoV-2 virus effectively with minimum clinical disease manifestations resembling the SARS-CoV-2 asymptomatic or mildly symptomatic transmission in young human population, Cox *et al.* explored the efficacy of EIDD-2801 in SARS-CoV-2-infected ferret models. The *in vivo* study involved administration of EIDD-2801 as oral gavage, at doses of 5 or 15 mg/kg b.i.d. 12 h p.i. or 15 mg/kg 36 h p.i. in ferrets (*Mustela putorius furo*) inoculated with 1×10^5 plaque-forming units of SARS-CoV-2 2019-nCoV/USA-WA1/2020 clinical isolate. The assay results unleashed the high potential of EIDD-2801, significantly decreasing the SARS-CoV-2 viral load in upper respiratory tract together with suppressing the transmission of infection to untreated contact animals.[14]

Abdelnabi *et al.* evaluated the anti-viral effect of EIDD-2801 in SARS-CoV-2-infected Syrian hamster model. The hamster models infected with 2×10^6 $TCID_{50}$ SARS-CoV-2 (BetaCov/Belgium/GHB-03021/2020 [EPI ISL 109 407976 | 2020-02-03]), were treated with 75 or 200 mg/kg b.i.d. of EIDD-2801 for 4 consecutive days. The assay results revealed a significant reduction in virus titers and RNA loads in lungs when given at 200 mg/kg twice a day with improved lung histopathology while a mild antiviral effect was observed on starting treatment 1 or 2 days p.i.[26]

MOLECULAR DOCKING

Enthused by the encouraging results from the literature, we performed the molecular docking using AutoDock Vina software to predict the best fit possible biological conformation of molnupiravir in the active site of a SARS-CoV-2 protein. The structure of SARS-CoV-2 (Protein Data Bank [PDB] ID: 6M71) with resolution 2.6Å was downloaded from the PDB. The protein was prepared using AutoDock 4.2.6. The two-dimensional (2D) structure of the active form of molnupiravir (NHC) was prepared using ChemDraw professional 16.0 software and converted to three-dimensional (3D) format by Chem3D Ultra 8.0. The energy of molnupiravir was minimized using Chem3D Ultra 8.0 and MOPAC then the pdbqt format of the active form of molnupiravir was prepared using PyMOL. The active form of molnupiravir was docked with active site of SARS-CoV-2 protein. A grid box was prepared with 30, 30, 30 centered (x, y, z) of (114.52, 114.11, 122.91) Å as reported.[27] Discovery studio visualizer was employed to view the docking results. The active form of molnupiravir displayed good binding energy of −6.4 and hydrogen bond interactions with five amino acids such as Tyr619, Asp760, Asp761, Trp800, and Glu811. The 2D and 3D binding patterns of the active form of molnupiravir are depicted in Figures 4 and 5.

CLINICAL TRIALS

The success of any new molecule depends on the promise shown by it in the clinical trials. A number of such trials involving this drug have been undertaken.

Phase I clinical trial (clinical trial identifier: NCT04392219)

First-in-human randomized, double-blind, placebo-controlled study was conducted in 130 healthy volunteers to evaluate the safety,

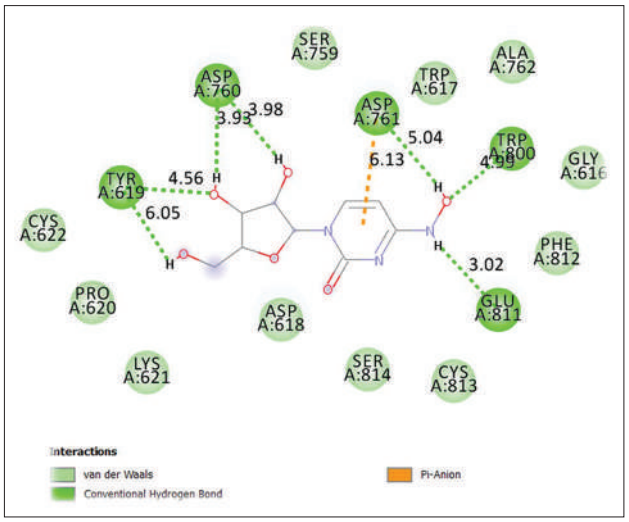


Figure 4: Two-dimensional interaction of target compound with severe acute respiratory syndrome coronavirus-2 protein (PDB ID: 6M71).

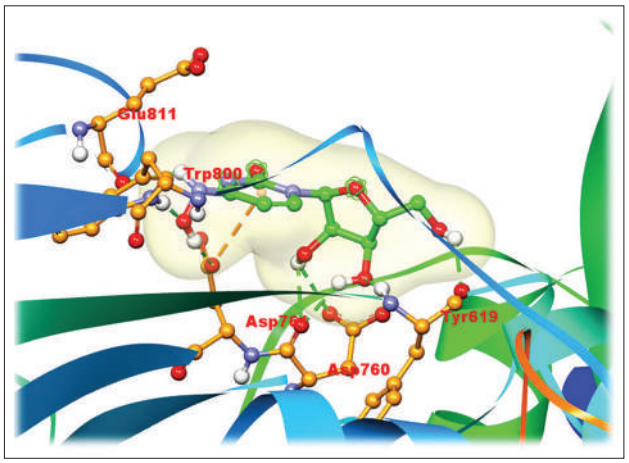


Figure 5: Three-dimensional interaction of target compound with severe acute respiratory syndrome coronavirus-2 protein (PDB ID: 6M71)

tolerability, and pharmacokinetics of orally administered EIDD-2801. For studying drug or placebo in single- and multiple-dose parts of the study, the randomization of eligible volunteers (age: 19–60 years; mean body mass index: 24.4–25.4 kg/m^2, mostly white, male) was done in a ratio of 3:1. For conducting the trial, each cohort comprising eight subjects was administered with 50–1600 mg single oral dose in single ascending dose part and 50–800 mg b.i.d. for 5.5 days in multiple ascending dose part. The study result displayed a high plasma concentration of EIDD-1931, the hydrolyzed form of prodrug EIDD-2801, possessing a median time of 1.00–1.75 h for maximum observed concentration. The Division of Microbiology and Infectious Diseases toxicity grading study demonstrated headache as the most frequent adverse event reported in 12.5% of molnupiravir administered subjects taking single ascending dose study and diarrhea in 7.1% of molnupiravir administered subjects taking multiple ascending dose study. In food-effect evaluation study also, only mild (grade 1) adverse event was observed. EIDD-2801 was found to be safe, well tolerated with no serious adverse effects. In case of single ascending doses, the administration of EIDD-2801 at doses between

Table 1: Clinical trials of molnupiravir for COVID-19

NCT number	Sponsor	Brief title	Phase	Reference
NCT04575584	Merck Sharp & Dohme Corp.	Efficacy and Safety of Molnupiravir (MK-4482) in Hospitalized Adult Participants With COVID-19 (MK-4482-001)	II/III	[29]
NCT04575597	Merck Sharp & Dohme Corp.	Efficacy and Safety of Molnupiravir (MK-4482) in Non-Hospitalized Adult Participants With COVID-19 (MK-4482-002)	II/III	[30]
NCT04405570	Ridgeback Biotherapeutics, LP	A Safety, Tolerability and Efficacy of Molnupiravir (EIDD-2801) to Eliminate Infectious Virus Detection in Persons With COVID-19	IIa	[31]
NCT04405739	Ridgeback Biotherapeutics, LP	The Safety of Molnupiravir (EIDD-2801) and Its Effect on Viral Shedding of SARS-CoV-2 (END-COVID)	IIa	[13]
NCT04392219	Ridgeback Biotherapeutics, LP	COVID-19 First in Human Study to Evaluate Safety, Tolerability, and Pharmacokinetics of EIDD-2801 in Healthy Volunteers	IIa	[12]

600 and 1600 mg gave mean C_{max} value of 13.2 ng/mL and median t_{max} value between 0.25 and 0.75 h. In multiple ascending dose study, a mean $t_{1/2}$ of 7.08 h was observed following 800 mg b.i.d of EIDD-2801. Therefore, molnupiravir displayed good tolerability, when administered in healthy volunteers, with dose-proportional pharmacokinetics. After the success of Phase I clinical trial, few Phase II/III trials also began, as shown in Table 1.[28]

CONCLUSION

COVID-19 pandemic has led to morbidities of millions of individuals till date. It is spreading worldwide with the emergence of different mutant strains. Several FDA approved drugs are under clinical trials against SARS-CoV-2 infection. Molnupiravir is one such drug which has been approved by FDA for influenza and is now under Phase II/III trials for SARS-CoV-2. Molnupiravir exerts its antiviral action by causing catastrophic mutations during viral RNA replication using RdRp. The Phase I trial of molnupiravir has proved it to be safe in healthy human volunteers. The pharmacokinetic profile of molnupiravir is equally encouraging. This article has reviewed its chemistry, pharmacology, and the progress through various clinical trials. We have carried out the molecular docking analysis of this drug with RdRp protein of SARS-CoV-2 where the drug demonstrated a high binding affinity involving hydrogen bond interactions with the active site residues. Therefore, our work substantiates the literature claims on the high potential of molnupiravir as an anti-viral agent against SARS-CoV-2 and other such CoV.

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The Role of 4-Thiazolidinone Scaffold in Targeting Variable Biomarkers and Pathways Involving Cancer

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Affiliations
PMID: 34229596 DOI: 10.2174/1871520621666210706104227

Abstract

Background: Cancer can be considered as a genetic as well as a metabolic disorder. The current cancer treatment scenario looks like aggravating tumor cell metabolism, causing the disease to progress even with greater intensity. The cancer therapy is restricted to the limitations of poor patient compliance due to toxicities to normal tissues and multi-drug resistance development. There is an emerging need for cancer therapy to be more focused towards better understanding of genetic, epigenetic and transcriptional changes resulting in cancer progression and their relationship with treatment sensitivity.

Objective: The 4-thiazolidinone nucleus possesses marked anticancer potential towards different biotargets, thus targeting different cancer types like breast, prostate, lung, colorectal and colon cancers, renal cell adenocarcinomas and gliomas. Therefore, conjugating the 4-thiazolidinone scaffold with other promising moieties or directing the therapy towards targeted drug delivery systems like the use of nanocarrier systems, can provide the gateway for optimizing the anticancer efficiency and minimizing the adverse effects and drug resistance development, thus providing stimulus for personalized pharmacotherapy.

Methods: An exhaustive literature survey has been done to give an insight into the anticancer potential of the 4- thiazolidinone nucleus either alone or in conjugation with other active moieties, with the mechanisms involved in preventing proliferation and metastasis of cancer covering a vast range of publications of repute.

Conclusion: This review aims to summarise the work reported on anticancer activity of 4-thiazolidinone derivatives covering various cancer biomarkers and pathways involved, citing the data from the year 2005 till now, which may be beneficial to the researchers for future development of more efficient 4-thiazolidinone derivatives.

Keywords: 4-Thiazolidinone; biotargets; cancer; cytotoxicity; genetic; transcriptional.

Related information

MedGen
PubChem Compound (MeSH Keyword)

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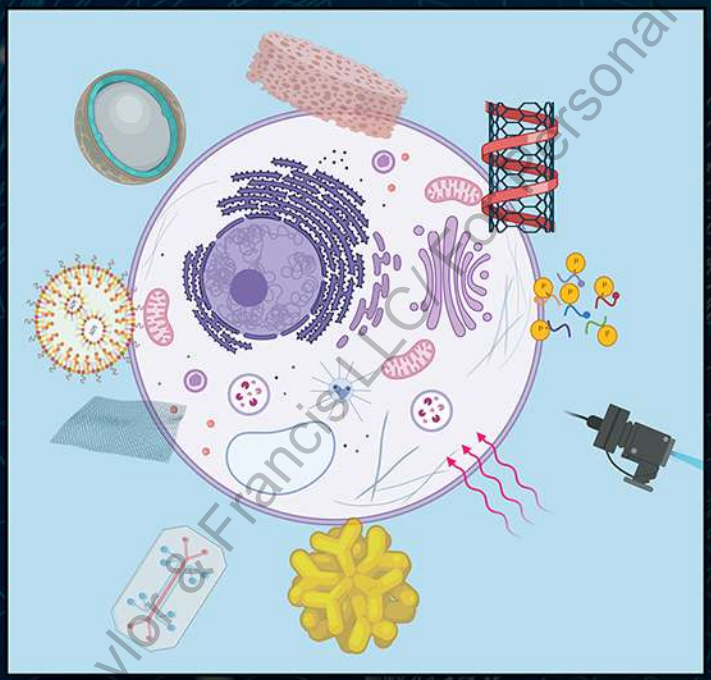
NANOPHARMACEUTICALS IN REGENERATIVE MEDICINE



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Edited by
Harishkumar Madhyastha and
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Contents

Foreword

Nanopharmaceutics is a branch of nanobiotechnology with vast applications in diagnostics, regenerative medicine, and drug development in current science of medicine. Within a short span of two decades, the subject has expanded into a promising arena for clinical and translational medicine. The biomedical scientists show immense interest in nanomaterials due to their extraordinary surface to volume area, tunable optical emission, unique electrical, and magnetic behaviour, which particularly helps in drug discovery research. The hybridisation of nanotechnology and tissue regeneration will open a new path of innovation and will have potential application to treat incurable diseases. The book '*Nanopharmaceuticals in regenerative medicine'* is an informative compilation of nanomedicine, combining description of pharmaceutical formulations and their mechanisms of action. The book provides the comprehensive bundle of information and accurate scientific information on nanopharmaceutical use in regenerative medicine and would be epochal to the scientific community, especially clinicians and pharmacists.

I applaud the editors, Dr. Harishkumar Madhyastha who has been my colleague for many years at University of Miyazaki and Smt. Durgesh Nandini Chauhan for the excellent compilation of chapters contributed by well-known scientists and academicians from different countries. All 18 chapters are different from each other in content, but share a single objective of nanopharmaceutical advancement. The most notable chapters include therapeutic applications, technological innovations, and tissue regeneration. The authors successfully navigate the chapter contents with updated literature. I believe '*Nanopharmaceuticals in regenerative medicine'* will remain a valuable resource for years to come.

Prof. Dr. Tsuyomu Ikenoue, MD. Ph.D.
President
University of Miyazaki
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Preface

Trajectory of scientific thoughts is propelling rapidly through good research communications. Research ideas will be broadcasted through good publications which are mainly dispersed by review manuscripts, book chapters, etc. A comprehensive scientific dissertation serves as a satellite stop reference book for budding academicians, scientists, professionals, and technologists. With extensive and annotated knowledge and information, the book is a gateway for knowledge dispersion and escalation, community curation, and finally betterment of society. With the advancement of scientific knowledge, a new paradigm of science, nanobiotechnology, is emerging in the area of biomedical science and regenerative medicine. In regenerative medicine arena, nanotechnologies have wide and high-impact benefits like drug development, diagnostics, and delivery system. This book provides an in-depth knowledge on applied nanobiomedical contents for university graduates, researchers, and technocrats with striking balance between fundamentals and applications for regenerative medicine. The book contains 18 chapters covering a wide range of topics related to chemistry, pharmacy, and material science. The chapters are broadly classified into three categories; potential insights into smart technologies, interpretations of different modes as delivery systems, and tissue engineering and generation aspects. Each chapter includes multidisciplinary approaches and recommendations to use the nanotechnologies for tissue regeneration with meaningful conclusions and attracts new ideas for future development. Chapters 1–5 emphasize the applications of nanoparticles in regenerative therapy. Chapters 6–12 focus on different technological approaches devoted to tissue recalcitrant engineering. Chapters 13–18 elucidate the updates on nanomaterials in the field of tissue regeneration, with special focus on osteoporosis, cancer, and cardiology with a pharmaceutical angle.

Date: 16 April 2021

Dr. Harishkumar Madhyastha

Durgesh Nandini Chauhan

Editors

Dr. Harishkumar Madhyastha Ph.D., FBRSI. Harishkumar Madhyastha, faculty at Department of Applied Physiology University of Miyazaki, Miyazaki, Japan. With two Ph.D. degrees, he ignited his research career as a scientist in *Spirulina* biotechnology at MCRC-Chennai. Later on, he pursued postdoctoral research at Miyazaki University that culminated in a faculty position in the Department of Applied Physiology at the University of Miyazaki from 2006. His current research interests include generation and delivery of nanosized metallic payloads for regenerative diseases application. His academic credentials are credited with more than 80 *Sci-E* indexed papers; *h*-value of *29*, clarivate analytic cumulative impact factor of *204.5* and RG score of *33.76* with *six* international patents. His research has been presented in conferences more than 100 and has been frequently picked up by national and international media. He is also actively involved in many international projects including ongoing Indo-Japan scientific and academic collaborations. He is Fellow of Biotechnology Research Society of India (FBRSI), Fellow of Royal Biological Society-London (FRBS-UK). He is an officially recognised Indo-Japan academic spokesperson of University of Miyazaki and engaged in outreach programs to further strengthen the cohesive relationship between Indian academicians and University of Miyazaki-Japan.

Mrs. Durgesh Nandini Chauhan, M.Pharma, has completed her B.Pharm degree in Pharmacy from the Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal, India and her M.Pharma in pharmaceutics from Uttar Pradesh Technical University, currently known as Dr. A.P.J. Abdul Kalam Technical University, Lucknow in 2006. She is presently working as Assistant Professor in Columbia Institute of Pharmacy, Raipur, Chhattisgarh, India. Mrs. Durgesh Nandini Chauhan has 14 years of academic (teaching) experience from Institutes of India in pharmaceutical sciences. She taught subjects as pharmaceutics, pharmacognosy, traditional concepts of medicinal plants, drug-delivery phytochemistry, cosmetic technology, pharmaceutical engineering, pharmaceutical packaging, quality assurance, dosage form designing and anatomy, and physiology.

She is member of Association of Pharmaceutical Teachers of India (APTI), SILAE: Società Italo-Latinoamericana di Etnomedicina (The Scientific Network on Ethnomedicine, Italy), and so forth. She has written more than 10 publications in national and international journals, 16 book chapters, and has edited 7 books. She is also active as a reviewer for several international scientific journals and active participant in national and international conferences.

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9

Extracellular Matrix: The State of the Art in Regenerative Medicine

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CONTENTS

Introduction

Regenerative medicine gained significant interest in the treatment of life-threatening diseases and disorders, especially in cardiovascular and neurodegenerative diseases (Mao and Mooney 2015). It is a multidisciplinary approach, which restores the normal physiological functions of the human body by replacement or repair of tissues and organs (Christ et al. 2013). Regenerative medicines are innovative therapies that involve various strategies of tissue engineering, stem cell biology, gene, and cellular therapeutics (Lorden et al. 2015). All regenerative medicine approaches depend upon cellular level events and their constituents, which are involved in various developmental or repair processes of human tissues, i.e. replacing damaged cells in the brain and pancreas (Mao and Mooney 2015). These transplanted cells perform all normal functions and functionally participate in the all tissue events (Chen and Liu 2016). Presently, regenerative medicine-based treatment is very expensive and not affordable by all (Mahalatchimy 2016).

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Regenerative medicine is defined as a cellular therapeutic approach which "substitutes or repair human cells, various tissues or organ systems, to restore normal physiological function of human body" (Han et al. 2020; Sampogna et al. 2015).

There are a number of regulatory issues that influence the development of regenerative medicine and thus, in this scenario, need additional focus on legislation for regenerative medicine (Kleiderman et al. 2018). Recent research reports suggested that stem cell-based therapy has a promising role in the treatment of deadly human diseases, i.e. leukaemia, breast cancer, and others (Aly 2020). The ultimate objective of regenerative medicine is the isolation of specialised cell constituents and implanted into a patient where it replaces or repairs damage part of tissue or cells through self-repair remodelling (Mao and Mooney 2015). Therefore, it regulates the functioning of native tissues or cells. It offers transformative and effective outcomes for targeting life-threatening acute and chronic conditions and also an alternative for degenerative and genetic disorders (Mahla 2016).

According to the status of the Global Regenerative Medicine Market forecast, the international market of regenerative medicine is continuously growing and expected to reach USD 17.9 billion by 2025 (marketsandmarkets 2020). Food and Drug Administration (FDA, United States) implemented the 21st Century Cures Act in 2016 for the regulation of regenerative medicine therapies under a special section 3033, which describes the term and conditions for designation of drug under Regenerative Medicine Advanced Therapy (RMAT) (Barlas 2018). The Cures Act improves the ability of scientific, technical, and professional experts regarding clinical trial designs for regenerative medicine. It will accelerate the production of regenerative medicine products with safety of patients (FDA 2020).

The Cures Act defines the regenerative medicine as:

> *cell therapy, therapeutic tissue engineering product, human cell and tissue product, or any combination product using such therapies or products intended to treat, modify, reverse, or cure a serious or life threatening disease.*
>
> (FDA 2021b)

There are currently four main categories of stem cells that have the clone ability and differentiate into particular types of cells.

i. **Embryonic stem cells:** Derived from the initial developmental phase of few days old embryos at the blastocyst stage. It has the potential to differentiate into various cells with a distinct biological response. Such cells are known as pluripotent (Romito and Cobellis 2016).
ii. **Foetal stem cells:** Isolated from aborted human foetuses, especially foetal blood, foetal tissues, and also bone marrow. They have the ability to differentiate but not all cells. They are known as multipotent and have been utilised in the regeneration and repair of damaged tissues/organs (Biehl and Russell 2009).
iii. **Cord blood and placental stem cells:** Obtained from umbilical cord blood and placentas. They possess the therapeutic potential and used in bone-marrow replacement therapies. They are not able to differentiate into all types of cells (Weiss and Troyer 2006).
iv. **Adult stem cells:** They are the most abundant cells, which are used for various therapies/conditions. They are isolated from almost all human tissue and organs. They are known as "somatic stem cells" (Liras 2010).

There is no doubt that regenerative medicine products provide a better treatment option than conventional drugs. But still, there are certain limitations and challenges for researchers and pharmaceutical companies that need to be addressed for the improvement of these specialised products (Dodson and Levine 2015). The following are the few noticeable points that should be considered during the design and production of regenerative medicine (Herberts et al. 2011):

i. **Safety:** The derived product should be safe and effective without any tumour formation or production of unwanted cell types.

ii. **Regulatory aspects and standardisation:** Must meet regulatory requirements which ensure product quality, safety, and efficacy as mention by standards (Rosemann et al. 2019).
iii. **Imaging and Monitoring:** Need sophisticated techniques with the features of observing all the changes and variation during cell behaviour (Leahy et al. 2016) and also, monitoring the migration of cells after administration (Naumova et al. 2014).
iv. **Manufacturing:** Manufacturing of viable (living) cells for regenerative medicine must follow through optimised process protocol to avoid cell variability (Martin et al. 2014).
v. Multidisciplinary research involves in regenerative medicine requiring effective communication within all research communities for better outcomes (Shineha et al. 2017).
vi. **Animal Models:** Appropriate animal models are needed for the comparison of animal embryos/human genetic or cellular material information (Ribitsch et al. 2020).
vii. **Scale up/Technology Transfer**: Large-scale production reduces the overall cost of the product. The scalable production processes provide safe and effective products (Pigeau et al. 2018).
viii. **Immunogenicity:** In regenerative therapies, a major issue is the rejection of transplanted cell by the patient. This could be overcome by exploring the research for new generation of immunosuppressant drugs (Charron 2013).
ix. **Cell Viability:** Cell viability and storage conditions (Yu et al. 2018).

A number of regenerative medicine which have already received FDA approval (FDA 2021a) and are commercially available are listed in Figure 9.1. This chapter explores the role of extracellular matrix (ECM) in regenerative medicine.

The Extracellular Matrix

Regenerative strategies mainly focus on stem cell-based or tissue engineering applications for remodelling and regeneration of defective cells, tissues, and organs. Stem cell differentiation is modulated by signals from the extracellular microenvironment including the extracellular matrix (ECM) (Chen and Liu 2016). Cellular migration and differentiation events are the main key factors that are considered for the design of regenerative medicine (Mata et al. 2017). The ECM is composed of several types of collagens, proteoglycans, glycoproteins, and glycosaminoglycans, which are assembled into a complex structure (Yue 2014). The composition of ECM varies from tissue to tissue and organ to organ (Kular et al. 2014). The distinctive functions of the ECM include cell adhesion, the physical barrier for different tissues. It also impacts many cellular functions, including mechanical stimulation from substrates, activation of intracellular signalling by cell adhesion molecules, and availability and action of soluble factor (Muncie and Weaver 2018).

The extracellular matrixes (ECM) define the tissue architecture and biochemical and biophysical features. The main organisational unit of the ECM called core matrisome, which includes different kinds of collagen (divided into several families), glycoproteins, and proteoglycans (Hynes and Naba 2012). Other than ECM, there are numerous non-ECM varying factors, which also participate in different cellular events, i.e. remodelling and cell behaviour. They mainly include proteases, growth factors, cytokines, and cross-linking enzymes (Vaday and Lider 2000). Collagen is the most abundant protein of mammalian ECM and accountable for the structural and functional integrity of the tissue (Frantz et al. 2010). Other structural molecules of ECM belong to the glycosaminoglycans class which includes hyaluronic acid (HA, non-sulphated glycosaminoglycan), chondroitin sulphate (CS, sulphated glycosaminoglycan), and heparin (natural glycosaminoglycan) Figure 9.2 (Pomin and Mulloy 2018). They play a vital role in elasticity, water retention, and resistance to compressive forces, while adhesion proteins play a significant role as molecular glue for a structural network of ECM complex. Examples of adhesion molecules are laminin, fibronectin, and tenascin-C (Walker et al. 2018).

Early in the 20th century, cell biologists worked in a two-dimensional (2D) framework, which includes separating and culturing cells from living tissue for replacing damaged or diseased tissue (O'Brien and Duffy 2015). With the advancement in the field of bioengineering and regenerative medicine, it is

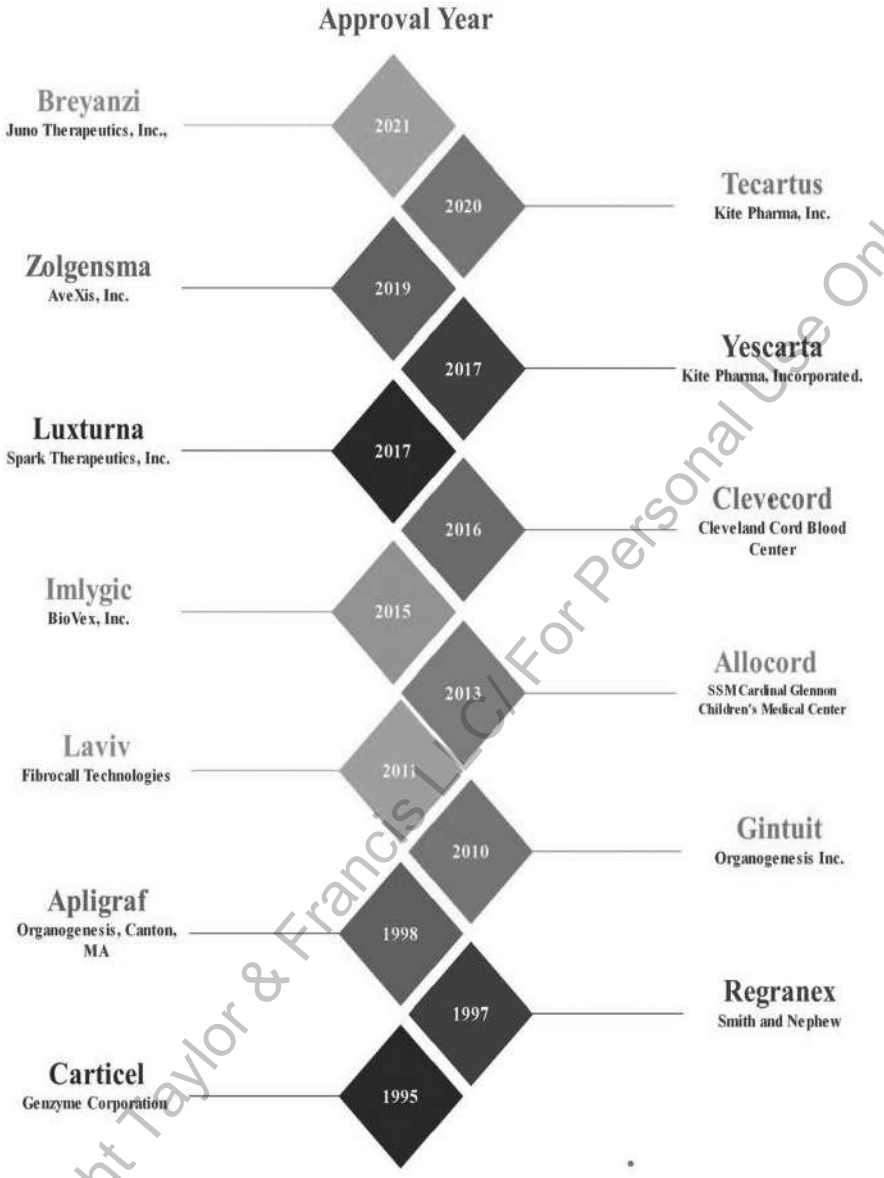

FIGURE 9.1 List of FDA Approved Products.

observed that multicellular organisms require a three-dimensional (3D) framework for structural integrity with specific microenvironments (Chen and Liu 2016). It is required to incorporate the knowledge of cell biology and cell transplantation with the discipline of material science for providing a 3D environment for growing cells and tissues. The evolution in the medical field has opened a new horizon for use of ECM in regenerative medicine. Various ECM analogues have been developed from synthetic scaffolds (Nikolova and Chavali 2019), hydrogels, and ceramic-based scaffolds (Hussey et al. 2018). These scaffolds are commonly made-up of synthetic and biodegradable polymers (Chaudhari et al. 2016). Commonly used polymers include polycaprolactone, polyethylene glycol, polyacrylic acid, hydroxyapatite or tricalcium phosphate, alginate, chitosan, and cellulose derived from plants (Hussey et al. 2018). Biomaterials used in regenerative medicine are broadly classified into two groups, i.e. naturally obtained and synthetic

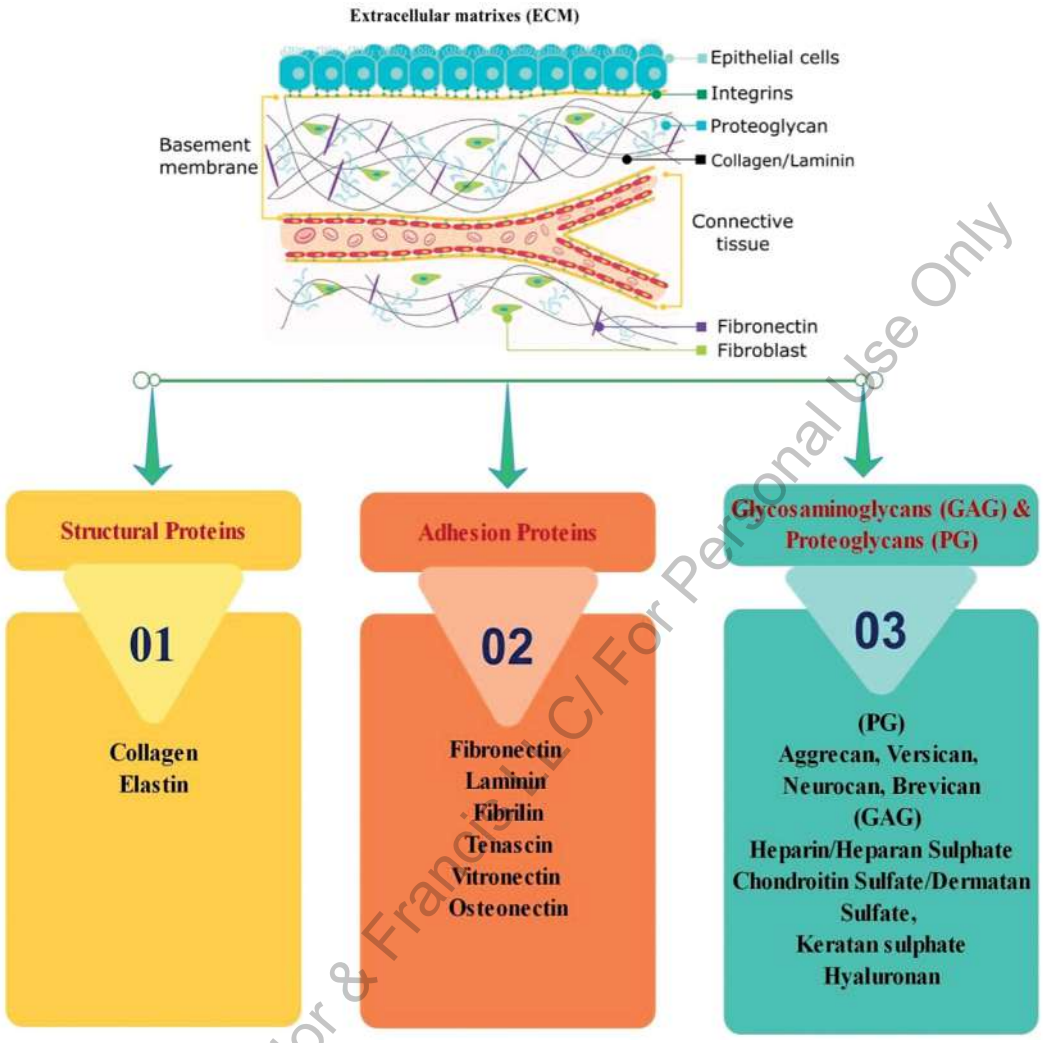

FIGURE 9.2 Composition of ECM (Kular et al. 2014).

materials (Fernandes et al. 2009). Natural materials are generally extracted or purified from ECM or its components such as collagen, laminin, and fibronectin (Frantz et al. 2010). Synthetic materials include polymers, metals or derived substrates. Both synthetic and natural materials have distinct pros and cons in regenerative medicine. Ideally, they are selected on the basis of condition and requirement of treatment. Biomaterials isolated from ECM show more unpredictability than synthetic polymers. In the case of synthetic polymers, immune response and their antigenicity is the major issue (Chen and Liu 2016). New trends and technologies in the bioengineering field reveal the functions of the ECM in regenerative medicine. This enriched the knowledge of ECM signalling in the functions of stem cells. These outcomes revealed the use of synthetic ECM scaffolds, which promote the endogenous stem cell repair and healing of damaged cells/tissues and mimic the native microenvironment (Chan and Leong 2008). A list of potential components of the extracellular matrix which are utilised in regenerative medicine (Traphagen and Yelick 2009) are summarised in Figures 9.3 and 9.4.

ECM-based biomaterials promote tissue remodelling in a precise and controllable manner. The decellularised ECM (DECM), which is water-insoluble matrix obtained after removal of cellular constituents

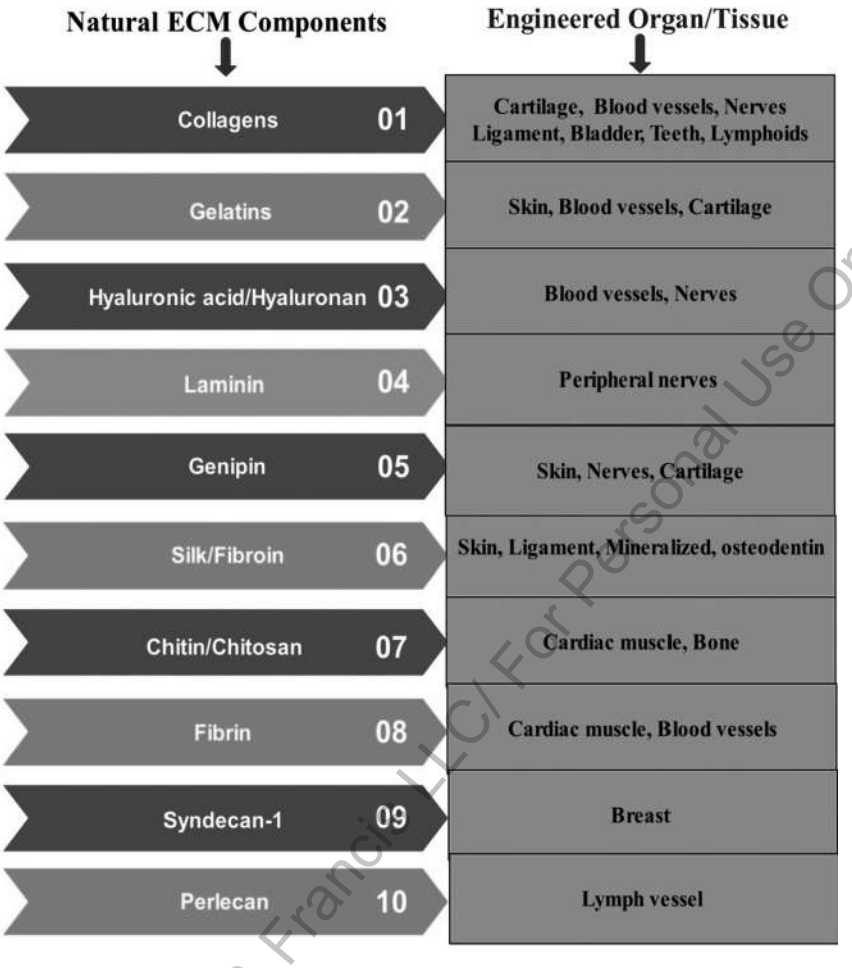

FIGURE 9.3 List of Engineered Organs and Tissues Based on ECM.

from ECM, also plays a significant role in the remodelling and repair process (Chakraborty et al. 2020). Due to biocompatibility and biodegradability, the DECM offers better results than other commonly used biomaterials (Liao et al. 2020). DECM-based tissue/organ, hydrogel, and microparticles have high demand in regenerative medicine (Parmaksiz et al. 2016).

Biomimetic materials can be fabricated using different techniques, i.e. soft lithography (Whitesides et al. 2001) (micro-contact printing), electrospinning (Braghirolli et al. 2014), and 3D printing (Atala and Forgacs 2019). Cellular constituents present within all tissues are required for tissue morphogenesis, differentiation, and the homeostasis process. Fundamentally, ECM can resolve various syndromes, physiological conditions, and defects in the body (Theocharis et al. 2019). In recent years, many studies indicate the role of native ECMs/DECM in regenerative medicine (Ramos and Moroni 2020). The main applications of ECMs include 3D tissue culturing (Edmondson et al. 2014), stimulate the wound healing process (Agren and Werthen 2007), activate stem cell differentiation (Gattazzo et al. 2014), and drug screening assays (Langhans 2018). It's also applied in cell repair pathways and functional recovery of kidney (Bulow and Boor 2019), adrenal glands (Ruiz-Babot et al. 2015), and reproductive organs (Yalcinkaya et al. 2014). ECMs have many applications due to their biocompatibility and *in vivo* replicate ability (Aamodt and Grainger 2016). This chapter summarises some research investigations based on EMCs in regenerative medicine.

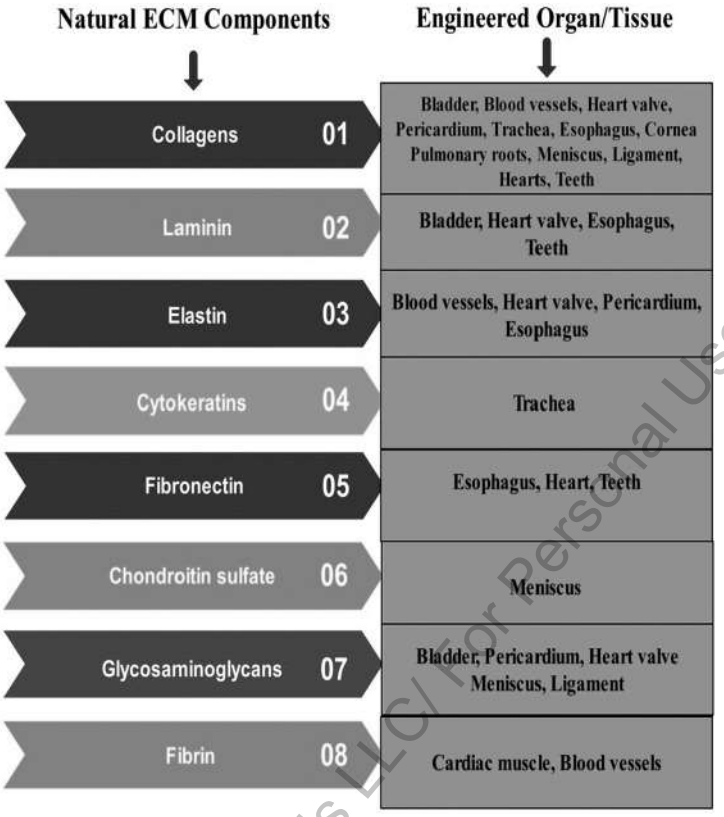

FIGURE 9.4 ECM Identified in Decellularised Organ and Tissue Studies.

Application of Extracellular Matrix

The chief proteins of the ECM are collagens and elastin. They are considered for biomedical applications because of their tensile strength and viscoelasticity to tissues. Other proteins include fibronectin, laminin, and nidogen, which act as connectors or linking proteins in the matrix network. Glycosaminoglycans (GAGs), proteoglycans, and growth factors are also promoting the *in vivo* construction of functional tissue (Mouw et al. 2014). Overall it is a challenging task due to limited knowledge and tissue to tissue variability. Ultimate goals of regenerative medicine can be achieved only if biomaterials maintain desired morphology, differentiation, proliferation, and metabolism of the cell.

Cardiac Extracellular Matrix

The heart is a vital and delicate organ of our body that requires sophisticated tissue architecture for normal functioning. It acts as a circulatory motor for our body that supplies the blood and fulfils the variable demands during the rest and exercise phase (Lee and Walsh 2016). This excitation-contraction, the cycle of the heart, developed a physical force at the cellular level of the myocardial structure. Overall, this process is regulated by the delicate organisation of the cardiac extracellular matrix. In each excitation and contraction cycle, a number of mechanical events are involved in myocardial elements (Stoppel et al. 2016).

Recent investigations suggest that ECM is found in all the segments of the heart. However, it is particularly present in mesenchyme structures and plays a role in valvuloseptal morphogenesis (Lockhart et al. 2011). Any impairment in the composition of ECM in mesenchyme structures often leads to congenital

heart disease. Several reported animal studies describe the involvement of ECM in congenital heart diseases (Hacker 2018). Studies indicate the involvement of aggrecan, hyaluronan, versican, collagen type I-V, fibulin1, and fibronectin (Wight 2018). The common complications are vascular defects, blood vessel rupture, and cardiomyopathy. ECM involves in the regulation of cell differentiation and proliferation, which serve the cell survival (Ponticos and Smith 2014).

Extracellular Matrix in Brain

A major part of the brain is occupied by ECM, which contains collagens, fibronectin, vitronectin, laminin, and perlecan especially in amyloid deposits of the brain (Bonneh-Barkay and Wiley 2009). These ECM components play the main role in the development of nervous tissue and also regulate cell adhesion (Barros et al. 2011). Matrix proteins are almost absent in the adult brain (Ruoslahti 1996). Any change that occurs in the composition of ECM after neural injury may result in drastic consequences. Brain injury may induce changes in chondroitin sulphate proteoglycans, which influence myelin repair (Rhodes and Fawcett 2004). During the early stage of neural growth, the ECM provides structural support and stimulates signalling pathways of proliferation, especially by proteoglycans, laminins, and integrins. Proteoglycans provide structural support while laminins and integrins enhance neural progenitor proliferation (Bonnans et al. 2014). They also modify the shape of neural progenitors and neurons. In addition to this, ECM components affect the migration of newborn neurons during cortical growth. The role of the ECM in the brain is highly complicated (Lu et al. 2011). The same ECM component performs multiple roles during neural development and also influences the functioning of neighbouring cells (Rozario and DeSimone 2010). Recently reported evidence indicates the involvement of the ECM in several disease conditions, such as traumatic brain injury (George and Geller 2018), Alzheimer's disease (Lepelletier et al. 2017), age-associated cognitive deficits (Richard and Lu 2019), and schizophrenia (Lubbers et al. 2014). ECM-based regenerative approaches are widely used in the repair of peripheral soft tissue but not in the case of the brain due to the invasive route of administration. It requires a very specific narrow needle-guided administration approach for specific targeting. Current research efforts in regenerative medicine suggest that ECM-based biomaterials could serve as regenerative therapies in the brain (Hwang et al. 2020). A variety of underlying factors and mechanisms are still under observation and site-specific administration of ECM-based biomaterials is another issue in development of regenerative medicine (Chen and Liu 2016).

Pulmonary Extracellular Matrix

Pulmonary ECM is a structural complex system of protein molecules, which participate in various biochemical processes (Burgstaller et al. 2017). The remodelling mechanism is important for tissue homeostasis and any change in it may result in conditions like chronic obstructive pulmonary disease (COPD). Impaired expression of ECM proteins seen in COPD leads to the degradation and disruption of alveolar walls and stiffening of minor airways, which result in obstruction of airways (Ito et al. 2019). Alterations in ECM composition also influence the immune cell movement and their maintenance in the lung (Bonnans et al. 2014). Any abnormal functioning of ECM and response of inflammatory cell surface receptors may modify the collagen microstructure of the lung (Hussell et al. 2018). It is observed that there is a change in collagen organisation in COPD lung as compared to normal lung. The imbalance of enzymes like lysyloxidase and transglutaminase2 may involve structural changes of ECM during COPD (Burgess et al. 2016). ECM regulates normal interstitial fluid dynamics and strength and elasticity, tissue repair, and remodelling in the lungs. Versican and perlecan participate in the balancing of tissue fluid homeostasis (Pelosi et al. 2007). In the area of regenerative medicine, several studies reported lung scaffolds from small and large animals as an alternative to lung transplantation (Ohata and Ott 2020). These lung scaffolds were decellularised and reseed with lung perfusion culture in bioreactors. The resulting bioartificial lungs are probable to solve the problem of donor organ shortage and also reduced the immunogenicity (Panoskaltsis-Mortari 2015).

Extracellular Matrix in Inflammatory Bowel Disease

Inflammatory Bowel Disease (IBD) is a global health issue and the specific aetiology of IBD is unknown. Ulcerative colitis and Crohn's disease are the two main forms of IBD and they are characterised by an unusual immune response linked with defects functioning in the intestinal epithelial cell barrier (Zhang and Li 2014). Macroscopic tissue injury and clinical features of IBD are developed by changes in the ECM. Any change in ECM constituents may result in intestinal inflammation and progression of IBD (Petrey and de la Motte 2017). The conventional treatments merely target treatment of inflammation not repair/recovery of damaged tissue. Recently published work reports the use of hematopoietic or mesenchymal stem cells (HSCs or MSCs) for the management of IBD (Martinez-Montiel Mdel et al. 2014). It may help to establish an effective regenerative medicine for IBD patients. The development of decellularisation techniques in biomedical engineering greatly assisted the site-specific applications of ECM bio-scaffolds in the gastrointestinal tract (Almeida-Porada et al. 2013).

Conclusion

In conclusion, it is clear that the manipulation of ECM may serve as natural mimicking scaffolds in the arena of regenerative medicine. Regenerative medicine will change the traditional methods of management of various life-threatening diseases and conditions. Moreover, there is no doubt that all classes of stem cells (embryonic, adult, and induced pluripotent stem cells) have the potential to control the variety of diseases. ECM and ECM-like materials are biocompatible and having integration with the physiological microenvironment and mimic the ECM structure of the target tissues. ECM supports various biological functions and preserves the structures of entire organs. Ideally, they are preferred over synthetic polymers for biomedical engineering because of their immune tolerance. ECM regulation can play a significant role in several body conditions such as COPD, spinal cord injury, and neurodegenerative disorder. Furthermore, innovative interdisciplinary approaches and advancements in methodologies may lead to the improvement and discovery of new treatments for human disease.

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Innovations in Plant Science for Better Health: *From Soil to Fork*

Herbs, Spices, and Medicinal Plants for Human Gastrointestinal Disorders

Health Benefits and Safety

Editors Megh R. Goyal | Preeti Birwal
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CHAPTER 1

Ethnopharmacology and Therapeutic Potential of *Carica papaya*

GURPREET SINGH, POOJA CHAWLA, ABDUL FARUK, and VINEY CHAWLA

ABSTRACT

Papaya (*Carica papaya* Linn) has been widely used as traditional herbal remedy for the prevention and management of several conditions and diseases. During the past few decades, it has been used in the treatment of digestive problems, wounds, dengue, and jaundice, etc. Its major bioactive phytoconstituents are: papain, chymopapain, alkaloids, flavonoids, lycopene, carotenoids, anthraquinones glycoside, antioxidants, and vitamins. This chapter has highlighted various ethnopharmacological and traditional uses of different parts of *Carica papaya.*

1.1 INTRODUCTION

Carica papaya is a member of the family *Caricaceae* (a family of dicots plants with four genera).[56] *Papaya* is a delicious fruit in most tropical and semitropical countries and is cultivated mostly for its consumption as fresh fruit, and for use in drinks, jams, salads, and candies.[2] The papaya plant has been well-documented in the literature for a number of medicinal properties and has been used against diseases, such as gastroenteritis, urethritis, typhoid fever, wound infection, asthma, rheumatism, fever, diarrhea, boils, and hypertension, etc.[7,11,37,59,60,67,71] All parts of papaya (seeds, roots, rinds, and fruits) have beneficial therapeutic and protective properties (Fig. 1.1). Different parts of the papaya plant have been used in

the food (nutraceuticals), skincare products, leather, and pharmaceutical production.[41] Scientists have reported the activity of papaya for antifertility, anthelmintic, and anti-inflammatoryeffects.[50,53,55,58,97] The latex of unripe fruit is widely used in pharmaceutical and cosmetics products.[18,69,78]

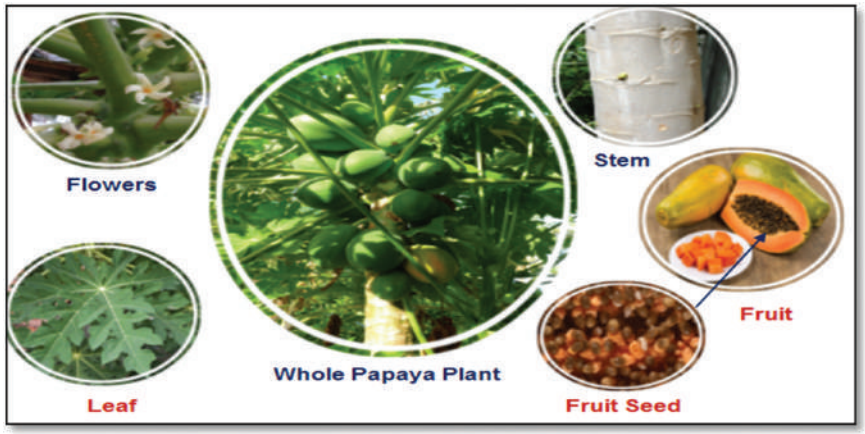

FIGURE 1.1 Major parts of *Carica papaya* plant.

The Spanish chronicler Oviedo indicated the papaya on Panamanian and Colombian coasts in 1526. Due to the high viability of papaya seeds, the fruit was rapidly produced in the tropics.[23] During this century, papaya has been cultivated in tropical regions with fertile soils and heavy rainfall. Then, papaya seeds were introduced to Southeast Asia and India by Spanish and Portuguese mariners. Later, papaya seeds reached Hawaii between 1800 and 1820.[77] In the 20th century, papaya seeds were taken to Barbados, Jamaica, Mexico, and Florida.

1.2 GEOGRAPHICAL DISTRIBUTION

It is local to the tropics of the Americas, however, now it is generally developed all through the world, and is accessible consistently.[3] It is cultivated in different parts of the world and the significant cultivators of papaya plants include India, tropical America, Europe, Australia, Hawaii, and South-East Asia.[30] Papaya is cultivated in all five continents due to its capability of growing in all soil types, but it requires good drainage.[1,73]

The major contribution of its total production[98] comes from Asia, Central America, and other countries as shown in Figure 1.2, and major cultivars of papaya plant are listed in Table 1.1. Different vernacular names of *C. papaya* and the taxonomic hierarchy of *C. papaya* have been illustrated by many investigators.[20,44,73]

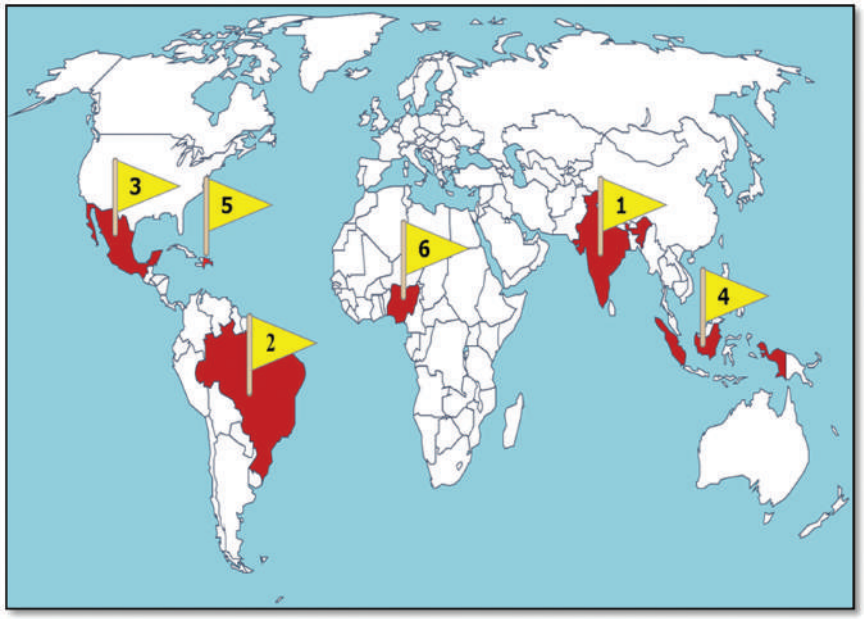

FIGURE 1.2 Major producers of papaya plant: (1) India, (2) Brazil, (3) Mexico, (4) Indonesia, (5) Dominican Republic, and (6) Nigeria.

1.3 MORPHOLOGY

Papaya is a small softwood and unbranched tropical fruit tree of 5–10 m in height with the spirally arranged leaves. The seven lobed leaves are large in diameter of about 50–70 cm, vary in sizes and shapes in different maturity stages. Fruits are commonly green while young and yellow-greenish or orange when ripe with the large ovoid smooth surface.[1,10] The fruit has a hollow berry, which contains small black seeds that constitute about 15% of the total weight and the seeds are lined in five rows to the interior wall

of the fruit. Papaya tree starts to bear fruit within 1–2 years.[72] It can be cultivated in either home gardens or outdoors.

TABLE 1.1 Major Cultivars of Papaya in the World.

Country	Variety
Australia	Improved Petersen, Guinea Gold
Barbados	Wakefield, Graeme
Cuba	Maradol
Dominican Republic	Cartagena
Florida	Cariflora, Betty, Homestead
Hawaii	Kapoho Solo,Waimanalo, Rainbow
India	Coorg Honey Dew, Coimbatore Varieties (CO1–CO8)
Indonesia	Semangka, Dampit
Malaysia	Eksotika, Sekaki
Mexico	Verde, Gialla, Cera, Chincona
Philippines	Cavite, Sinta
South Africa	Hortus Gold, Kaapmuiden
Taiwan	Tainung five
Thailand	Sai-nampueng, Khaek Dam
Trinidad	Santa Cruz Giant, Cedro
Venezuela	Paraguanera, Roja

On the basis of reported literature, papaya plant is categorized into three primary sexes (Fig. 1.3), such as male (staminate) (♂), hermaphrodite (bisexual) (⚥), and female (pistillate) (♀). A typical male and female plants bear individual unisexual flowers, while hermaphrodite plant bears a combination of male unisexual and hermaphroditic flowers.[33,54] The typical female flower is mostly large and conical in shape when it is mature with five petals spread from the base. The ovary is large in structure with a circular smooth surface, which produces spherical or ovoid-shaped flowers. Fruit progresses from globular to egg-shaped. In the case of hermaphrodite intermediate type, the flower is undefined and petals may be fused in their length or may be free from the base. Hermaphrodite elongated type of flower has fused petals from one-fourth to three-fourths of their total length with 10 anthers, out of which five are long and five are short. The long ovary contains five or more carpels and forms the fruit which is cylindrical to pear-shaped and is of great commercial value.

The typical male flower has a long and thin corolla. It contains anthers in two series of five; one series is longer than the other. The male flowers have nonfunctional rudimentary pistil.[33,61] Multiple species of papaya have been documented in the scientific literature, which belong to five genera, that is, *Jacaratia*, *Jarilla*, *Horovitzia*, *Carica*, and *Vasconcellea*.[24]

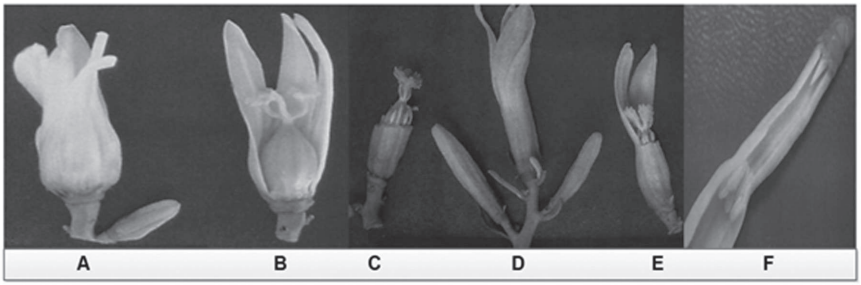

FIGURE 1.3 Six varieties of flowers of papaya plant: Typical female (A, B). Hermaphrodite intermediate (C). Hermaphrodite elongated (D). Hermaphrodite sterile (E). Typical male (F).

1.4 PHYTOCONSTITUENTS

Primary phytoconstituents reported from various parts of the *C. papaya* plant include papain (proteolytic enzyme), lycopene (tetraterpene), carotenoids, alkaloids, monoterpenoids, flavonoids, mineral (potassium, etc.), vitamins (A, C, and E; thiamine, niacin, and riboflavin), malic acid, and glycosides.[1,34,69,74,81,96] Fresh fruit juice contains flavonoids, tannins, and anthocyanins with antioxidant ability as free radical scavengers.[68] Young leaves of papaya include carpaine, pseudocarpaine, dehydrocarpaine, choline, carposide, and vitamins (C and E). Phytochemical analysis of the different parts of the plant revealed the presence of various bioactive phytochemicals, which have pharmacological importance (Fig. 1.4).

Papaya fruit exhibits wide range of medicinal properties (i.e., antimicrobial, antiviral, anti-inflammatory, healing of wound and dressing aid, anticancer, neurodegenerative, diuretic, abortifacient agent, and contraceptive).[43] It is highly well-known for its nutritional values and it aids in digestion. Extract of the whole fruit contains immunity boosters (i.e., vitamin C, ferulic, caffeic acid, and *p*-coumaric) that protect human cells against oxidative stresses.[13]

Unripe fruit of papaya contains proteolytic enzyme papain (cysteine protease), which acts like pepsin in gastric juice. The papain is more active

in green fruit and shows extensive proteolytic activity toward proteins. The extract from the seeds of papaya shows antioxidant and anticancer activities due to the presence of various phenolic compounds, vanillic acid, and vitamin C.[52,62,86]

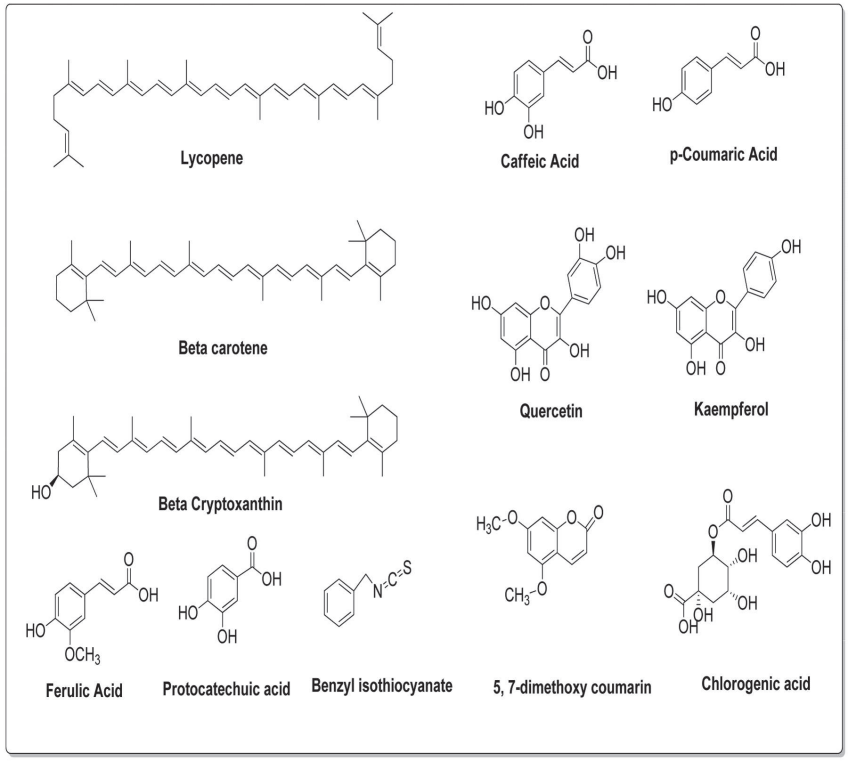

FIGURE 1.4 The structures of some phytoconstituents isolated from *C. papaya*.

Another source of papain is latex, which is harvested by incision on the surface of unripe fruit. After 4–5 days, latex is collected and further processed into dry powder for various uses in pharmaceutical and food industries.[51] The process of isolation of papain from unripe fruit latex is shown in Figure 1.5.

The papaya fruit is suitable for human consumption due to its nutritional and digestive value, with a low caloric content, which provides a favorable cost-benefit to human health.[69] Furthermore, scientific studies report the nutritional content of 100 g of ripe and unripe papaya fruits as summarized

in Table 1.2. Results revealed that unripe papaya has the highest concentrations of different vitamins and minerals as compared with ripe fruits.[22,79]

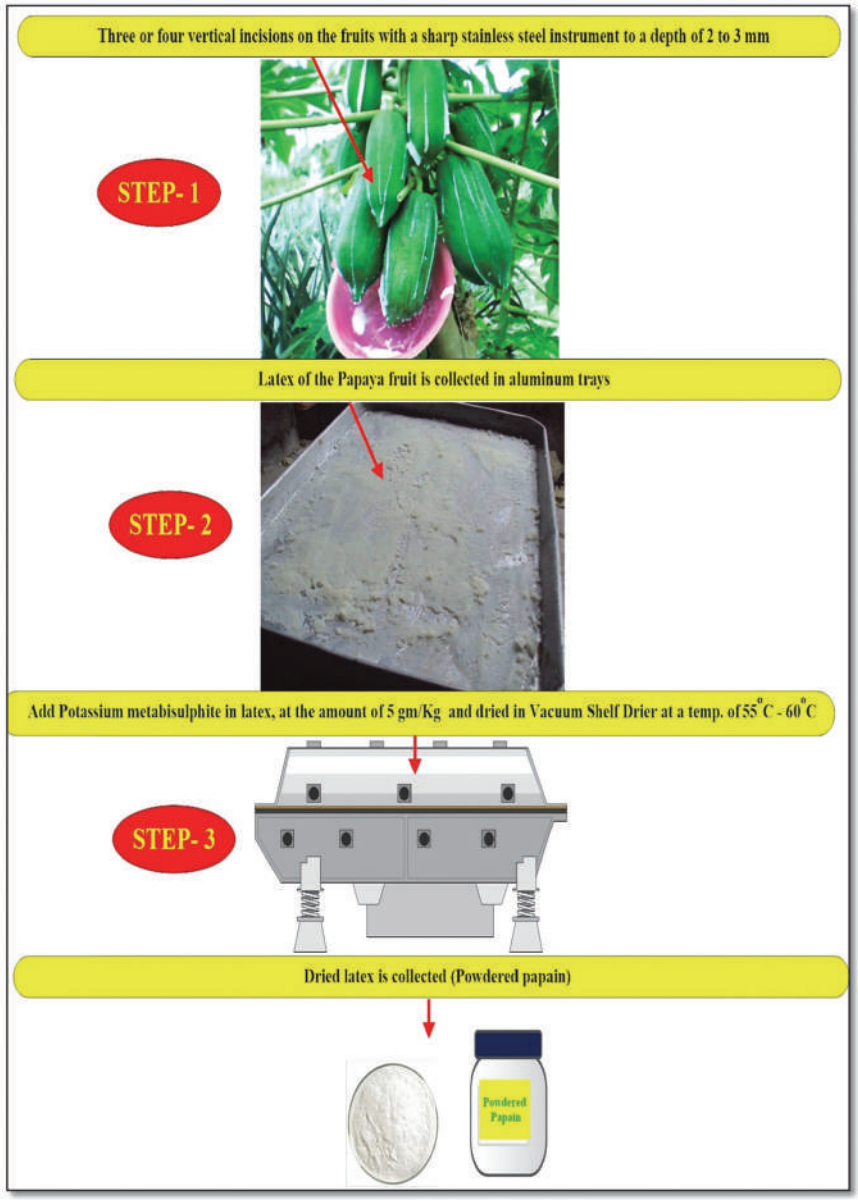

FIGURE 1.5 Isolation of papain powder from the latex from the papaya fruit.

TABLE 1.2 Nutritional Value of a Papaya Fruit.

Constituent	Ripe fruit (g)	Unripe fruit (g)
Water	89.1	92.6
Proteins	8.26	10.8
Total lipid	0.93	1.35
Ash	0.00459	6.76
Carbohydrates	86.2	81.1
Mineral Macronutrients:		
Sodium	0.1284	0.2838
Potassium	1.238	2.743
Magnesium	0.2294	0.6351
Calcium	0.1468	0.4324
Micronutrients:		
Iron	0.01284	0.00811
Copper	0.00018	0.00014
Zinc	0.00092	0
Vitamins:		
Vitamin C	0.5688	0.0003919
Thiamine	0.00028	0.00054
Riboflavin	0.00028	0.026
Niacin	0.0028	0.00405
Carotene	7.807(µg)	0

1.5 PHARMACOLOGICAL ACTIVITIES AND THERAPEUTIC USAGES OF *CARICA PAPAYA*

Every part of papaya plant holds the therapeutic value from leaves to roots.[56,69] The fruits, latex, and juice of papaya plant are the main source of many vitamins, which aid in dyspepsia, intestinal irritation, and habitual constipation.

The main constituent papain plays a vital role to improve the immune system.[9] In traditional veterinary medicine, papaya seeds are used as de-wormers and is also used in tropical folk medicine. The fresh latex is used as a vermifuge.[6] Papain is a proteolytic digestive enzyme that is used in several herbal formulations. Fresh juice of papaya prepared from peeled or unpeeled fruit is also sold as immunity booster drink because of its low cost, easy availability throughout the year and high nutritive value. In certain countries, the latex of the plant is used for tumors of uterus,

psoriasis, and ringworm. The root infusion is used against syphilis.[82] Through several scientific studies, the traditional, pharmacological, and biological effects of *C. papaya* have been validated.[10,44,74,78]

1.5.1 Anthelmintic Activity

A wide collection of papaya and their extracts have been used traditionally for the management of helminths (parasites). Papaya contains many biologically active compounds with varying properties in fruit, latex, leaves, and roots that aid in digestion. It has also been employed for treating intestinal worms.[6,16] Papain, which is present in the latex of unripe green fruits of papaya, has been commercialized in various forms. Dried seeds of papaya have shown significant activity in the management of human intestinal parasites, which have increased the stool clearance rate of parasites without any side effects. It is represented as a novel class of antihelminthic due to the efficacy of papaya latex and cysteine proteinases against *Heligmosomoid espolygyrus* (nematode).[89] Shaziya et al. reported the antihelminthic action of papaya leaves on *A. Caninum* nematode infecting mice.[87]

Papain is a protein enzyme with cysteine protease, chymopapain, and lysozyme, which can accelerate the reaction within body cells. During the digestion process, pancreas commonly produces enzymes in the human body, these enzymes break down the foods into micronutrients, which can be used by the body for energy and other functions.[12] Two main proteolytic enzymes (papain and chymopapain) in the latex of the papaya simply break down the proteins into amino acids through cleavage of the peptide bond. These proteins contained peptide bonds and can be easily broken down by enzymatic action into easily digestible micronutrients. It also helps to promote the digestion of wheat protein.[40]

1.5.2 Antioxidant Activity

Antioxidant properties of aqueous extract of papaya leaves were evaluated in alcohol-induced acute gastric damage. The outcomes revealed that gastric ulcer index was significantly better in rats pretreated with the extract of papaya leaf as compared with the alcohol-treated rats. Further, leaf extract also offered reduced blood oxidative stress level in rats via the reduction

of lipid peroxide levels in plasma and amplified red blood cell glutathione peroxidase activity.[39]

Another study showed strong in vivo antioxidant actions of ethyl acetate fraction of unripe pulp of papaya on antioxidant enzymes (i.e., glutathione peroxidase (GPX), glutathione S-transferase (GST), glutathione reductase (GR), catalase, and glucose-6-phosphate dehydrogenase (G6PD)) in albino mouse. It has been suggested that it can be used for protection against gastric ulcer and oxidative stress.[64] Natural source of antioxidants may responsible for total antioxidant effect due to the presence of carotenoid, polyphenols, vitamin C, and vitamin E.[57] Several studies showed that the antioxidant property is related to the diminished DNA damage and decreased lipid peroxidation, which maintained the immune function.[46,48]

1.5.3 Antiviral Activity

The published studies on dengue specified that the juice of papaya leaves could help to increase the platelets and white blood cells count in these patients.[15,80] A study in 2012 has reported about in vitro studies of papaya leaf extracts on persons infected with dengue. Papaya leaf extract inhibited the heat- and hypotonicity-induced hemolysis of red blood cells and has membrane-stabilizing properties.[76] In a randomized controlled trial in dengue patients, there was an increment in platelets-related genes like arachidonate 12-lipoxygenase and platelet-activating factor receptor gene and that contributed to the prevention of platelet lysis. In folk medicine, papaya leaves have been used for the management of dengue fever with hemorrhagic symptoms.[91]

1.5.4 Antimicrobial Activity

Osato et al.[65] and Calzada et al.[17] reported the ability of papaya seeds as antimicrobial agent against several Gram-positive and Gram-negative bacteria like *Trichomonas vaginalis* trophozoites, *Bacillus subtilis, Escherichia coli* and *Salmonella typhi*.[17,65] The aqueous extract of papaya leaves and roots at different concentrations showed antimicrobial effects against pathogenic bacteria.[8] The pulp and fruits of papaya also showed remarkable antibacterial effect against *B. subtilis, K. pneumonia, P. vulgaris, E. coli, P. aeruginosa, S. typhi, E. cloacae*, *and S. aureus*.[11]

1.5.5 Antifungal Activity

The papaya leaves and seeds of ripe and unripe fruits were evaluated against phytopathogenic fungi (i.e., *R. stolonifer*, Fusarium spp. and *C. gloeosporioides*), which exhibited good antifungal activity. The antifungal activity was observed to increase in a concentration-dependent manner.[19] The latex of papaya also inhibits the growth of *Candida albicans*. The latex shows antifungal activity due to partial degradation of the outermost layers of fungal cell wall, which lacks polysaccharides.[26] The synergistic effect of latex of papaya with fluconazole in *C. albicans* was also reported.[25]

1.5.6 Anti-Inflammatory Activity

It has been well documented in the literature that the dried papaya leaves are used for the management of inflammation, arthritis, rheumatism, and as wound dressing material. The ethanolic extract of the leaves was examined in rats using a paw edema model with indomethacin-treated control group. The results showed that the extracts significantly reduced edema and amount of granuloma. Similar results were confirmed with other models, that is, cotton pellet granuloma model and formaldehyde-induced arthritis model.[67,92,93]

Papaya leaves are a rich source of carpaine, nicotinic acid, which may be accountable for the anti-inflammatory effect. Ahmed et al.[4] assessed the inflammation at acute, subchronic, and chronic phase using the cotton pellet granuloma model, formaldehyde-induced arthritis and carrageenan-induced paw edema models. They suggested that the anti-inflammatory activity of the ethyl alcohol extract of papaya was due to the inhibition of *prostaglandin*- mediated inflammation.[4] Papaya leaf extract also exhibited anti-arthritic activity by the modulation of inflammatory mediators, such as, cytokines or chemokines, prostaglandins or leukotrienes.[67]

1.5.7 Antifertility Effects

The antifertility activity of papaya fruit was evaluated in adult rat and pregnant rat model. The results revealed that the unripe fruit disturbed the estrous cycle and encouraged the abortion.[27] Seed extract showed antifertility activity due to gradual degeneration of Sertoli and Leydig cells,

which induced long-term azoospermia.[95] A recent report revealed that seeds possess reversible male contraceptive potential by directly rendered the spermatozoa process.[90] It is further reported that root extract exerts morphological changes in the endometrium of rat uterus[83] and the aqueous extract of seeds has shown miscarriage in female *Sprague Dawley* rats.

The crude extract of papaya bark showed antifertility activity in rats due to its effect on sperm motility; and while the aqueous/petroleum ether/alcoholic extracts in rabbits inhibited ovulation cycle. Therefore, it can be utilized as an effective contraceptive in animals.[47] It was further reported that the unripe or half-ripe fruits contain a high concentration of the latex, which increased the uterine contraction. Normal consumption of ripe papaya is safe in pregnancy, but unripe papaya is unsafe.[2]

1.5.8 Anticancer Activity

Many studies scientifically validated the anticancer effects of papaya leaves. The aqueous extract of papaya leaves exhibits a dose-dependent significant activity against the cells of breast and lung adenocarcinoma, cervical, hepatocellular and pancreatic epithelial carcinoma, and mesothelioma. These results indicate that extracts may inhibit the growth of different types of cancer cell lines. However, the precise cellular mechanism of action remains unclear.[29,66] Several studies have claimed that mechanisms in the inhibition of proliferation by papain include the production of cytokines by human peripheral blood mononuclear cells, interfering in cancer cell wall and cleavages of proteins into amino acid form.[21]

Leaves of *C. papaya* (which contain a high concentration of tocopherol, lycopene, flavonoid, and benzyl isothiocyanate) potentially contribute to anti-tumor activity.[79] Similarly, fermented product of papaya (FPP®) claimed the immunity booster and antioxidant activity. The role of free radicals in propagating cancer is fully documented. Thus, by acting as an antioxidant, it helps to control cancerous growth.[49]

1.5.9 Antihypertensive Activity

Methanolic extract of papaya elicited the antihypertensive effects due to in vivo inhibition of angiotensin-converting enzyme and it improved the effect on the baroreflex. It was reported that angiotensin-converting

enzyme inhibitory activity was similar to those of enalapril and reduced the cardiac hypertrophy.[14]

1.5.10 Antimalarial Activity

Daily consumption of papaya leaves is a common practice in tropical communities for preventing malaria caused by *Plasmodium* genus. In vitro antiplasmodial effect of the leaf extracts was reported to be due to carpaine, which is an alkaloid.[42,94] Petroleum ether extract of the rind of papaya fruit also exhibits antimalarial activity.[99]

1.5.11 Hematological Activity

The study revealed that phytochemicals in seed, leaf, and pulp produced significant effects on certain blood parameters in treated rats. A dose-dependent effect was observed, which could be attributed to the existence of folic acid, vitamin B_{12}, alkaloids, and glycosides. It can be used for the treatment of sickle-cell anemia.[36,38]

1.5.12 Wound Healing Activity

Papaya latex contains papain, which can break down the necrotic tissue contributing to wound healing process. The study showed that the latex of *C. papaya* decreases the oxidative tissue damage thus ensuring the clot formation process during healing and the increase in di-hydroxyproline content.[28] It is also known to be effective in diabetic wound healing by preventing infection due to its antimicrobial activity.[5]

1.5.13 Hepatoprotective Activity

Ethanol and aqueous extracts of papaya fruit hold the hepatoprotective effect against carbon tetrachloride (CCl_4)-induced hepatotoxicity in rats. Results revealed significant hepatoprotection by reduction in biochemical parameters, such as, SGPT (serum glutamic pyruvic transaminase), SGOT (serum glutamic-oxaloacetic transaminase), ALP (alkaline phosphatase), and serum bilirubin, which are indicators of liver damage.[75]

1.5.14 Topical Use

Various topical applications of papaya fruits have been used in developing countries, such as topical ulcer dressings and burn dressing. It is a cost-effective remedy for desloughing necrotic tissue and preventing burn wound infection.[31] It also provides a granulating tissue, which is suitable for the application of skin graft. Now-a-days, papaya is commonly used in children's burns dressing. Papaya fruit is crushed and is daily applied on the infected burns as a layer.[88]

1.6 SUMMARY

Scientists around the globe have focused on papaya plant for its high medicinal value with simple availability in nature. *C. papaya* has the potential of capturing the global market of herbal formulations for therapeutic potential in digestive disorders. However, this needs a clinical validation. The presence of secondary metabolites has been identified, which may help in the planning of such clinical studies, which are needed to understand and explore the exact pharmacological and molecular mechanisms action of *C. papaya* activity. It will also help to establish its toxicity profile along with drug interactions.

KEYWORDS

- **abortifacient**
- **anthelmintic activity**
- **antifertility**
- ***Carica papaya***
- **caricaceae**
- **chymopapain**
- **dengue**
- **digestion enhancer**
- **nutraceutical**
- **papain powder**

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REVIEW ARTICLE

Computational Design of Molecularly Imprinted Polymers in Drug Delivery Systems: A Comprehensive Review

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Abstract: ***Background:*** Nowadays, biomedical research has been focusing on the design and development of new drug delivery systems that provide efficient drug targeting. The molecularly imprinted polymers (MIPs) have attracted wide interest and play an indispensable role as a drug carrier. Drug delivery systems based on MIPs have been frequently cited in the literature. They are cross-linked polymers that contain binding sites according to the complementary structure of the template molecules. They possess distinctive features of structure predictability and site recognition specificity. Versatile applications of MIPs include purification, biosensing, bioseparation, artificial antibodies, and drug delivery. An ideal MIPs should include features such as biocompatibility, biodegradability, and stability.

Objective: In this article, we elaborate on the historic growth, synthesis, and preparation of different MIPs and present an updated summary of recent advances in the development of new drug delivery systems which are based on this technique. Their potential to deliver drugs in a controlled and targeted manner will also be discussed.

Conclusion: MIPs possess unique advantages, such as lower toxicity, fewer side effects, and good therapeutic potential. They offer administration of drugs by different routes, *i.e*., oral, ocular or transdermal. Despite several advantages, biomedical companies are hesitant to invest in MIPs based drug delivery systems due to the limited availability of chemical compounds.

Keywords: Molecular imprinted polymer, Methacrylic acid, density functional theory, polymerization process.

1. INTRODUCTION

Molecularly Imprinted Polymers (MIPs) are cross-linked polymers having specific binding sites/cavities for the target molecule [1]. They have been widely used for various pharmaceutical applications due to their specific molecular recognition and stable physicochemical properties [2-5]. They are man-made synthetic polymers that possess the capacity to distinguish and bind specific substrates with high accuracy. MIPs are known for their robustness and resembling antibodies capabilities. They are designed with the involvement of various interdisciplinary techniques *e.g*., polymer, organic, analytical, physical, and biochemistry [6-8]. Nowadays, MIPs play a vital role in the design of sustained and controlled drug delivery systems [9, 10]. They are stable and biocompatible in nature but need to be further studied because they are mostly synthesized using organic solvents. Current researches focus on the utilization of computer-based high-throughput screening techniques for transformation from lab to clinical applications [11, 12]. MIPs have significant prospects in the targeted diagnosis and treatment of tumors [13]. The use of molecular imprinting technology with computer-based design has potential in drug delivery systems [10]. There have been extensive papers published on the topic of molecularly imprinted polymers in the various journals which have been surveyed through SciFinder® and Scopus. From the explored search term, "Molecularly Imprinted Polymer", the total number of papers was 10143 in Scopus, and for SciFinder® the number was 21775. Similar research is accomplished for "Molecularly Imprinted Polymer in Drug Delivery". From the explored search, it was noted that there is a sharp growth in the number of published papers (Fig. **1**). This emphasized the importance of molecularly imprinted polymers in drug delivery systems and the growing interest of the scientific community in this field. The renowned scientists Wulff, Mosbach, and Klaus Mosbach reported the landmark research on molecularly imprinted polymers which can be synthesized through the copolymerization process [14-16].

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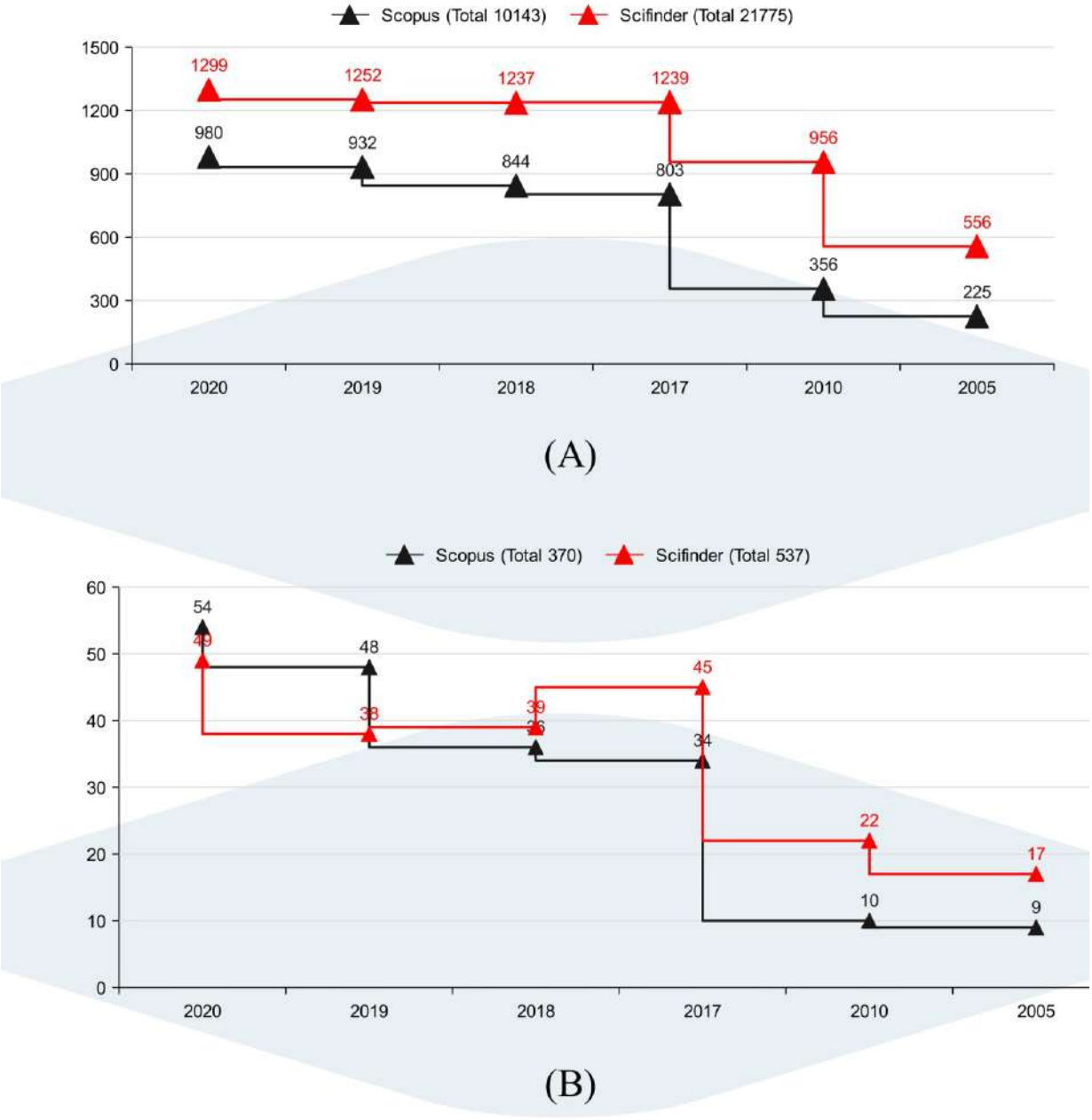

Fig. (1). Year wise publication analysis on (**A**) Molecularly Imprinted Polymer and (**B**) Molecularly Imprinted Polymer in Drug Delivery (Scopus & SciFinder® database). (*A higher resolution / colour version of this figure is available in the electronic copy of the article*).

MIPs are cross-linked polymers prepared by the processing of cross-linkers and the functional monomers in the presence of the template molecules. Their ability to respond to a variety of external stimuli (such as pH, temperature, photonic irradiation, electronic, and magnetic field interference) has earned them significant attention in drug delivery [17]. Ideal MIPs require mainly molecular recognition ability and exhibit specific site binding capability for targeting and controlled release of drugs [18]. Molecular recognition features of MIPs mainly depend upon the shape, size, and interactions of the template and imprinted cavities [19]. The fabrication of MIPs involves three main components which are responsible for their specific functionality *i.e.*, template (target molecule), functional monomer, and excess of cross-linker [20]. The various potential applications of MIPs in the field of biomedicine [4, 7, 21] are illustrated in Fig. (**2**).

1.1. Preparation of MIPs

MIPs are usually prepared by polymerization process through covalent or non-covalent interactions and in some cases a combination of both [20, 22]. MIPs utilize the template- mediated polymerization process. The main production components of MIPs include backbone, and functional monomer, a template molecule and a cross-linker [3]. The fabrication mechanism of MIPs involves the preparation of a solution that contains a backbone monomer, functional mon-

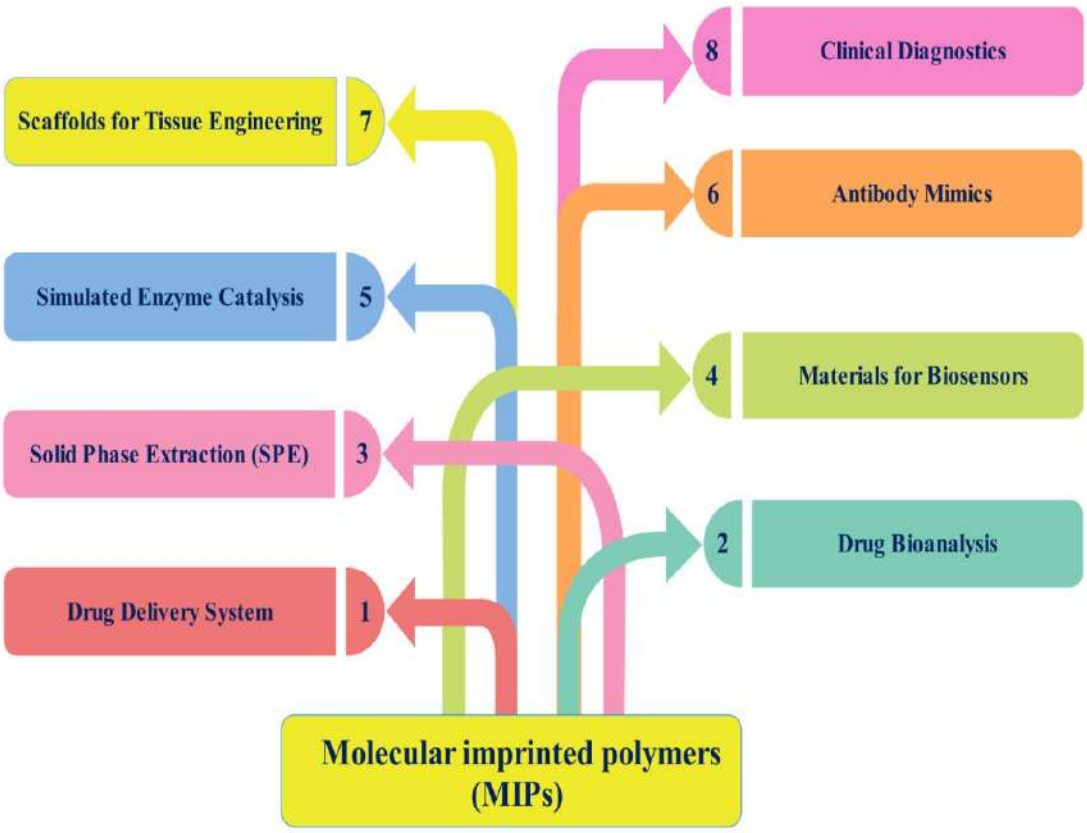

Fig. (2). Applications of Molecularly imprinted polymers (MIPs). (*A higher resolution / colour version of this figure is available in the electronic copy of the article*).

omers, and cross-linker in the presence of the template molecule (target molecule) [23]. The overall process is divided into three essential steps which are shown in Fig. (**3**).

Step 1 involves the assembly of the pre-polymerization network, followed by polymerization in step 2 and the removal of the template in step 3, thus liberating the binding site [24]. During this process, the template molecule is allowed to interact with functional groups of monomer solutions in the presence of a cross-linker so as to form a stable self-assembled complex [25]. Specific recognition of template molecules is influenced by the type of interaction established between them whether covalent or non-covalent [26]. As such covalent interactions are selective and stronger than non-covalent interactions. After the polymerization, the template molecule is cleaved from the resultant molecular imprinting polymers.

1.2. Building Blocks for MIPs

The main building blocks for the assembly of MIPs are backbone monomers, functional monomers, and cross-linkers. They all play a specific and critical role in the performance efficiency of smart polymers.

1.2.1. Backbone Monomers

Backbone monomers are the moieties that bind to the template molecule and may offer non-specific binding opportunities. They play a role in the swelling of the system and the nature of the monomers used influences the intensity of the swelling effect [20]. The backbone monomers also control the manner in which the template molecule is released from polymer assembly. They facilitate the multiple point interaction with the template molecule and enhance template binding capacity [27].

1.2.2. Functional Monomers

Functional monomers are another important part of the imprinted polymer process which provides complementary interactions with the template molecules. These monomers are used to improve the functionality features and properties of the final imprinting polymers [3].

The functional monomer mainly involves an arrangement of a cross-linked polymer matrix around the template molecule in the presence of a cross-linker [27]. Overall stability and rigid polymer matrix structure depend upon the cross-linker to the functional monomer molar ratio (C/M). The specificity, selectivity, and efficiency of imprinted polymers also depend upon the C/M ratio. Thus, a low C/M ratio in the range of 1 to 3 results in the formation of closely located binding sites while a large C/M ratio in the range of 7 to 10 results in a decrease in the number of formed binding sites especially in the case of non-covalent interactions. The optimal ratio of functional monomer to template molecule reported was 4:1 [28]. This rigid polymer matrix structure facilitates the subsequent step of removal of the template molecule. The selectivity and binding capacity of imprinted polymer is also influenced by the type and amount of the cross-

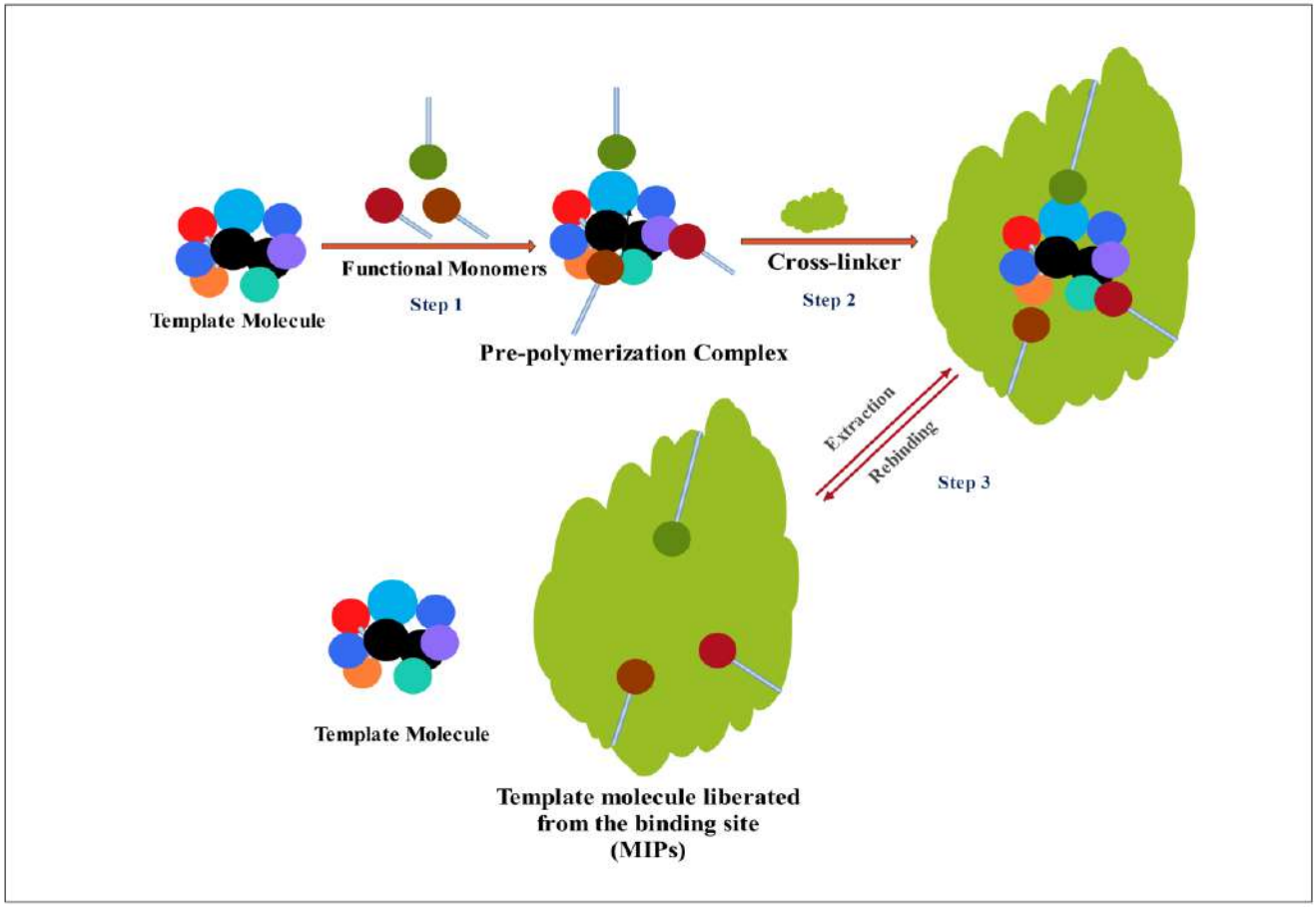

Fig. (3). Schematic interpretation of the formation of MIPs. (*A higher resolution / colour version of this figure is available in the electronic copy of the article*).

linker used in the polymerization process. Thus, the selection of functional monomers is important for the specificity, selectivity, and efficiency of imprinted polymers [3].

1.2.3. Cross-linkers

Cross-linker controls the morphology and serves to stabilize the imprinted binding sites in imprinted polymers. They provide mechanical stability and retain their molecular recognition capability [29]. They are also accountable for fixing the special orientation of the functional monomer relative to the template molecule and providing rigidity to the polymer structure. Optimizing the amount and type of cross-linker strongly influences the final size, yield, and type of final product *i.e.*, gel-type, macroporous, or a microgel powder [26]. The mechanical stiffness or flexibility of the polymer network and site confirmation is also controlled by the cross-linker [30].The quantity of the cross-linking agent is a key factor and it should be high enough to maintain overall stability even after template removal [31]. The hydrophilicity and hydrophobicity of a cross-linker with respect to reaction medium influences physicochemical stability and site-specificity of the imprinted polymer [27].

1.2.4. Templates

The template molecule also plays a vital role throughout the molecular imprinting processes. A template molecule should have the following features [20, 23].

i. It should contain polymerizable groups.

ii. It must be resistant to moderately elevated temperatures or UV radiation exposure.

iii. It should be chemically inert during polymerization.

iv. It must attain a definite orientation during molecular imprinting processes.

v. It should leave cavities without any change in size, shape, and molecular interactions of MIPs.

1.2.5. Photo-initiators

A photo-initiator initiates the polymerization process upon irradiation after the absorption of light. During this process, the photo-initiator absorbs the photons and forms reactive species, which convert from a single state to a triplet state and thus initiate a chemical reaction [32]. Photo-initiators should exhibit several important features [23, 33]:

1. High absorption at the exposure wavelength.
2. High reactivity towards the monomer.
3. Adequate solubility in the system.
4. Thermal stability.
5. It should be non-toxic, biocompatible, and easy to handle.
6. Cheap and low production cost.

Table 1. List of commonly used building blocks for assembly of MIPs.

Functional monomers (FM)	Acrolein, Acrylamide, Acrylic acid, Acrylonitrile, Allylamine p-Divinylbenzene, N, N-Diethylamino ethyl methacrylate Ethylene glycol dimethacrylate, Itaconic acid, Methacrylic acid N,N'-Methylene bisacrylamide, Urocanic acid, Vinyl benzene1-Vinylimidazole, 2-Vinylpyridine, 4-Vinylpyridine
Cross-Linkers (CL)	Ethylene glycol dimethacrylate (EGDMA), Trimethylolpropane trimethacrylate (TRIM), *p*-divinylbenzene (DVB), and *N*,*N*'-methylene bisacrylamide (MBAA)
Photo-initiators	2,2′ -Azobis(2-methylpropixonitrile) (xAIBN), Benzoin, 2-Isopropylthioxanthone, Benzoyl peroxide, Ethyl-2-chloro-propionate, Ammonium persulphite, Azo-bi- isobutyro nitrile

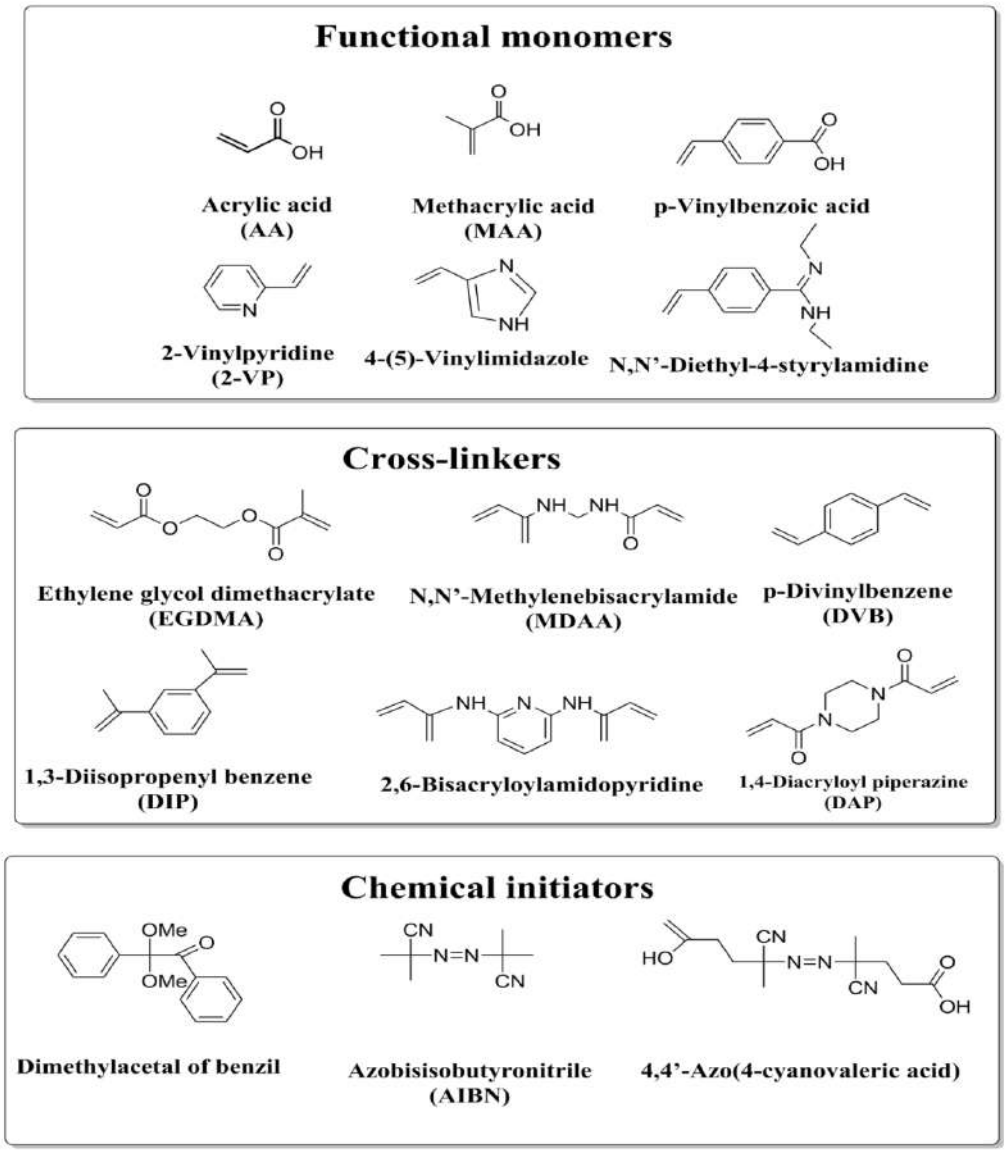

Fig. (4). The chemical structures of some functional monomers, cross-linkers, and chemical initiators used in MIPs synthesis.

Commonly used functional monomers (FM), crosslinkers (CL), and photo-initiators [3, 23] are listed in Table **1** and Fig. (**4**).

1.3. Computer-assisted Design of MIPs

The design of molecular imprinting polymers through computational tools is very effective. The main advantage of the computer-assisted rational design of MIPs is cost effectiveness especially in the screening of functional monomers [34]. Computer-assisted design of MIPs plays a significant role in the development of the biomedical field. At present, experimental trials are time-consuming and cause the wastage of chemicals [35]. It is possible to calculate energy and carry out a preliminary screening of the structural configura-

tion of polymer before the start of the actual experiment through the use of computer simulations. This strategy saves a lot of time and money [36]. The main focus lies in the comparison of the binding energy of complexes formed between a template molecule and functional monomers. The success of MIPs generally depends on the selection of an optimal functional monomer and its configuration with the template molecule [23]. The selection of optimal functional monomers is a time-consuming process. Many computational approaches and a virtual library of functional monomers are reported in the literature as guiding documents for optimizing the imprinting conditions [37]. Various molecular models are reported for the design of MIPs such as density functional theory (DFT) [38, 39], Molecular Operating Environment (MOE) [35], and the Hartree-Fock (HF) method [40, 41]. Computational tools facilitate the understanding of intermolecular interactions in molecular imprinting. In order to understand the configuration of template-monomer complexes in MIPs at the molecular level, a model is a setup in computational tools. Before the start of computational tools, a virtual library of a few functional monomers is developed for the conformational optimization process with template molecules [42]. Then, the most stable template-monomer complex is searched on the basis of the interaction energy (E) of a specific feature as per the selected model. A higher value of interaction energy indicates the higher affinity and selectivity between template-monomer complexes [43]. Table **2** records some of the success stories involving the computer design of MIPs.

1.4. Characterization of the MIPs

Different techniques have been used to characterize the physicochemical properties of molecular imprinting polymers [53]. In some cases, more than one techniques are used to evaluate these properties. They are selected on the basis of synthesis and further processes involved in the polymerization step. The techniques are summarized in Fig. (**5**) [54]. The interdisciplinary nature of MIPs greatly affects the selection of suitable methods for commercial applications and the interpretation of the data for regulatory requirements [55].

1.4.1. Thermogravimetric Analysis (TGA)

TGA is used to characterize the decomposition and thermal stability of MIPs. Physical and chemical changes of MIPs due to heating are examined in terms of the percentage of weight loss as a function of temperature. The TGA thermogram represents the difference between the decomposition stage of monomer and MIP at high-temperature conditions. Under dry nitrogen environment conditions, the samples are heated to a particular temperature at a rate of 10°C/min for examination. The weight percentage of each ensuing mass change of MIPs increases as the temperature rises [56, 57].

1.4.2. Adsorption Isotherm

The adsorption isotherms studies play an important role in the theoretical evaluation and interpretation of thermodynamic parameters of MIPs. A number of isotherms have been successfully employed to calculate the binding properties of MIPs. The adsorption isotherm equations give details regarding the binding equilibrium between target molecules and MIPs. With the help of these equations, the binding affinity and homogeneity of the binding-site distribution can be measured [58-59]. Several studies have been reported in the literature that use different models *i.e*., simple Langmuir, SIPs models, Bi-Langmuir models, Jovanovic model, Bi-Jovanovic model, and Freundlich-Jovanovic model [60].

1.4.3. Scanning Electron Microscopy (SEM)

Scanning Electron Microscopy is used to observe the surface microscopic characteristics of the imprinted polymers (shape and size). It provides a direct image of the topographical nature of the surface from all the emitted secondary electrons. For surface morphology, samples are mounted on the sample holder and a thin layer of gold is applied to the sample surface for imaging purposes. Its high resolution

Table 2. Computer-assisted design of MIPs.

S. No.	Template	Computational Approach/Theory	Software	Year	Refs.
1	Furosemide	Density functional theory (DFT)	Gaussian 3	2010	[44]
2	Chlorogenic Acid	Hartree-Fock (HF) method	Gaussian 3	2011	[45]
3	Allopurinol	Hartree-Fock (HF) method	Gaussian 9	2012	46]
4	Methadone	Density functional theory (DFT)	Gaussian 3	2012	[47]
5	Capsaicin	Simplified molecular-input files entry string	ChemDB tool	2014	[48]
6	Melamine	Density functional theory (DFT)	Gaussian 9	2015	[49]
7	Andrographolide	Restricted Hartree-Fock (RHF) semi- empirical method	HyperChem 8.0.10	2017	[50]
8	Levetiracetam	MMFF94x force field, Molecular Operating Environment (MOE)	Gaussian 9	2018	[35]
9	Clenbuterol	Density functional theory (DFT)	Gaussian 9	2018	[34]
10	Bilobalide	Molecular orbital (MO) calculations	Gaussian 16	2020	[51]
11	Bisphenol A	Hartree-Fock restricted (RHF)	Gaussian 9	2020	[52]

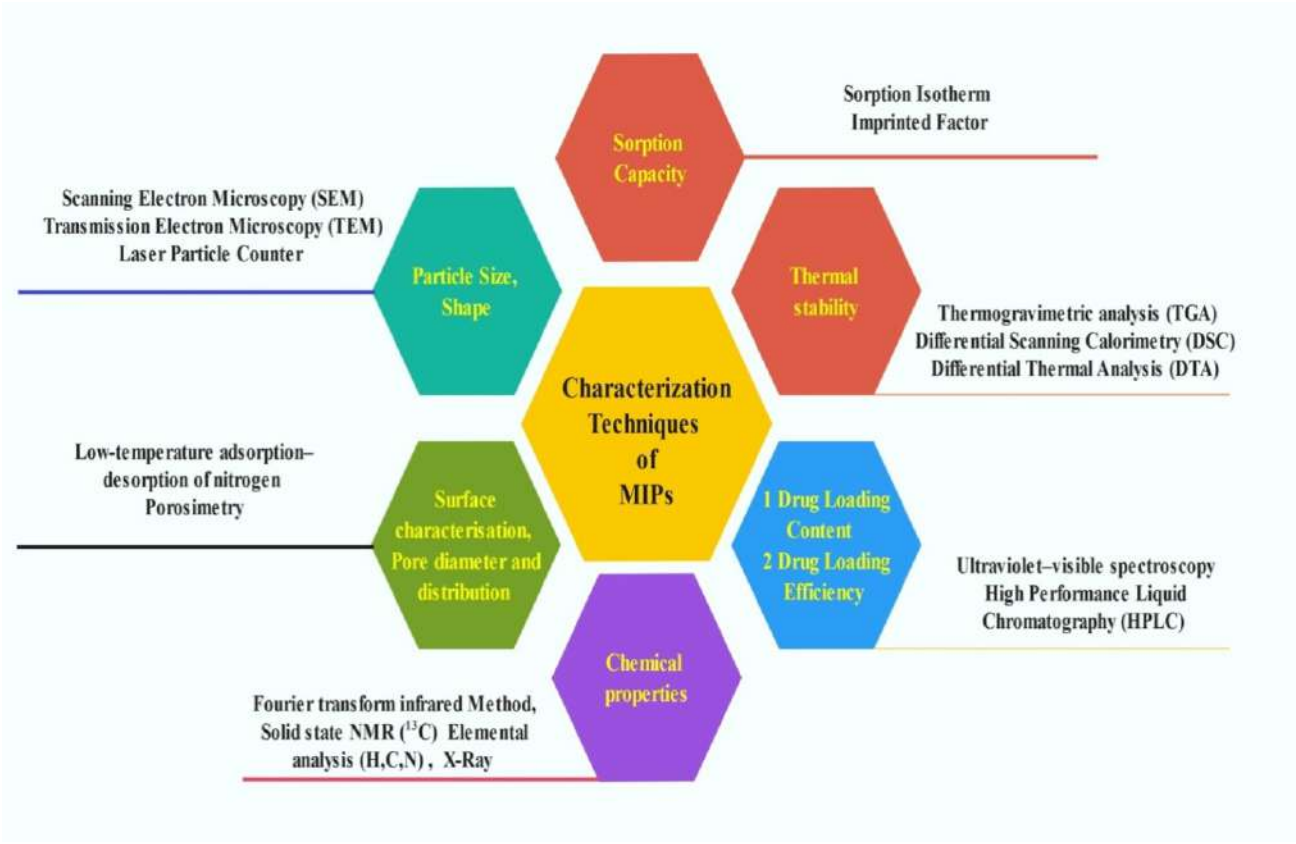

Fig. (5). Techniques used for the characterization of the MIPs. (*A higher resolution / colour version of this figure is available in the electronic copy of the article*).

makes it one of the best suitable methods for surface morphology studies [61-62].

1.4.4. Fourier Transform Infrared Method

FTIR spectroscopy is a suitable method to determine the functional groups and types of bonds present in MIP [63]. The FTIR spectra (KBr pellet) of the prepared polymers MIP, monomer, the cross-linker, and the template coating are recorded in the range of 4000-400cm^{-1}. It also provides information about the formation of a new bond in the MIP and rationalizes the mechanisms of recognition during the imprinting process [64, 65].

1.4.5. UV Spectroscopy

UV spectroscopy is providing information regarding the saturation of template molecules with functional monomer building blocks. It mainly provides information about the binding capacity of functional monomers with the template molecule. As per the literature reviewed, several studies have been reported for the determination of the binding capacity of MIPs by the UV Spectroscopy method [23, 66].

1.4.6. Nuclear Magnetic Resonance (NMR) spectroscopy

The NMR spectroscopy is a useful tool to investigate the interaction between functional monomer and template in the pre-polymerization process. The chemical shift studies and nuclear overhauled effect (NOE) allow the calculation of dissociation constants and the types of interactions occurring in the pre-polymerization mixture. It also recognizes the specific sites in interacting structures that engage in the formation of MIPs [67-69].

2. MIPS-MEDIATED DRUG DELIVERY SYSTEM

MIPs have a potential role in site-specific drug delivery systems due to their good molecular recognition performance [70]. They are perfectly complementary to the target biomolecule and are also known as "artificial antibodies" [71]. Various key features which are worth consideration for MIPs development include the rigidity of the polymer structure, high flexibility, Good accessibility, mechanical, thermal, and chemical stability [9,72].

MIPs are showing an increase in popularity, owing to their recognition characteristics, as can be observed from the increased number of investigated reports related to the application of MIPs in drug delivery systems [3, 10]. We reviewed all available databases and comprehensively summarize the utility of MIPs as innovative pharmaceutical polymers in Table **3**.

Moreover, stimuli-responsive molecularly imprinted polymers such as temperature-responsive, pH-responsive, photo-responsive, and magnetism responsive has drawn the greatest attention. Stimuli-responsive MIPs are comprehensively summarized in Table **4**. Whereas, methacrylic acid (MAA) is the most commonly used functional monomer, prevalent cross-linkers are ethylene glycol dimethacrylate (EGDMA) and N,N O-methylene bisacrylamide (MBA). It is

Table 3. List of MIPs-based drug carrier systems.

S. No.	Drug/Molecule	Carrier System	Main Components FM/ CL/ Initiator	Year	Refs.
1.	Atropine	Microspheres	MAA,TRIM/ EPI, Genipin	2020	[73]
2.	Sunitinib	Theranostic systems	MAA/ EGDMA/AIBN Fluorescent marker: Rhodamine 6G	2020	[13]
3.	Diclofenac	Nanospheres	MAA/ EGDMA/ AIBN	2018	[74]
4.	Fenbufen	Carbon Nanotubes	4-vinylpyridine (4-VP)/ EGDMA	2018	[75]
5.	Mitomycin C	Cryogel Membranes	MAH/ HEMA, MBAAm	2018	[76]
6.	Donepezil	Microparticles	MAA, GMA, HEMA/ EGDMA	2016	[77]
7.	Trinitroglycerin	Nanoparticles	MAA/ TRIM	2016	[78]
8.	L-DOPA	Nanosponge	β-cyclodextrin/ 1,1′-Carbonyldiimidazole	2016	[79]
9.	Olanzapine	Nanoparticles	MAA/ EGDMA/ AIBN	2016	[80]
10.	Azithromycin	Nanoparticles	FMAA/ EDMA/AIBN	2015	[81]
11.	Sitagliptin and Metformin	Nanoparticles	MAA,MMA/ EGDMA	2015	[82]
12.	Nicotine	MIPs	MAA/ EGDMA	2014	[83]
13.	Propranolol HCL	Polymer complex	MAA/ EGDMA	2013	[84]
14.	Tetracycline	Microporous MIPs	MAA/ EGDMA/ AIBN	2013	[85]
15.	Dipyridamole	Microspheres	MAA/ EGDMA/AIBN	2011	[86]
16.	Bromhexine	MIPs	MAA/ EGDMA/AIBN	2011	[87]
17.	Citalopram	MIPs	MAA/ EGDMA/AIBN	2011	[88]
18.	Flufenamic Acid	MIPs	MAA, NIPAAm/EGDMA/ AIBN	2011	[89]
19.	Glycyrrhizic Acid	MIPs	MAA, DMAEMA, HEMA/EGDMA/AIBN	2010	[90]
20.	Tramadol	MIPs	MAA/EGDMA/ AIBN	2010	[91]
21.	Nicotinamide	Microspheres	MAA/EGDMA/AIBN	2010	[92]
22.	5-Fluorouracil	Hydrogel nanospheres	MAA/ EGDMA/AIBN	2009	[93]
23.	α-Tocopherol	MIPs	MAA/TRIM/AIBN	2008	[94]
24.	Levonorgestrel	MIPs	MAA/TRIM/AIBN	2008	[95]
25.	Propranolol	Granules and beads for matrix tablets	MAA, NAA/ EGDMA/AIBN	2000	[96]

Table 4. List of Stimuli-responsive MIPs-based drug carrier systems.

S. No	Drug/ Molecule	Carrier System	Stimuli-responsive	Main Components FM/ CL/ Initiator	Year	Refs.
1.	Curcumin	Nanocomposite	pH-responsive	AA, β-CD/TEOS,HEMA/AIBN	2021	[97]
2.	5-Fluorouracil	Nanoparticles	Reduction-responsive	iPOx/ DTDPA	2020	[98]
3.	Doxorubicin	Graphene Quantum Dots	pH-responsive	HEMA/MBA	2020	[99]
4.	Acyclovir Valacyclovir	Hydrogel Contact Lenses	pH-responsive	MAA/EGDMA,/ AIBN	2020	[100]
5.	Paclitaxel	Microparticles	pH-responsive	MAA, HEMA/ EGDMA,TRIM	2019	[101]
6.	Capecitabine	Floating MIPs	pH-responsive	MAA/MPDE,MPDB, CPCE, CPCP/AIBN	2019	[102]
7.	Acyclovir	Microspheres	Photo- responsive	ADDDM/TEA, TMA	2018	[103]
8.	5-Fluorouracil	Microspheres	Thermo- Magnetic bi-responsive	NIPAM/MBA	2017	[104]
9.	Quercetin	Nanogel	Magnetic responsive	VI/TG	2016	[105]
10.	Letrozole	Nanoparticles	Magnetic responsive	MAA/TRIM/AIBN	2016	[106]
11.	5-Fluorouracil	Carbon Nanospheres	Thermo- Magnetic bi-responsive	NIPAM/ MBA/APS	2016	[107]
12.	5-Fluorouracil	Microspheres	Thermo- Magnetic bi-responsive	NIPAM/ MBAA/ APS	2015	[108]
13.	Salicylic Acid	Sol-Gel Polymers	pH-responsive	1-(4-vinylphenyl)-3-(3,5-bis(trifluoromethyl)phenyl)urea, APTES TMPS/ TEOS	2014	[109]
14.	Mitomycin C	Nanoparticles	Thermo responsive	MAH/ HEMA, EGDMA	2014	[110]
15.	Diclofenac	Carbon nanotubes (CNTs)	Electro responsive	MAA/ EGDMA/AIBN	2013	[111]
16.	Aspirin	Magnetic nanoparticles	Magnetic responsive	MAA/TRIM	2009	[24]

generally observed that pH-responsive MIPs offer great potential than other stimuli-responsive ones.

CONCLUSIONS AND FUTURE PERSPECTIVE

In recent years, novel MIPs have received substantial attention and investigation due to their excellent recognition properties. Stimuli-responsive molecularly imprinted polymers have drawn the greatest attention and the mechanism of response can be understood in both theoretical and practical terms. Various stimuli-responsive molecularly imprinted polymers include thermo-responsive, pH-responsive, photo responsive MIPs, biomolecule responsive and ion responsive MIPs. They possess unique advantages, such as lower toxicity, fewer side effects, and good therapeutic potential. They offer administration of drugs by different routes, *i.e*., oral, ocular, or transdermal. Despite several advantages, biomedical companies are hesitant to invest in MIPs-based drug delivery systems due to the limited availability of chemical compounds. Consequently, MIPs have not yet reached clinical trial phases, although this technology has a vast prospective for creating novel dosage forms and devices that may be useful for the treatment and diagnosis of various diseases. Future studies and the development of more clinical trials will lead to the use of MIPs as dual integration tools for therapy and diagnostic (theranostic) purposes for patients. More strategies are needed to realize the targeted efficacy of MIPs.

LIST OF ABBREVIATIONS

AA	=	Acrylic acid
ADDDM	=	*N*-(4-((4-amino-2,6-dimethoxyphenyl)diazenyl)-3,5-dimethoxyphenyl)methacrylamide
ADDDMN	=	(4-((4-amino-2,6-dimethoxyphenyl)diazenyl)-3,5-dimethoxyphenyl)methacrylamide
AIBN	=	2,2′-Azoisobutyronitrile
APS	=	Ammonium persulfate
APTES	=	*3-Aminopropyl)triethoxysilane*
CPCE	=	4-Myanophenyl cyclohexyl ethylene
CPCP	=	4-Cyanophenyl cyclohexyl propylene
DMAEMA	=	2-(dimethylamino)ethyl methacrylate
DTDPA	=	3,3′-dithiodipropionic acid
EGDMA	=	Ethylene glycol dimethacrylate
EPI	=	Epichlorohydrin
GMA	=	Glycidyl methacrylate
HEMA	=	2-hydroxyethylmethacrylate
HEMA	=	Hydroxyethyl methacrylate
iPOx	=	2-Isopropenyl-2-oxazoline
MAA	=	Methacrylic acid
MAH	=	N-Methacryloyl-L-histidine methyl ester
MBA	=	N,N'-Methylenebisacrylamide ethylene
MBAA	=	N,N'-Methylenebisacrylamide
MBAAm	=	methylene bisacrylamide
MPDB	=	4-Methylphenyl dicyclohexyl butylene
MPDE	=	4-methylphenyl dicyclohexyl ethylene,
NAA	=	N-acryloyl-alanine
NIPAAm	=	N-Isopropyl acrylamide
NIPAM	=	*N-Isopropylacrylamide*
TEA	=	Triethanolamine ,
TEOS	=	Tetraethyl orthosilicate
TG	=	Tragacanth Gum
TMA	=	Trimethacrylate
TMPS	=	Trimethoxyphenylsilane
TRIM	=	Trimethylolpropane trimethacrylate
VI	=	N-Vinyl imidazole
β-CD	=	Acrylated β-cyclodextrin

HIGHLIGHTS

Concept of Molecularly Imprinted Polymer

Role in drug delivery systems

Focus on Computer-Aided Design

Methacrylic acid as main functional monomers

Recent application of Molecularly Imprinted Polymer in drug delivery system

CONSENT FOR PUBLICATION

Not applicable.

FUNDING

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CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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ਫਾਰਮੇਸੀ ਕਾਲਜ ਨੇ ਗੜ੍ਹਵਾਲ ਯੂਨੀਵਰਸਿਟੀ ਨਾਲ ਕੀਤਾ ਸਮਝੌਤਾ

ਮੋਗਾ, 6 ਮਾਰਚ (ਜੀਪੀ ਸਾਊਰੇ)– ਸੂਬੇ ਦੀ ਪ੍ਰਮੁੱਖ ਸੰਸਥਾ ਆਈ. ਐਸ. ਐਫ. ਕਾਲਜ ਆਫ ਫਾਰਮੇਸੀ ਨੇ ਡਿਪਾਰਟਮੈਂਟ ਆਫ ਫਾਰਮਾਸਿਊਟੀਕਲ ਸਾਇੰਸਿਜ਼ ਐਚ. ਐਨ. ਬੀ. ਗੜ੍ਹਵਾਲ ਯੂਨੀਵਰਸਿਟੀ (ਸੈਂਟਰਲ ਯੂਨੀਵਰਸਿਟੀ) ਸ੍ਰੀਨਗਰ ਨਾਲ ਸਮਝੌਤਾ ਕੀਤਾ ਹੈ। ਸੰਸਥਾ ਦੇ ਡਾਇਰੈਕਟਰ ਡਾ. ਜੀ. ਡੀ. ਗੁਪਤਾ ਨੇ ਦੱਸਿਆ ਕਿ ਡਾ. ਅਬਦੁਲ ਫਾਰੂਖ ਹੈੱਡ ਡਿਪਾਰਟਮੈਂਟ ਆਫ ਫਾਰਮਾਸਿਊਟੀਕਲ ਸਾਇੰਸਿਜ਼ ਨੇ ਆਈ. ਐਸ. ਐਫ. ਕਾਲਜ ਆਫ ਫਾਰਮੇਸੀ ਦੇ ਨਾਲ ਸਮਝੌਤਾ ਕਰ ਕੇ ਵਿੱਦਿਅਕ ਖੇਤਰ ਅਤੇ ਰਿਸਰਚ ਦੇ ਖੇਤਰ 'ਚ ਕੰਮ ਕਰਨ 'ਤੇ ਸਹਿਮਤੀ ਜ਼ਾਹਿਰ ਕੀਤੀ। ਇਸ ਸਮਝੌਤੇ ਤਹਿਤ ਯੂਨੀਵਰਸਿਟੀ ਅਤੇ ਆਈ. ਐਸ. ਐਫ. ਕਾਲਜ 'ਚ ਰਿਸਰਚ ਸਹੂਲਤਾਂ ਦਾ ਵਿਦਿਆਰਥੀ ਇਸਤੇਮਾਲ ਕਰ ਸਕਣਗੇ।

ਚੇਅਰਮੈਨ ਪ੍ਰਵੀਨ ਗਰਗ, ਡਾਇਰੈਕਟਰ ਡਾ. ਜੀ. ਡੀ. ਗੁਪਤਾ, ਵਾਈਸ ਪ੍ਰਿੰਸੀਪਲ ਡਾ. ਆਰ. ਕੇ. ਨਾਰੰਗ ਸਮਝੌਤੇ ਪੱਤਰ ਦੀ ਕਾਪੀ ਦਿਖਾਉਂਦੇ ਹੋਏ। (ਕਟਾਰੀਆ)

ਇਸ ਦੇ ਨਾਲ ਹੀ ਰਿਸਰਚ ਪ੍ਰਾਜੈਕਟ, ਫੈਕਲਟੀ ਐਕਸਚੇਂਜ ਪ੍ਰੋਗਰਾਮ ਦੇ ਤਹਿਤ ਵਿਦਿਆਰਥੀਆਂ ਅਤੇ ਸਟਾਫ ਨੂੰ ਨਵੀਂ ਤਕਨੀਕ ਸਿੱਖਣ ਦਾ ਮੌਕਾ ਮਿਲੇਗਾ। ਇਸ ਤੋਂ ਇਲਾਵਾ ਸੰਸਥਾ ਵੱਲੋਂ ਫੈਨੇਕਸੇਮ ਫਾਰਮਾਸਿਊਟੀਕਲ ਲਿਮਟਿਡ ਨਾਲ ਸਮਝੌਤੇ ਪੱਤਰ 'ਤੇ ਦਸਤਖ਼ਤ ਕੀਤੇ ਗਏ। ਇਹ ਫਾਰਮਾਸਿਊਟੀਕਲ ਕੰਪਨੀ ਵਿਦਿਆਰਥੀਆਂ ਨੂੰ ਟ੍ਰੇਨਿੰਗ, ਪਲੇਸਮੈਂਟ ਅਤੇ ਕੈਮੀਕਲ ਕਰੋਨਾ ਗਤੀਵਿਧੀ ਲਈ ਜ਼ਰੂਰੀ ਸਮੱਗਰੀ ਮੁਹੱਈਆ ਕਰਵਾਏਗੀ। ਫੈਨੇਕਸੇਮ ਦੇ ਮੈਨੇਜਿੰਗ ਡਾਇਰੈਕਟਰ ਸਚਿਨ ਮੇਹਰਪਾਲ ਨੇ ਇਸ ਸਮਝੌਤੇ 'ਤੇ ਖੁਸ਼ੀ ਜ਼ਾਹਿਰ ਕਰਦਿਆਂ ਕਿਹਾ ਕਿ ਇਸ ਸਮਝੌਤੇ ਨਾਲ ਰਿਸਰਚ ਅਤੇ ਡਿਵੈਲਪਮੈਂਟ ਦੀਆਂ ਗਤੀਵਿਧੀਆਂ 'ਚ ਹੋਰ ਤੇਜ਼ੀ ਆਵੇਗੀ। ਇਸ ਮੌਕੇ ਸੰਸਥਾ ਦੇ ਚੇਅਰਮੈਨ ਪ੍ਰਵੀਨ ਗਰਗ, ਸੈਕਟਰੀ ਇੰਜੀ. ਜਨੇਸ਼ ਗਰਗ, ਡਾ. ਮੁਸਕਾਨ ਗਰਗ, ਡਾਇਰੈਕਟਰ ਡਾ. ਜੀ. ਡੀ. ਗੁਪਤਾ, ਵਾਈਸ ਪ੍ਰਿੰਸੀ. ਡਾ. ਆਰ. ਕੇ. ਨਾਰੰਗ ਅਤੇ ਸਮੂਹ ਫੈਕਲਟੀ ਸਟਾਫ ਨੇ ਸਮਝੌਤੇ ਪੱਤਰ 'ਤੇ ਦਸਤਖ਼ਤ ਕਰ ਕੇ ਸਾਰਿਆਂ ਨੂੰ ਵਧਾਈ ਦਿੱਤੀ।

आई.एस.एफ. कॉलेज ऑफ फार्मेसी ने गढ़वाल विश्वविद्यालय से किया समझौता

बीएम 5 मार्च (अकलिख्वेवाल): पक्कलां में स्थित संस्था आई.एस.एफ. कॉलेज ऑफ फार्मेसी ने डिपार्टमेंट ऑफ फार्मास्यूटिकल साइंस एच.एन.बी. गढ़वाल यूनिवर्सिटी (सेंट्रल यूनिवर्सिटी) श्रीनगर के साथ समझौता पत्र पर हस्ताक्षर किए हैं।

संस्था के डायरैक्टर डा. जी.डी. गुप्ता ने बताया कि डा. अब्दुल कादर हैड डिपार्टमेंट ऑफ फार्मास्यूटिकल साइंस ने आई.एस.एफ. कॉलेज ऑफ फार्मेसी के साथ हस्ताक्षर का विश्लेषण एवं रिसर्च के क्षेत्र में कार्य करने पर सहमति व्यक्त की। इस समझौते तहत वि.वि.कालेज एवं आई.एस.एफ. कॉलेज में उपलब्ध सिर्फ सुविधाओं का ज्ञान उपयोग कर सकेंगे। इसके साथ ही रिसर्च प्रोजैक्ट, फैकल्टी एक्सचेंज प्रोग्राम तहत छात्रों एवं स्टाफ को नई तकनीक सीखने का अवसर मिलेगा। इसके साथ ही संस्था ने कोनीकोसमी फार्मास्यूटिकल

समझौता पत्र की कापी दिखाते आई.एस.एफ. कॉलेज ऑफ फार्मेसी के चेयरमैन प्रवीण गर्ग, डायरैक्टर डा. जी.डी. गुप्ता, वाइस प्रिंसीपल डा. आर.के. नरुला। (अकलिख्वेवाल)

लिमिटेड के साथ समझौता पत्र पर हस्ताक्षर किए। यह फार्मास्यूटिकल कम्पनी छात्रों को ट्रेनिंग, प्लेसमैंट एवं कॉस्मैटिक ड्रग डिलीवरी के लिए आवश्यक सामग्री उपलब्ध करवाएगी ताकि नए प्रोडक्टों को लैब में मार्कीट तक भेजा जा सके। कोनीकोसमी के मैनेजिंग डायरैक्टर जतिन खेजरात ने इस समझौते पर खुशी व्यक्त करते कहा कि संस्था की रिसर्च एवं डिलीवरीमैंट की गतिविधियों में और तेजी आएगी व छात्रों को रोजगार व स्व-रोजगार उपलब्ध कराने के लिए सहयोग मिलेगा।

इस मौके पर संस्था के चेयरमैन प्रवीण गर्ग, खंचित हेमी, जनेश गर्ग, डा. मुस्कान गर्ग, डायरैक्टर डा. जी.डी. गुप्ता, वाइस प्रिंसीपल डा. आर.के. नरुला एवं समूह फैकल्टी स्टाफ ने समझौता पत्र पर हस्ताक्षर के लिए सभी को बधाई दी।

आइएसएफ ने गढ़वाल विश्वविद्यालय से किया समझौता

श्रीनगर : अंतरराष्ट्रीय कॉलेज ऑफ फार्मेसी और इंटर यू डिसिप्लिनरी ऑफ फार्मास्यूटिकल साइंसेज एंड रिसर्च यूनिवर्सिटी ऑफ गढ़वाल के बीच समझौते पर एक समारोह किए गए। समारोह के मुख्यअतिथि डॉ. जीतेंद्र कुमार ने बताया कि डॉ. अब्दुल समद हज डिग्री कॉलेज ऑफ फार्मास्यूटिकल साइंसेज ने अंतरराष्ट्रीय कॉलेज ऑफ फार्मेसी के साथ समझौता कर विद्यार्थी हित एवं विकास के क्षेत्र में कार्य करने का महत्वपूर्ण संकल्प भी।

इस अवसरों के तहत विश्वविद्यालय एवं अंतरराष्ट्रीय कॉलेज में उपलब्ध विभिन्न सुविधाओं का लाभ उठाकर कर सकेंगे। इसके साथ ही विभिन्न इंटरनेशनल, नेशनलों एवं वर्कशॉप के माध्यम से एक दूसरे के नई तकनीकों सीखने का अवसर मिलेगा। इसके साथ ही संस्था की ओर से अंतरराष्ट्रीय फार्मास्यूटिकल लि. के साथ समझौते एक पर हस्ताक्षर किए। यह फार्मास्यूटिकल कंपनी दवाई का दुनिया, एशियाके इस फार्मास्यूटिकल हब लिमिटेड के लिए अंतरराष्ट्रीय कार्यों उपलब्ध कराएगी, ताकि नए शोधार्थी को फील में सहिंत उच्च पेशे जा सके। इस मौके पर संस्था के एसोसिएट प्रोफेसर वर्ग, प्रतिभा इतो, उपेक्षा वर्मा, डॉ. मुस्कान वर्मा, डायरेक्टर डॉ. जीतेंद्र कुमार, डा. विनिता डुडी, आदेश नहेरा एवं अन्य फैकल्टी सदस्य ने कार्यक्रम का एक समारोह एवं कार्य का कार्यक्रम दी।

अंतरराष्ट्रीय कॉलेज ऑफ फार्मेसी के प्रतिनिधि व डॉ. जीतेंद्र कुमार, विश्वविद्यालय प्रतिनिधि व अन्य वर्ग समझौता पर्यवेक्षक हुए • संवाद

समागम का उद्घाटन डायरैक्टर . गुप्ता, उप प्रिंसीपल डा .नारंग आदि ने किया

आई.एस.एफ. कालेज में राष्ट्रीय कांफ्रैंस करवाई

मोगा, 27 फरवरी (गुलाटी) : राज्य की प्रमुख शिक्षण संस्था आई.एस.एफ. कालेज आफ फार्मेसी में इंटलैक्चुअल प्रापर्टी राइट्स फार फोरवार्ड लुकिंग फार्मास्यूटिकल व रिसर्च के साथ इंडस्ट्रीअल मशीनरी इक्विपमैंट के द्वारा एक दिवसीय राष्ट्रीय सैमीनार कांफ्रैंस का आयोजन आडीटोरियम हाल में आयोजित किया गया। इस कांफ्रैंस का शुभारंभ संस्था के चेयरमैन इंजीनियर सर्व, डा. अमृत फाम्मा पहलाज यूनिवर्सिटी बीकानेर, डा. राहुल अनेजा वाइस प्रैजीडैंट आई.पी.आर., जैनिथ बेवरेज पैसेंजिज डायरैक्टर कुनोर कोस्मो इंडस्ट्रीज लिमिटेड, एस.पी.आर के अध्यक्ष एवं संस्था के डायरैक्टर डा.जी.डी. गुप्ता, उप प्रिंसीपल डा. आर.के.नारंग, एस.पी.आर. के प्रैस अध्यक्ष डा. सिद्धार्थ मेहन ने संयुक्त तौर पर ज्योति प्रज्वलित करके किया। इस मौके पर डा. सिद्धार्थ मेहन ने आए हुए सभी मेहमानों का स्वागत किया। कांफ्रैंस को संबोधित करते डायरैक्टर डा.जी.डी. गुप्ता ने एस.पी.आर के द्वारा चल रही सभी गतिविधियों व संस्था के बारे में विस्तृत जानकारी दी। इस मौके पर वाइस प्रैजीडैंट डा. राहुल अनेजा ने पैटैंट को अभिनवेशन, प्रोटैक्शन एवं आई.पी.आर के बारे में विस्तृत जानकारी दी।

डा. राहुल अनेजा को सम्मानित करते चेयरमैन इंजीनियर सर्व डायरैक्टर डा.जी.डी. गुप्ता व अन्य। (गुलाटी)

इस मौके पर डा. अमृत फाम्मा पहलाज यूनिवर्सिटी बीकानेर ने आए हुए सभी मेहमानों का कांफ्रैंस में उपस्थित होने पर धन्यवाद किया। कांफ्रैंस में मंच का संचालन डिंपल इकबाल एवं देवी अरोड़ा ने बड़ी खूबसूरती ढंग से किया। इस मौके पर एस.पी.आर के सचिव डा. ज्योत्स्न नवलत ने एस.पी.आर पंजाब सेंटर आफ कांफ्रैंस के आयोजन पर बधाई दी। इस मौके पर फैकल्टी स्टाफ एवं विद्यार्थी उपस्थित थे।

आई.एस.एफ. कालेज ने गढ़वाल विश्वविद्यालय व कोनोरकोस्मो से किया समझौता

कोनोरकोस्मो कंपनी छात्रों को देगी ट्रेनिंग व करवाएगी प्लेसमेंट

वेंडरमैन इंडिया गर्ग, डायरेक्टर डा. जी. डी. गुप्ता, डा.डिसौजा डा. आर.के.नारंग समझौते पत्र की कापी दिखाते हुए। (जागरण)

बेरंग, 5 मार्च (गुलारी) : आई.एस.एफ.कालेज आफ फार्मेसी की ओर से डिपार्टमेंट आफ फार्मास्यूटिकल साइंसिस एच.एन.बी. गढ़वाल यूनिवर्सिटी (नेहरू यूनिवर्सिटी) श्रीनगर के साथ समझौते पत्र पर हस्ताक्षर किए गए।

संस्था के डायरेक्टर डा.जी.डी. गुप्ता ने बताया कि डा. अब्दुल फतह हैड डिपार्टमेंट आफ फार्मास्यूटिकल साइंसिस ने आई.एस.एफ. कालेज आफ फार्मेसी के साथ हस्ताक्षर कर विशेष क्षेत्र एवं रिसर्च के क्षेत्र में कार्य करने पर सहमति व्यक्त की। इस समझौते के तहत विश्वविद्यालय व आई.एस.एफ. कालेज में उपलब्ध रिसर्च सुविधाओं का लाभ उठाकर कर सकेंगे। इसके साथ ही रिसर्च प्रोजेक्ट, फैकल्टी एक्सचेंज प्रोग्राम के तहत छात्रों एवं स्टाफ को नई तकनीकी सीखने का अवसर मिलेगा। इसके साथ ही संस्था की ओर से कोनोरकोस्मो फार्मास्यूटिकल लिमिटेड के साथ समझौते पत्र पर हस्ताक्षर किए। यह फार्मास्यूटिकल कम्पनी छात्रों को ट्रेनिंग, प्लेसमेंट व कोआपरेटिव ट्रेनिंग के लिए आवश्यक सहायी उपलब्ध करवाएगी, ताकि वह प्रोजेक्टों को लैब में सफलता तक पहुंचा सके। कोनोरकोस्मो के मैनेजिंग डायरेक्टर जतिन सोलंकी ने इस समझौते पर खुशी व्यक्त करते हुए संस्था की ओर से रिसर्च एवं डिवलपमेंट की गतिविधियों में और अधिक तेजी आएगी व छात्रों को रोजगार व स्वयं का रोजगार को प्रारंभ करने के लिए सहयोग करेंगे। इस मौके पर संस्था के चेयरमैन प्रवीण गर्ग, सचिव इंजी. अनिल गर्ग, डा. मुस्कान गर्ग, डायरेक्टर डा.जी.डी. गुप्ता, उप प्रिंसीपल डा. आर.के.नारंग एवं समूह फैकल्टी स्टाफ ने समझौते पत्र पर हस्ताक्षर पर सभी को बधाई दी।

ਇਕ ਰੋਜ਼ਾ ਰਾਸ਼ਟਰੀ ਕਾਨਫਰੰਸ ਦਾ ਆਯੋਜਨ

ਕਾਨਫਰੰਸ ਦੌਰਾਨ ਗੁਰੂਆਣਾ ਕਲਾਂ ਸੰਸਥਾ ਦੇ ਚੇਅਰਮੈਨ ਪ੍ਰਵੀਨ ਗਰਗ। ਜੰਮੂ

ਮੰਡਾ, 27 ਫਰਵਰੀ (ਡੀਪੀ ਰਾਜੌਰੇ):-ਸੂਬੇ ਦੀ ਪ੍ਰਮੁੱਖ ਵਿਦਿਅਕ ਸੰਸਥਾ ਆਈ. ਐੱਸ. ਐੱਫ. ਕਾਲਜ ਆਫ ਫਾਰਮੇਸੀ ਵਿਖ ਇੰਸਟੀਚਿਊਸ਼ਨਲ ਪ੍ਰਾਪਰਟੀ ਰਾਈਟਸ 'ਤੇ ਸੋਸਾਇਟੀ ਆਫ ਫਾਰਮਾਸਿਊਟੀਕਲ ਅਤੇ ਕਿਸਾਫ ਦੇ ਨਾਲ ਸਿਸਟੀਚਿਊਸ਼ਨਲ ਬੁਆਇਨੀ ਇੰਪੋਰੈਂਸ ਵੱਲੋਂ ਇਕ ਰੋਜ਼ਾ ਨੈਸ਼ਨਲ ਕਾਨਫਰੰਸ ਦਾ ਆਯੋਜਨ ਆਡੀਟੋਰੀਅਮ ਹਾਲ ਵਿਖ ਕੀਤਾ ਗਿਆ। ਇਸ ਕਾਨਫਰੰਸ ਦੀ ਸ਼ੁਰੂਆਤ ਸੰਸਥਾ ਦੇ ਚੇਅਰਮੈਨ ਪ੍ਰਵੀਨ ਗਰਗ, ਡਾ. ਅਬਦੁਲ ਵਾਹਦ ਸ਼ਹੁਕਾਫ ਯੂਨੀਵਰਸਿਟੀ ਬ੍ਰੂਨੇਈ, ਡਾ. ਫਾਰੂਕ ਤਰੰਜਾ ਸਾਇੰਟਿਸਟ ਆਈ. ਪੀ. ਆਰ., ਜਤਿਨ ਗੋਤਰਪਾਲ ਮੈਨੇਜਿੰਗ ਡਾਇਰੈਕਟਰ ਕੁਨੋਰ ਕੈਮੀਕਲ ਪ੍ਰਾਈਵੇਟ ਲਿਮਟਿਡ, ਐੱਸ. ਪੀ. ਆਰ. ਦੇ ਪ੍ਰਧਾਨ ਅਤੇ ਸੰਸਥਾ ਦੇ ਡਾਇਰੈਕਟਰ ਡਾ. ਜੀ. ਡੀ. ਗੁਪਤਾ, ਵਾਈਸ ਪ੍ਰਿੰਸੀਪਲ ਡਾ. ਆਰ. ਕੇ. ਨਾਰੰਗ, ਐੱਸ. ਪੀ. ਆਰ. ਦੇ ਸੁਬਾ ਪ੍ਰਧਾਨ ਡਾ. ਸਿਦਾਰਥ ਮੱਹਨ ਨੇ ਸਾਂਝੇ ਤੌਰ 'ਤੇ ਸਵਿੱਤੀ ਬਾਲ ਕੇ ਕੀਤੀ। ਇਸ ਮੌਕੇ ਡਾ. ਸਿਦਾਰਥ ਨੇ ਆਏ ਹੋਏ ਸਾਰੇ ਮਹਿਮਾਨਾਂ ਦਾ ਧੰਨਵਾਦ ਕੀਤਾ। ਕਾਨਫਰੰਸ ਨੂੰ ਸੰਬੋਧਨ ਕਰਦਿਆਂ ਡਾਇਰੈਕਟਰ ਡਾ. ਜੀ. ਡੀ. ਗੁਪਤਾ ਨੇ ਐੱਸ. ਪੀ. ਆਰ. ਵੱਲੋਂ ਚੁੱਕੇ ਜਾ ਰਹੇ ਕਦਮਾਂ ਅਤੇ ਸੰਸਥਾ ਬਾਰੇ ਜਾਣਕਾਰੀ ਦਿੱਤੀ। ਇਸ ਦੌਰਾਨ ਸਾਇੰਟਿਸਟ ਡਾ. ਫਾਰੂਕ ਤਰੰਜਾ ਨੇ ਪੇਟੈਂਟ ਦੀ ਮਹੱਤਤਾ, ਫਾਈਲਿੰਗ ਅਤੇ ਆਈ. ਪੀ. ਆਰ. ਦੀ ਮਹੱਤਤਾ ਬਾਰੇ ਜਾਣੂ ਕਰਵਾਇਆ। ਉਨ੍ਹਾਂ ਕਿਹਾ ਕਿ ਦੇਸ਼ ਅਤੇ ਵਿਦੇਸ਼ ਵਿਚ ਆਈ. ਪੀ. ਆਰ. ਦੀ ਮੰਗ ਲਿਤੇਤਰ ਵੱਧ ਰਹੀ ਹੈ। ਇਸ ਦੌਰਾਨ ਡਾ. ਅਬਦੁਲ ਵਾਹਦ ਨੇ ਆਈ. ਪੀ. ਆਰ. ਬਾਰੇ ਦੰਸਲਿਆਂ ਨੋਕਲ ਲਕੀਕ ਡਲਿਵਰੀ ਸਿਸਟਮ ਅਤੇ ਕਿਸਫ ਕਰਕ ਨੂੰ ਪੇਟੈਂਟ, ਟਰਾਂਸਫਰ ਟੈਕਨਾਲੋਜੀ ਅਤੇ ਇੰਡਸਟਰੀ ਤੇਕ ਤੋਸਟ 'ਤੇ ਲੇਖ ਲਿੱਖਾ। ਪ੍ਰੋ. ਸੌਰਭ ਬੈਸ ਨੇ ਆਏ ਹੋਏ ਸਾਰੇ ਮਹਿਮਾਨਾਂ ਦਾ ਕਾਨਫਰੰਸ ਵਿਚ ਸ਼ਮੂਲ ਹੋਣ 'ਤੇ ਧੰਨਵਾਦ ਕੀਤਾ। ਸਟੇਜ ਦੀ ਕਾਰਵਾਈ ਕਿਸਕਪ੍ਰਸੇਜ ਅਤੇ ਡੋਲੀ ਅਰੋੜਾ ਨੇ ਸੰਭਾਲੀ। ਜਿਸ ਮੌਕੇ ਐੱਸ. ਪੀ. ਆਰ. ਦੇ ਸੈਕਟਰੀ ਡਾ. ਉਪਿੰਦਰ ਨੇ ਐੱਸ. ਪੀ. ਆਰ. ਪੰਜਾਬ ਸਟੇਟ ਚੈਪਟਰ ਨੂੰ ਕਾਨਫਰੰਸ ਦੇ ਆਯੋਜਨ ਲਈ ਵਧਾਈ ਦਿੱਤੀ। ਇਸ ਦੌਰਾਨ ਵੈਲਿਕਟੀ ਸਰਾਫ ਅਤੇ ਵਿਦਿਆਰਥੀ ਹਾਜ਼ਰ ਸਨ।

ਜਗ ਬਾਣੀ Fri, 28 February 2020
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आइएसएफ कॉलेज ऑफ फार्मेसी में चेयरमैन प्रवीण गर्ग, डॉ. अब्दुल फारूख व डॉ. राहुल तनेजा कांफ्रेंस के बाद डॉ. जीडी गुप्ता को सम्मानित करते हुए • जागरण

आइएसफ कॉलेज ऑफ फार्मेसी में करवाई कांफ्रेंस

संवाद सहयोगी, मोगा : आइएसएफ कॉलेज ऑफ फार्मेसी में इंटलेक्चुअल प्रॉपर्टी राइट्स पर सोसायटी ऑफ फार्मास्यूटिकल एवं रिसर्च के साथ इंस्टीट्यूशनल क्वालिटी इंप्रूवमेंट द्वारा एक दिवसीय राष्ट्रीय सेमिनार कांफ्रेंस का आयोजन ऑडिटोरियम हाल में किया गया।

कांफ्रेंस का शुभारंभ संस्था के चेयरमैन प्रवीण गर्ग, डॉ. अब्दुल फारूख गढ़वाल यूनिवर्सिटी श्रीनगर, डॉ. राहुल तनेजा साइंटिस्ट आइपीआर, जतिन खेड़पाल मैनेजिंग डायरेक्टर कुनार फेरमो प्राइवेट लिमिटेड, एकपीअर के अध्यक्ष एवं संस्था के डायरेक्टर डॉ. जीडी गुप्ता, वाइस प्रिंसिपल डॉ. आरके नारंग, एसपीअर के प्रोग्राम्यक्ष डॉ. सिद्धार्थ मेहन ने संयुक्त तौर पर ज्योति प्रज्वलित करके किया। इस दौरान डॉ. जीडी गुप्ता ने एकपीअर के द्वारा चल रही रही गतिविधियों व संस्था के बारे में विस्तृत जानकारी दी। इस मौके पर साइंटिस्ट डॉ. राहुल तनेजा ने पेटेंट की उपयोगिता, फाइलिंग एवं आईपीआर की उपयोगिता बारे अवगत करवाया।

उन्होंने कहा कि देश एवं विदेश में आइपीआर की मांग निरंतर बढ़ रही है। डॉ. अब्दुल फारूख ने आइपीआर पर प्रकाश डालते हुए नोवल ड्रग डिलीवरी सिस्टम व रिसर्च वर्क को पेटेंट, ट्रांसफर टेक्नालाजी तथा इंडस्ट्री तक पहुंचने पर जोर दिया। इस मौके पर फैकल्टी स्टाफ एवं विद्यार्थी उपस्थित थे।

ਇਕ ਰੋਜ਼ਾ ਕੌਮੀ ਕਾਨਫਰੰਸ ਕਰਵਾਈ

ਵਕੀਲ ਮਹਿਰੋ, ਮੋਗਾ

ਸੂਬੇ ਦੀ ਪ੍ਰਮੁੱਖ ਵਿਦਿਅਕ ਸੰਸਥਾ ਆਈਐਸਐਫ ਕਾਲਜ ਆਫ ਫਾਰਮੇਸੀ ਵਿਚ ਇੰਟਲੈਕਚੁਅਲ ਪ੍ਰਾਪਰਟੀ ਰਾਈਟਸ ਤੇ ਸੁਸਾਇਟੀ ਆਫ ਫਾਰਮਾਸਿਊਟਿਕਲ ਤੇ ਕਿਸਰਚ ਦੇ ਨਾਲ ਇੰਸਟੀਚਿਊਸ਼ਨਲ ਕੁਆਲਿਟੀ ਇੰਸ਼ੋਰੈਂਸ ਵੱਲੋਂ ਇਕ ਰੋਜ਼ਾ ਨੈਸ਼ਨਲ ਕਾਨਫਰੰਸ ਆਫ ਫਾਰਮਾਸਿਊਟੀਕਲ ਹਾਲ 'ਚ ਕਰਵਾਈ ਗਈ। ਕਾਨਫਰੰਸ ਦੀ ਸ਼ੁਰੂਆਤ ਸੰਸਥਾ ਦੇ ਚੇਅਰਮੈਨ ਪ੍ਰਦੀਪ ਗਰਗ, ਡਾ. ਅਬਦੁਲ ਫਾਰੂਖ ਗੜ੍ਹਵਾਲ ਯੂਨੀਵਰਸਿਟੀ ਸ੍ਰੀਨਗਰ, ਡਾ. ਰਾਹੁਲ ਤਨੇਜਾ ਸਾਇੰਟਿਸਟ ਆਈਪੀਐਚ ਜਰਿਨ ਸੋਕਰਪਾਲ ਮੈਸੇਚਿਉਸ਼ਟ ਡਾਇਰੈਕਟਰ ਚੁਨੇਰ ਕੈਮਸੇ ਪ੍ਰਾਈਵੇਟ ਲਿਮਿਟਡ, ਐਸਪੀਐਚ ਦੇ ਪ੍ਰਧਾਨ ਤੇ ਸੰਸਥਾ ਦੇ ਡਾਇਰੈਕਟਰ ਡਾ ਜੀਡੀ ਗੁਪਤਾ, ਵਾਈਸ ਪ੍ਰਿੰਸੀਪਲ ਡਾ. ਆਰਕੇ ਨਾਰੰਗ, ਐਸਪੀਐਚ ਦੇ ਮੁਖੀ ਪ੍ਰਧਾਨ ਡਾ. ਸਿਦਾਰਥ ਮੱਹਨ ਨੇ ਸਾਂਝੇ ਤੌਰ 'ਤੇ ਸ਼ੰਮੀ ਜਗਾ ਕੇ ਕੀਤੀ।

ਇਸ ਮੌਕੇ ਡਾ. ਸਿਧਾਰਥ ਮੱਹਨ ਨੇ ਆਏ ਹੋਏ ਸਾਰੇ ਮਹਿਮਾਨਾਂ ਦਾ ਧੰਨਵਾਦ ਕੀਤਾ। ਕਾਨਫਰੰਸ ਨੂੰ ਸੰਬੋਧਨ ਕਰਦੇ ਹੋਏ ਡਾਇਰੈਕਟਰ ਡਾ. ਜੀਡੀ ਗੁਪਤਾ ਨੇ ਐਸਪੀਐਚ ਵੱਲੋਂ ਚੱਲ ਰਹੀ ਗਤੀਵਿਧੀਆਂ ਤੇ ਸੰਸਥਾ ਬਾਰੇ ਜਾਣਕਾਰੀ ਦਿੱਤੀ। ਇਸ ਮੌਕੇ ਸਾਇੰਟਿਸਟ ਡਾ. ਰਾਹੁਲ ਤਨੇਜਾ ਨੇ ਪੈਟੇਂਟ ਦੀ ਪ੍ਰਿਪਰੇਸ਼ਨ, ਫਾਈਲਿੰਗ ਤੇ ਆਈਪੀਐਚ ਦੀ ਪ੍ਰਿਪਰੇਸ਼ਨ ਬਾਰੇ ਜਾਣੂ ਕਰਵਾਇਆ। ਉਨ੍ਹਾਂ ਕਿਹਾ ਕਿ ਦੇਸ਼ ਤੇ ਵਿਦੇਸ਼ 'ਚ ਆਈਪੀਐਚ ਦੀ ਮੰਗ ਨਿਰੰਤਰ ਵੱਧ ਰਹੀ ਹੈ।

ਇਸ ਮੌਕੇ ਡਾ. ਅਬਦੁਲ ਫਾਰੂਖ ਨੇ ਆਈਪੀਐਚ ਬਾਰੇ ਦੇਸਣੇ ਹੋਏ ਨੋਬਲ ਡੋਜਰਾ ਡਿਲੀਵਰੀ ਸਿਸਟਮ ਤੇ ਕਿਸਰਚ ਵਰਕ ਨੂੰ ਪੈਟੇਂਟ, ਰਾਸਲਟੀ ਟੈਕਨਾਲੋਜੀ ਅਤੇ ਇੰਡਸਟਰੀ ਤੋਂ ਫੰਡਜ਼ 'ਤੇ ਜ਼ੋਰ ਦਿੱਤਾ। ਇਸ ਮੌਕੇ ਪ੍ਰੋ. ਸੰਦੀਪ ਗੋਸੇ ਨੇ ਆਏ ਹੋਏ ਸਾਰੇ ਮਹਿਮਾਨਾਂ ਦਾ ਕਾਨਫਰੰਸ 'ਚ ਸ਼ਾਮਲ ਹੋਣ 'ਤੇ ਧੰਨਵਾਦ ਕੀਤਾ। ਕਾਨਫਰੰਸ 'ਚ ਸਟੇਜ ਦੀ ਕਾਰਵਾਈ ਵਿਸਵਪ੍ਰਸਿੱਧ ਤੇ ਡੋਲੀ ਅਰੋੜਾ ਨੇ ਸੰਭਾਲੀ। ਇਸ ਮੌਕੇ ਐਸਪੀਐਚ ਦੇ ਕੈਮਟਰੀ ਡਾ. ਧੀਰਿੰਦਰ ਨਰਾਇਣ ਨੇ ਐਸਪੀਐਚ ਪੰਜਾਬ ਸਟੇਟ ਬ੍ਰਾਂਚ ਨੂੰ ਕਾਨਫਰੰਸ ਦੇ ਆਯੋਜਨ ਲਈ ਵਧਾਈ ਦਿੱਤੀ।

ਸੰਸਥਾ ਦੇ ਚੇਅਰਮੈਨ ਪ੍ਰਦੀਪ ਗਰਗ,ਵਾਈਸ ਪ੍ਰਿੰਸੀਪਲ ਡਾ. ਆਰ.ਕੇ ਨਾਰੰਗ ਡਾ ਅਬਦੁਲ ਫਾਰੂਖ ਗੜ੍ਹਵਾਲ ਯੂਨੀਵਰਸਿਟੀ ਸ੍ਰੀਨਗਰ ਨੂੰ ਸਨਮਾਨਤ ਕਰਦੇ ਹੋਏ।

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ISF College of Pharmacy, Moga	ISF College of Pharmacy, Moga	ISF College of Pharmacy, Moga	ISF College of Pharmacy, Moga

Progress Report (Financial Year, 2022 – 2023) with Major Achievements and Observations

Development of large scale seedlings and promotion of cultivation of selected high altitude medicinal plants (*Nardostachys grandiflora*, *Aconitum balfourii*, *Aconitum heterophyllum*, *Picrorhiza kurrooa, Saussurea costus* and *Valeriana wallichii*) in farmer's field in high altitude region of Uttarakhand" for easy availability of raw materials as well as conservation of species in natural habitats

Memorandum of Understanding (MOU) between HAPPRC & JWCT (15/9/2020)

Project Sponsored by

Jivanti Welfare and Charitable Trust (JWCT), New Delhi
M/S Dabur Research & Development Centre (DRDC), Dabur India Limited (DIL),
Sahibabad, Ghaziabad (U.P.), India

At

High Altitude Plant Physiology Research Centre (HAPPRC)
Hemvati Nandan Bahuguna Garhwal University, Srinagar (Garhwal), Uttarakhand
Ph. 01346-252172, 253760; Fax: 01346- 252070
Principal Investigator: Dr. Vijay Kant Purohit

Project Details

1. Project Proposal: Development of large scale seedlings and promotion of cultivation of selected high altitude medicinal plants (*Nardostachys grandiflora*, *Aconitum balfourii*, *Aconitum heterophyllum*, *Picrorhiza kurrooa, Saussurea costus* and *Valeriana wallichii*) in farmer's field in high altitude region of Uttarakhand" for easy availability of raw materials as well as conservation of species in natural habitats.

2. Financial Assistant Providing Agency: Jivanti Welfare and Charitable Trust (JWCT), New Delhi through M/S Dabur Research & Development Centre (DRDC), Dabur India Limited (DIL), Sahibabad, Ghaziabad (U.P.), India

3. Project Implementing Agency: High Altitude Plant Physiology Research Centre (HAPPRC), Hemvati Nandan Bahuguna Garhwal University, Srinagar (Garhwal)-246 174

4. Project Executing Authority: Director, HAPPRC

5. Project Principal Investigator: Dr. Vijay Kant Purohit, Sr. Scientific Officer, HAPPRC

6. Project Period: 3 years

7. Project Cost: Rupees Thirty one lakh three thousand only (Minimum Rupees 31.03 Lakh)

8. Grant Received: Rs. 24,88,300 (Rupees twenty four lakh eighty eight thousnad three hundred only)

9. Financial year: March to March

10. Major objective of the project: Development of large scale seedlings and promotion of cultivation of selected medicinal plants in farmers' fields for easy availability of raw materials as well as conservation of species in natural habitats.

11. Details of objectives/technicalities of the project: Mass scale planation of quality planting materials of high value threatened medicinal species is one of the viable options for conservation and sustainable utilization. It will also provide great livelihood opportunities to the poor and marginal farmers in rural areas. The present project has been proposed in these lines with the following technicalities.

- Mass scale production and multiplication arrangement of quality planting material through nursery development and utilization of other regional resource of public and private sector.
- Distribution of plantlets for extensive plantations of the species in suitable areas.
- Training and skill development of the farmers for plantation, maintenance/ after care harvesting and post- harvest management of the selected species.
- To develop plantations and harvesting protocols of the species for future replications.
- To ensure people's participation in long term maintenance of the plantation for their optimum production.
- Income augmentation through livelihood support generation for small and marginal farmers (especially women).

- Conduct Research and Domestication of the selected species for promoting cultivation.
- Rhizospheric studies of Vatsanabh, Jatamansi etc. will be carried out in joint collaboration between Dabur & HAPPRC.

12. Project Deliverables:

1. The plantation in the selected areas of Uttarakhand with an aim to natural resource augmentation and supplement the livelihood of local community through sustainable harvesting.
2. Methods to develop sustainable plant part collection in an eco-friendly manner may be by engaging with other partners.
3. Both the signing parties to abide by the same and work together to ensure that, the targets of the project are met effectively.
4. Submission of report has to be ensured by HAPPRC on quarterly basis as per the prescribed format under CSR norms.
5. Social benefit aspects for the outcome of project.
6. Sharing of scientific data outcome and publication from this project.

13. Work done so far upto 31 March 2023: To develop the mass scale Quality Planting Material (QPM), i.e. seedlings and further promotion of cultivation in farmers and community owned land preferable in high altitude region of Chamoli, Rudraprayag, Pauri, Tehri, Bageshwar, Nainital, and Pithoragarh districts of Uttarakhand, six highly important medicinal plants have been selected **(Table 1).** Besides the development of mass scale seedlings and promotion of cultivation, the rhizospheric studies of the selected medicinal and aromatic plants have been also proposed. In continuation of the proposed work, the total 6ha (300 nali) of land has been attempted/covered under cultivation. Approximate 2,78,625 seedlings were developed and approximate 1391.62 gm of seeds were collected. During the report period 15 villages, 4 development block and three districts with 577 farmers/villages has been covered through organizing the 15 farmers workshop/training/ plant distribution programme so far. The details of the work performed with photographs are depicted as follows.

Table 1. List of proposed medicinal and aromatic plants under project.

Sr.No.	Plant species	Local Name	Geographical Distribution (m asl)	Survival Status	Cultivation Status in Uttarakhand	Specimen Photo of the selected species
1.	*Nardostachys grandiflora*	Jatamansi/ Masi	3200-5000	EN	Very poor	
2.	*Aconitum balfourii*	Vatsanabha, Mitha Vish	2800-4200	EN	Poor	

3.	*Aconitum heterophyllum*	Atis, Atvika	3000-4500	EN	Moderate	
4.	*Picrorhiza kurrooa*	Kutki, Kedar kadwi	3000-4500	R-EN	Good	
5.	*Saussurea costus*	Kuth	2600-4000	R-EN	Good	
6.	*Valeriana wallichii*	Tagar, Sugandhbala	1500-2500		Very poor	

14. Photographs of the seedlings developed and kept for further growth in shade house at Baniyakund (2460m asl), cultivation in farmers field, monitoring of the works with some other activities performed during the year (April – June, 2022) under J.W.C.T. project.


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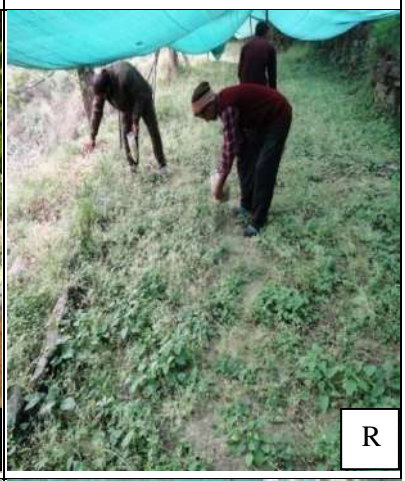
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Figure 1. A-D Field visit of village of Partha, E-I Field visit of village of Rushiyana, J-K Field visit of village of Kasbinagar, L-N Field visit of village of Sunaumallah, O-P Seed collection of *Valeriana jatamansi* at our Nursery Kulsari (Chamoli), Q-T Seed sowing of *Saussurea costus*, *Nardostacys grandiflora*, at Kulsari nursery (Chamoli), U-X transport of project related materials from Srinagar to Kulsari nursery (Chamoli), Y-Z,a Field visit of village of Tyuri, b-g,m Field visit of village of Shyalmi, h-I Seed sowing of*Nardostachys grandiflora* and *Aconitum heterophyllum* in Poly house at Baniyakund, k Seedling of *Saussurea costus*, n-s land preparationand construction of Polytunalsat Baniyakund for seed sowing work and seeds of *Aconitum balforii, Nardostachys grandiflora*and *Saussurea costus* sowed inside the constructed polytunnels.

Table 2. Details of newly added farmers in cultivation practice of selected species.

Sr. No.	Name of the farmer	Name of the village	Contact number of the farmer	Name of the species cultivating by farmer	Land occupied under cultivation (Nali)	Status of the cultivation	Additional crop cultivating by farmers
1.	Shri Dalveer Singh	Partha	8057691089	*Saussurea costus, Valeriana jatamansi,*	0.5	Initiated	Potato, Barley, wheat, Rice, Amaranthus
2.	Smt. Gita Devi	,,	9999620298	*Picrorhiza kurrooa*	1.0	Well performance	Potato, Barley, wheat, Rice, Amaranthus
3.	ShriRaghuveer Singh	,,		*Picrorhiza kurrooa*	0.5	Initiated	Potato, Barley, wheat, Rice, Amaranthus
4.	Shri Govind Singh	,,		*Picrorhiza kurrooa*	0.5	Initiated	Potato, Barley,

							wheat, Rice, Amaranthus
5.	Shri Pushkar Singh	,,	8755047543	*Picrorhiza kurrooa*	0.5	Initiated	Potato, Barley, wheat, Rice
6.	Shri Paan Singh	,,			0.5	Initiated	Potato, Barley, wheat, Rice
7.	Shri Gajae Singh	Tran Partha	8979705536	*Picrorhiza kurrooa, Rheum emodi*	0.5	Initiated	Potato, Barley, wheat
8.	Shri Balwant Singh Negi	,,	8192862863	*Valerianajatamansi*	0.5	Initiated	Initiated
9.	Smt. Bhawani Devi	,,	9756240196	*Picrorhiza kurrooa*	0.5	Initiated	Potato, Barley, wheat, Rice
10.	ShriRatan Singh	,,	-	*Picrorhiza kurrooa*	0.5	Initiated	Potato, Barley, wheat, Rice
11.	Shri Anand Singh	,,	-	*Saussurea costus, Valeriana jatamansi, Picrorhiza kurrooa*	1.0	Well performance	Potato, Barley, wheat, Rice
12.	Shri Madho Singh	,,	-	*Picrorhiza kurrooa*	0.5	Initiated	Potato, Barley, wheat, Rice
13.	Shri Bhuwan Singh Pimoli	,,	-	*Saussurea costus, Valeriana jatamansi, Picrorhiza kurrooa*	0.5	Initiated	Potato, Barley, wheat, Rice
14.	Shri Kuwar Singh (Pardhan)	,,	-	*Saussurea costus, Picrorhiza kurrooa*	1.0	Initiated	Potato, Barley, wheat, Rice
15.	Shri PitamberDutt	,,	9871084382	*Picrorhiza kurrooa*	1.0	Initiated	Potato, Barley, wheat, Rice
16.	Shri RamChander	,,	7668581366	*Picrorhiza kurrooa*	1.5	Well performance	Potato, Barley, wheat, Rice
		Rusiyana					
17.	Shri Bharat Singh Rana	,,	7060449964	*Picrorhiza kurrooa, Aconitum hetrophyllum, Valeriana jatamansi*	2.0	Well performance	Potato, Barley, wheat, Rice
18.	Shri Sudershan Singh Rana	,,	7456966732	*Picrorhiza kurrooa, Saussurea costus, Rheum emodi, Valeriana jatamansi*	1.0	Well performance	Potato, Barley, wheat, Rice
19.	Shri Mohan Singh	,,	9634123066	*Picrorhiza kurrooa*	1.5	Well performan	Potato, Barley,

	Rauthan					ce	wheat, Rice
21.	Shri Mohan Singh Rawat	,,	7500677806 21	*Picrorhiza kurrooa*	1.0	Well performan ce	Potato, Barley, wheat, Rice
23.	Shri Dinesh Singh Rawat	,,	-	*Picrorhiza kurrooa*	2.0	Well performan ce	Potato, Barley, wheat, Rice
24.	Shri Pushkar Singh Rana	,,	-	*Picrorhiza kurrooa*	1.5	Well performan ce	Potato, Barley, wheat, Rice
25.	Shri Puna Singh Rawat	,,	-	*Picrorhiza kurrooa*	0.5	Initiated	
26.	Shri Mahendar Singh	,,	9878149527	*Saussurea costus*	-	Interested	
		Kasbinagar					
27.	Shri Balwant Ram	Kasbinagar	8865042109	*Picrorhiza kurrooa*	2.0	Well performan ce	Barley, wheat, Rice
28.	Shri Gajpal Ram	,,	9690499157	-	-	Interested	Walnut, Rice, Wheat,
29.	Shri DevSinghB handari	**Sunaumall a**	9557461512	-	-	Interested	Potato, wheat, Rice
30.	Gudi Devi	,,	,,	-	-	Interested	,,
31.	Kundan Singh	,,	8979011384	-	-	Interested	Potato, Coriander, Wheat, Rice
32.	Shri Kalm Singh Semwal	**Tyuri**	7455807117	-	-	Interested	Wheat, Rice,Barley, Millet
33.	Smt. Sharita Devi	,,	7895949115	-	-	Interested	Wheat, Rice,Barley, Millet
34.	Dr. D.S. Rawat	,,	9412404077	*Picrorhiza kurrooa*	50.0	Well performan ce	Wheat, Rice,Barley, Millet
35.	Shri Yogendar Singh	Ushara (Shayamli)	7500659381	*Picrorhiza kurrooa*	0.5	Well performan ce	Wheat, Rice,Barley, Millet
36.	Shri Parmod Singh Bejwal	,,	-	-	-	Interested	Wheat, Rice,Barley, Millet
37.	ShriPardeep Singh Bejwal	,,	-	-	-	Interested	Wheat, Rice,Barley, Millet
38.	Shri Rajender Singh	,,	-	-	-	Interested	Wheat, Rice,Barley, Millet
39.	Shri Veer Singh Bejwal	,,		*Picrorhiza kurrooa*	2.0	Well performan ce	Wheat, Rice,Barley, Millet
40.	Shri Perbal Singh Bejwal	,,		*Picrorhiza kurrooa*	2.0	Well performan ce	Wheat, Rice,Barley, Millet
41.	Shri Satveer Singh Bejwal	,,	9389307557	*Picrorhiza kurrooa*	1.0	Well performan ce	Wheat, Rice,Barley, Millet
42.	Shri Kalm	,,	9690079914	*Picrorhiza*	1.0	Well	Wheat,

	Singh Bejwal			*kurrooa*		performance	Rice,Barley, Millet
43.	Shri Pardeep Singh Bejwal	,,		*Picrorhiza kurrooa*	0.5	Well performance	Wheat, Rice,Barley, Millet
44.	Shri Satyender Singh Bejwal	,,		*Picrorhiza kurrooa*	0.5	Well performance	Wheat, Rice,Barley, Millet
45.	Shri noop Singh Negi	,,		*Picrorhiza kurrooa*	2.0	Well performance	Wheat, Rice,Barley, Millet
45.	Shri Ramesh Singh Bejwal	,,		*Picrorhiza kurrooa*	1.5	Well performance	Wheat, Rice,Barley, Millet
47.	Shri Kuwar Singh (Pardhan)	,,		*Picrorhiza kurrooa*	3.0	Well performance	Wheat, Rice,Barley, Millet
48.	Shri Darshan Singh Bejwal	,,		*Picrorhiza kurrooa*	-	Interested	Wheat, Rice,Barley, Millet
49.	ShriGajae Singh			*Picrorhiza kurrooa*	0.5	Well performance	Wheat, Rice,Barley, Millet
50.	ShriVirendar Singh Negi	,,		*Picrorhiza kurrooa*	-	Interested	Wheat, Rice,Barley, Millet
51.	Shri Jai Singh Bejwal			*Picrorhiza kurrooa*	-	Interested	Wheat, Rice,Barley, Millet
52.	ShriSumant Singh		8958342983	*Picrorhiza kurrooa*	0.5	Initiated	Wheat, Rice,Barley, Millet
53.	Shri Mohan Singh (Teacher)		-	-	-	Interested	Wheat, Rice,Barley, Millet
54.	ShriDilip Singh		-	-	-	Interested	Wheat, Rice,Barley, Millet

15. Information about sale of raw as well as planting material of selected species recorded during field visit.

Farmers get income for their livelihood:

1. Shri Balwant Ram (Kasbinagar) sold 18 kg dry roots of kutki worth of rupees 27000 and also sold 20000 cuttings of kutki worth of rupees 20000.

2. Shri Gajpal Ram (Kasbinagar) sold 10 kg seed of kuth@ 500/kg and earn rupees 5000.

3. Shri Sudarshan Singh Rana (Ruisiyaan) sold 20 kg dry roots of kutki worth of rupees 29000.

4. ShriYogendrasingh (Shayalmi, ushara) sold 20 kg seed of kuth@ 200/ kg worth of rupees 2000 and also sold 50 kg dry root of kutki@ Rs. 1200/ kg and earn rupees 60000 through HRDI, Gopeshwar, mandal.

5. Anoop Singh Negi (Shayalmi, ushara) sold 15 kg of kutki@ Rs. 1200/ kg worth of rupees 18000 throughHRDI, GopeshwarMandal.

6. Tungnath group of farmers (Shayalmi, ushara) sold 8 lakh kutki cutting@ Rs. 1.0/cutting worth of rupees 800000 through HRDI, Gopeshwar, Mandal.

7. Dr. D.S. Rawat (Tyuri, Guptkashi) sold 2.0quntals kutki @ Rs. 1450/ kg worth rupees 290000 through HRDI, Gopeshwarmandal.

16. Details of seedlings distributed to faermers for promotion of cultivation of selected species 2022-2023.

Figure 2. Uprooting and packing of quality planting material of *P. kurooa*, *(A-D)*, *N. grandiflora* (F-H), *A. heterophyllum* (I-K) and *V.wallichii* from field stations Baniyakund, Pothivasa and Kulsari of HAPPRC for farmers distribution under JWCT project.

Table 3. Summary of seedlings distributed to farmers in the month of July-September 2022.

Sr. NO.	Name of the species	Number of seedlings distributed
1.	*P. kurrooa*	1,91,550
2.	*N. grandiflora*	19.930
3.	*A. heterophyllum*	14,045
4.	*V. wallichii*	48,100
5.	*S. costus*	5000
6.	**Total Number of seedlings distributed**	**2,78,625**

17. Details of farmers workshop/training/ plant distribution programme organized during the 2022-2023.

Table 4. Summary of Farmer's on-farm workshop cum training/plant distribution programme.

Sr.No.	Activity	No.
1.	On-farm workshop cum training/plant distribution programme	15
2.	Toatl Number of district covered under cultivation	03
3.	Total number of institutional members (HAPPRC) attended programme	68
4.	Total number of Males farmers (GEN) attented programme	280
5.	Total number of Females farmers (GEN) attended programme	235
6.	Total number of Males farmers (SC) attended programme	41
7.	Total number of Females farmers (SC) attended programme	21
8.	**Total number of farmers/participants attended meetings**	**645 (577 farmers)**

Note- GEN (General), SC (Scheduled Cast)

Table 5. Summary of seedlings distributed to farmers in the month of July-September 2022.

Sr. NO.	Name of the species	Area covered under cultivation
1.	*P. kurrooa*	4.75 acre (96 Nali)
2.	*N. grandiflora*	0.50 acre (10 Nali)
3.	*A. heterophyllum*	0.35 acre (7.02 Nali)
4.	*V. wallichii*	1.19 acre (24.05Nali)
5.	*S. costus*	0.12 acre (2.5 Nali)
6.	**Total area occupied under cultivation/ plantation**	**6.91 acre (139.57 Nali)**

Table 6. List and Summary of villagers/farmers and other participants attended one day on farm workshop/Training/plants distribution programme organized during July to August 2022.

Sr.No.	Name of the village	Participants				Other participants	Institutional members (HAPPRC)	Total participants
		Male (Gen)	Female (Gen)	Male (SC)	Female (SC)			
1.	**Teela**	37	04	08	10	-	05	64
2.	**Pala-Kurali**	24	36	0	0	06	05	71
3.	**Gainthnda**	23	14	10	5	01	05	58
4.	**Kaviltha**	9	19	0	0	03	05	36
5.	**Jaal Malla**	11	18	0	0	02	05	36
6.	**Jaal Talla**	09	28	0	0	02	05	44
7.	**Chaumasi**	11	20	0	0	02	05	38
8.	**Kulpudi**	11	05	01	0	0	04	21
9.	**Rushyan**	10	0	0	0	0	03	13

10.	**Ratgaov**	13	0	02	0	0	03	18
11.	**Taal**	12	8	05	0	0	04	29
12.	**Syanri Bang**	27	24	0	0	05	04	60
13.	**Pagna**	25	17	01	04	-	04	51
14.	**Sitel**	31	25	03	-	11	07	77
15.	**Syanri Bhair**	27	17	11	02	01	04	62
Total participants		**280**	**235**	**41**	**21**	**33**	**68**	**678**

Table 7. Seedlings/plants provided /distributed to villagers/farmers during on farm level workshop /training/plant distribution programme organized during July to August 2022.

Sr.No.	**Name of the villages**	**Name of the plants distributed**					**Total no. of plants distributed**
		P. kurrooa	***A. heterophyllum***	***N. grandiflora***	***V. wallichii***	***S. costus***	
1.	**Teela**	14,750	2950	-	5900	-	
2.	**Pala Kurali**	30,000	3000	6000	6000	-	23,600
3.	**Gaithana**	10,400	1000	2000	5,200	-	45,000
4.	**Kaviltha**	2,800	-	-	5,600	-	18,600
5.	**Jaal Malla**	5,800	-	-	5,800	-	8,400
6.	**Jaal Talla**	7,400	-	-	7,400	-	11,600
7.	**Chaumasi**	6,200	775	1,550	-	-	14,800
8.	**Kulpudi**	5,100	-	-	1700	-	8,525
9.	**Rushyan**	2,000	1000		2500	-	6,800
10.	**Ratgaov**	22,500	1000	-	3,000		5,500
11.	**Taal**	10,000	-	-	5,000	5,000	26,500
12.	**Syanri Bangali**	10,200	2,550	1,530			20,000
13.	**Pagna**	23,500	-	-	-	-	14,280
14.	**Sitel**	29,500	1,770	8,850	-	-	23,500
15.	**Syanri Bhainti**	11,400		-			40,120
Total		**1,91,550**	**14,045**	**19,930**	**48,100**	**5000**	**2,78,625**

18. Details of farmers workshop cum training/plant distribution programme organsied during the year 2022-2023

The numbers of farmers workshop cum training/plant distribution programme were organized under JWCT project in different area of Uttarkhand for acheiveing the cultivation target of selecdted species. During the entire period of workshop cum training programme the project staff and representative of institute briefs about the aim of the project, role of HAPPRC, work plan of participants followed by diffusion of technical information about cultivation and distribution of plants of selected species to farmers.

Table 8. List of villagers/farmers participated in one day On-farm farmer's workshop cum training programme organized at Village Pala Kurali, Block, Jakholi, Rudraprayag on 12/July/2022 under J.W.C.T. Project.

Sr.No.	**Villagers Name**	**Father/Husband Name**	**Address**
1.	Shri Suryapal Singh Rana	Shri Asad Singh	**Vill-**Pala Kurali **Block &Distt. -**Jakholi, Rudraprayag **Contact No.-** 7465964681 **Aadhar No.-** 304465923973

2.	Shri Ravindra Singh Rana	Shri Jabbar Singh Rana	**Vill-**Pala Kurali **Block &Distt. -**Jakholi, Rudraprayag **Contact No.-** 9389703778 **Aadhar No.-** 787809975948
3.	Shri Narottam Singh Rana	Shri Ameer Singh Rana	**Vill-**Pala Kurali **Block &Distt. -**Jakholi, Rudraprayag **Contact No.-** 7818039564 **Aadhar No.-** 893805772806
4.	Shri Rakesh Singh Rana	Shri Umrav Singh Rana	**Vill-**Pala Kurali **Block & Distt.-**Jakholi, Rudraprayag **Contact No.-** 7248625456
5.	Shri Bhagwan Singh Rana	Shri Gabbar Singh Rana	**Vill-**Pala Kurali **Block & Distt.-**Jakholi, Rudraprayag **Contact No.-** 7534063904 **Aadhar No.-** 533744433892
6.	Smt. Beena Devi	Shri Dinesh Rana	**Vill-**Pala Kurali **Block &Distt. -**Jakholi, Rudraprayag **Contact No.-** 7055968537 **Aadhar No.-** 910561568370
7.	Smt. Pushpa Devi	Shri Surendra Rana	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7505824758 **Aadhar No.-** 805532445130
8.	Smt. Sunita Devi	Shri Trilok Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 6398821034 **Aadhar No.-** 626478618985
9.	Shri Vinod Singh	Shri Vachan Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 8192959490 **Aadhar No.-** 458712587278
10.	Smt. Chaita Devi	Shri Meharvan Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Aadhar No.-** 727263497923
11.	Smt. Shashi Devi	Shri Madhusudan Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7505123979 **Aadhar No.-** 604241638671
12.	Smt. Rinki Devi	Shri Rajesh Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 8941886509 **Aadhar No.-** 625309287735
13.	Smt. Vijaya Devi	Shri Satpal Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 9012268140 **Aadhar No.-** 750765191651
14.	Smt. Jasdei Devi	Shri Jai Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 6396742801 **Aadhar No.-** 796011362357
15.	Smt. Rajni Devi	Shri Kuldeep Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 8476944137 **Aadhar No.-** 676776074299
16.	Smt. Guddi Devi	Shri Balveer Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7409640836 **Aadhar No.-** 610278932538
17.	Shri Govind Singh	Shri Bhagwan Singh	**Vill-**Pala Kurali

			Block &Distt.-Jakholi, Rudraprayag **Contact No.-** 9625075469 **Aadhar No.-** 729979632867
18.	Shri Manveerendra Singh	Shri Bachan Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 8958135079 **Aadhar No.-** 554154845552
19.	Smt. Veena	Shri Raghuveer Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 8865864816 **Aadhar No.-** 549153943622
20.	Smt. Vineeta Devi	Shri Narendra Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7417018521 **Aadhar No.-** 803352129529
21.	Smt. Anita Devi	Shri Bhupendra Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 8449135591 **Aadhar No.-** 760917897450
22.	Smt. Raji Devi	Shri Dhan Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 8445671828 **Aadhar No.-** 260508792242
23.	Smt. Roopa Devi	Shri Rukam Singh	**Vill-**Pala Kurali **Block &Distt. -**Jakholi, Rudraprayag **Contact No.-** 6397728517 **Aadhar No.-** 676265296251
24.	Smt. Pushpa Devi	Shri Guddu Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7055631279 **Aadhar No.-** 783159581632
25.	Smt. Sumitra Devi	Shri Uday Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7247821212 **Aadhar No.-** 380423562797
26.	Smt. Sarita Devi	Shri Chain Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7088198816 **Aadhar No.-** 935920306561
27.	Smt. Darshni Devi	Shri Bachan Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7533937834 **Aadhar No.-** 457527648630
28.	Smt. Anuradha Devi	Shri Jairaj Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 8006531823 **Aadhar No.-** 628513216638
29.	Smt. Suneeta Devi	Shri Nathi Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7900582560 **Aadhar No.-** 879315254402
30.	Smt. Lakshmi	Shri Balwant Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7505177982 **Aadhar No.-** 228204243104
31.	Shri Padam Singh	Shri Karan Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 9411398556 **Aadhar No.-** 327512788635

32.	Shri Ravindra Singh	Shri Pratap Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 8938928927 **Aadhar No.-** 576834695884
33.	Shri Baishak Singh	Shri Musha Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Aadhar No.-** 301941080183
34.	Shri Suresh Singh	Shri Chhota Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 9355495406 **Aadhar No.-** 653669977356
35.	Shri Sate Singh	Shri Tirpal Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 9967377934 **Aadhar No.-** 726808914400
36.	Shri Jaspal Singh	Shri Gabar Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 8449627193 **Aadhar No.-** 776062928026
37.	Shri Leelanand Thapliyal	Shri Narayan Dutt	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 9720756117 **Aadhar No.-** 655872115578
38.	Smt. Roshani Devi	Shri Pushkar Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 9548441648 **Aadhar No.-** 595553937137
39.	Smt. Maya Devi	Shri Narendra Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7251926729 **Aadhar No.-** 560928341678
40.	Shri Rakesh Singh	Shri Chhota Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 9756823301 **Aadhar No.-** 298036357588
41.	Shri Mukesh Singh	Shri Chhota Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 8958560566 **Aadhar No.-** 752890057445
42.	Shri Digraj Singh Rana	Shri Dinesh Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 8006239765 **Aadhar No.-** 816754735614
43.	Shri Virendra Singh	Shri Amar Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 8126634395 **Aadhar No.-** 778080416049
44.	Smt. Kuwari Devi	Shri Daleb Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 97560069779 **Aadhar No.-** 527869878628
45.	Smt. Anari Devi	Shri Chait Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7055192088 **Aadhar No.-** 969845889216
46.	Smt. Deepa Devi	Shri Pradeep Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7536069550 **Aadhar No.-** 962460998378

47.	Smt. Lakshmi Devi	Shri Ajay Shankar Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 9627625954 **Aadhar No.-** 248186208697
48.	Smt. Kavita Devi	Shri Makan Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7409438199 **Aadhar No.-** 559933753205
49.	Smt. Usha Devi	Shri Jatan Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 8475865365 **Aadhar No.-** 661871755461
50.	Shri Chain Singh	Shri Avtar Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7088198816 **Aadhar No.-** 341313510998
51.	Shri Kamana Bhandari	Shri D.S.Bhandari	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 8475980471
52.	Shri Sunil Kumar Maithani	Shri D.N.Maithani	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag
53.	Smt. Bharti Devi	Shri Ranjeet Rawla	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 8954305464
54.	Shri Ashwal Gaur	Shri H.M.Gaur	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7467843141
55.	Shri Subhash Singh Rana	Shri Pratap Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7500301843 **Aadhar No.-** 491433819868
56.	Shri Hayat Singh	Shri Chatar Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 8954392188 **Aadhar No.-** 554510156857
57.	Smt. Sona Devi	Shri Roshan Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7466042645 **Aadhar No.- 416194559931**
58.	Shri Raghuveer Singh	Shri Jeet Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 9675347529 **Aadhar No.- 829643787949**
59.	Shri Madan Singh	Shri Shyam Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 9645347529 **Aadhar No.- 431222770664**
60.	Smt. Sulochana Devi	Shri Sukhchain Singh	**Vill-**Pala Kurali **Block &Distt. -**Jakholi, Rudraprayag **Contact No.-** 7617576523 **Aadhar No.-** 283472947749
61.	Smt. Saukari Devi	Shri Mangal Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 9818623846 **Aadhar No.- 443187721665**
62.	Smt. Mamta Devi	Shri Chaman Singh	**Vill-**Pala Kurali **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7983655985 **Aadhar No.- 961530882478**

63.	Smt. Thuma Devi	Shri Puran Singh	**Vill-**Pala Kurali **Block &Distt. -**Jakholi, Rudraprayag **Aadhar No.- 623062754883**
64.	Smt. Darshni Devi	Shri Veer Singh	**Vill-**Pala Kurali **Block &Distt. -**Jakholi, Rudraprayag **Aadhar No.- 871325568537**
65.	Shri Beerbal Singh Rana	-	**Vill-**Pala Kurali **Block &Distt. -**Jakholi, Rudraprayag
66.	Dr. Vijay Kant Purohit	Shri A. P. Purohit	**HAPPRC, Contact No.- 9456531715**
67.	Shri Kailash Kandpal	Shri B. P. Kandpal	**HAPPRC, Contact No.- 7302808941**
68.	Shri Jaidev Chauhan	Shri B. S. Chauhan	**HAPPRC, Contact No.- 8126211560**
69.	Shri Vipin Rawat	Shri P. S. Rawat	**HAPPRC, Contact No.- 9458113893**
70.	Shri Kamal Pundir	Shri G. S. Pundir	**HAPPRC, Contact No.- 9540468782**

Figure 3. Photographs of On-farm farmers workshop cum training/plant distribution programme organized at Pala Kurali village, district Rudraprayag on 12/07/2022. Delivered technical knowledge by Dr. V.K. Purohit (SSO) to farmers/participants (A-G), distributed plant material to farmers (H-J), farmers/participants group photograph (K-L).

Table 9. List of Villagers/Farmers participated in one day On-farm farmers workshop cum training/plant distribution programme for promotion of cultivation of MAP's at Village Gainthana Block, Jakholi, Rudraprayag on 12/7/2022 under J.W.C.T. Project.

Total participants: 54 (male- 35, female-19)

Sr.No.	Villagers Name	Father/Husband Name	Address
1.	Shri Sarveer Singh Mengwal	Late Shri Buddhi Singh	**Vill-**Gainthana **Block &Distt. -**Jakholi, Rudraprayag **Contact No.-** 9758634254
2.	Shri Anusuya Prasad	Shri Balveer Chomwal	**Vill-**Gainthana **Block &Distt. -**Jakholi, Rudraprayag **Contact No.-** 7251079688
3.	Shri Harendra Singh	Shri Govind Singh	**Vill-**Gainthana **Block &Distt. -**Jakholi, Rudraprayag **Contact No.-** 9758656459
4.	Shri Mohan Lal Shah	Shri Dillu Shah	**Vill-**Gainthana **Block &Distt. -**Jakholi, Rudraprayag **Contact No.-** 8958395424
5.	Shri Shivraj Singh	Shri Katag Singh	**Vill-**Gainthana **Block &Distt. -**Jakholi, Rudraprayag **Contact No.-** 9759412169
6.	Shri Virendra Singh	Shri Mahendra Singh	**Vill-**Gainthana **Block &Distt. -**Jakholi, Rudraprayag **Contact No.-** 9702560573 **Aadhar No.-** 308359136715
7.	Shri Sajjan Singh	Late Shri Dal Bahadur Sing	**Vill-**Gainthana **Block &Distt. -**Jakholi, Rudraprayag **Contact No.-** 8393931593 **Aadhar No.-** 566212677130
8.	Shri Prakash Chand	Shri Prem Shah	**Vill-**Gainthana **Block &Distt. -**Jakholi, Rudraprayag **Contact No.-** 7409982828
9.	Shri Pritam Singh	Late Shri Umrav Singh	**Vill-**Gainthana **Block &Distt. -**Jakholi, Rudraprayag **Contact No.-** 9675730456
10.	Shri Gambhir Singh	Late Shri Jagat Singh	**Vill-**Gainthana **Block &Distt. -**Jakholi, Rudraprayag **Contact No.-** 9619581358
11.	Shri Mahesh Lal	Shri Shobha Lal	**Vill-**Gainthana **Block &Distt. -**Jakholi, Rudraprayag **Contact No.-** 7830956067
12.	Shri Chiranji Lal	Shri Shibbu Lal	**Vill-**Gainthana **Block &Distt. -**Jakholi, Rudraprayag **Contact No.-** 8006027450
13.	Shri Ranvir Singh	Late Shri Keshar Singh	**Vill-**Gainthana **Block &Distt. -**Jakholi, Rudraprayag **Contact No.-** 8650702284
14.	Shri Lakhan Singh	Late Shri Bhauh Singh	**Vill-**Gainthana **Block &Distt. -**Jakholi, Rudraprayag **Contact No.-** 9675346365
15.	Shri Ram Lal	Shri Udai Lal	**Vill-**Gainthana

			Block &Distt. -Jakholi, Rudraprayag **Contact No.-** 8393857913
16.	Shri Guddu Singh	Shri Chand Singh	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7902146678
17.	Shri Ranjeet Singh	Late Shri Hayat Singh	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 9568449256
18.	Shri Kapoor Lal	Late Shri Keshru Lal	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 9719149034
19.	Smt. Mamta Devi	Shri Mohan Singh	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7249942581
20.	Smt. Seema Devi	Shri Vikram Singh	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7830128895
21.	Smt. Pinki Devi	Shri Virendra Singh	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 8954324932
22.	Smt. Shashi Devi	Shri Pradeep	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7409344002
23.	Smt. Rukma	Shri Sabbal	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag
24.	Smt. Chhoti Devi	Shri Indra Singh	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 8192065392
25.	Smt. Neema Devi	Shri Rajkapur Singh Mengv	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 9627484106
26.	Smt. Rajni Devi	Shri Meharban Singh	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag
27.	Smt. Sharmila Devi	Shri Vijaypal Singh Mengw Singh	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 9536661865
28.	Smt. Rajni Devi	Shri Surjeet Singh Mengwa	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 8057052123
29.	Smt. Sharmila Devi	Shri Surjeet Singh Mengwa	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 9627484106
30.	Smt. Rajni Devi	Shri Surjeet Singh Mengwa	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 8057052123
31.	Shri Prakash Singh	Shri Umed Singh	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7251804850
32.	Shri Avtar Singh	Shri Mohan Singh	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7251925681

			Aadhar No.- 306624176354
33.	Smt. Kastura	Late Shri Prem Singh	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag
34.	Shri Man Singh Nepali	Shri Nakul Singh	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7088496507
35.	Shri Vikram Singh	Shri Bal Singh	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag
36.	Shri Kripal Singh	Late Shri Umrav Singh	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 8006626928
37.	Shri Pratap Singh	Late Shri Hukam Singh	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag
38.	Shri Rajkumar	Late Shri Umrav Singh	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag
39.	Shri Rajendra Shah	Shri Prem Shah	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag
40.	Shri Jeewan Lal	Shri Paatu Lal	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 8194049387
41.	Shri Kabutar Singh	Shri Shiv Singh	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 9548826928
42.	Smt. Phooldei	Late Shri Amar Singh	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag
43.	Smt. Mamta Devi	Shri Om Prakash	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag
44.	Smt. Pooja	Shri Rajendra Chomwal	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 8650903653
45.	Smt. Rukmani Devi	Shri Jagori Chomwal	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag
46.	Smt. Prabha Devi	Shri Manoj Kumar	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7617643841
47.	Smt. Vineeta Devi	Shri Kmalesh Shah	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 9536747874
48.	Kumari Sweta	Shri Manohar Chomwal	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7830163448
49.	Shri Kapoor Shah	Shri Bhupati Shah	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 9761681259
50.	Smt. Gaura Devi	Shri Shurveer Singh	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7251811323
51.	Shri Dhan Lal	Shri Bachhu Lal	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7618465372
52.	Smt. Suraji Devi	Shri Dhomu Lal	**Vill-**Gainthana

			Block &Distt.-Jakholi, Rudraprayag
53.	Smt. Manju Devi	Shri Kutma	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7830180194
54.	Smt. Jas Devi	Shri Guddu Lal	**Vill-**Gainthana **Block &Distt.-**Jakholi, Rudraprayag **Contact No.-** 7830180194
55.	Dr.V.K. Purohit	Late Shri A.P. Purohit	**HAPPRC, Contact No.-** 9456531715
56.	Shri Kailash Kandpal	Shri B. P. Kandpal	**HAPPRC, Contact No.-** 7302808941
57.	Shri Jaidev Chauhan	Shri B. S. Chauhan	**HAPPRC, Contact No.-** 8126211560
58.	Shri Vipin Rawat	Shri P. S. Rawat	**HAPPRC, Contact No.-** 9458113893
59.	Shri Kamal Pundir	Shri G. S. Pundir	**HAPPRC, Contact No.-** 9540468782

Figure 4. Photographs of On-farm farmers workshop cum training/plant distribution programme organsied at Village Gainthana Block, Jakholi, Rudraprayag on 12/7/2022 under J.W.C.T. Project. Delivered technical knowledge by Dr. V.K. Purohit (SSO) to farmers/participants (A-B), plant material distributed to farmers (C-E), group photograph of farmers/participants (F).

Table 10. List of Villagers/Farmers participated in one day On-farm farmers workshop cum training/plant distribution programme for promotion of cultivation of MAP's at Village Kaviltha Block, Ukhimath, Rudraprayag on 19/July/2022 under J.W.C.T. Project.
Total participants: 35 (male- 17, female-19)

S.N.	Villagers Name	Father/Husband Name	Address
1.	Shri Devendra Singh Negi	Shri Makar Singh Negi	**Vill-**Kaviltha **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 9045183495**
2.	Shri Kuldeep Singh	Shri Kunwar Singh	**Vill-**Kaviltha **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-9675852923**
3.	Shri Arvind Singh	Shri Abbal Singh	**Vill-**Kaviltha **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-9720592827** **Aadhar No.-663105982011**
4.	Shri Digvijay Rawat	Shri Narendra Singh Rawat	**Vill-**Kaviltha

			Block &Distt.-Ukhimath, Rudraprayag **Contact No.-8194095634**
5.	Shri Balwant Singh Rawat	Shri Bagh Singh	**Vill-**Kaviltha **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-9761868101** **Aadhar No.-234015000424**
6.	Shri Mahendra Singh Rawat	Shri Kalam Singh Rawat	**Vill-**Kaviltha **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-8941912851** **Aadhar No.-498885695501**
7.	Shri Pradeep Rawat	Shri Dev Singh Rawat	**Vill-**Kaviltha **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-7895728859**
8.	Smt. Bhama Devi	Shri Rajesh Gaur	**Vill-**Kaviltha **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-8393027651**
9.	Smt. Sangeeta Devi	Shri Chandramohan Bhatt	**Vill-**Kaviltha **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 7037391051**
10.	Smt. Puja Devi	Shri Dinesh Chandra Gaur	**Vill-**Kaviltha **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 9720026627**
11.	Smt. Sulochana Devi	Shri Jaykrishna Chamola	**Vill-**Kaviltha **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-8979039669**
12.	Smt. Beena Devi	Lt. Shri Purosottam Bhatt	**Vill-**Kaviltha **Block &Distt.-**Ukhimath, Rudraprayag
13.	Smt. Sudha	Shri Kunwar Singh Rawat	**Vill-**Kaviltha **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 6978510432**
14.	Smt. Jyoti Devi	Shri Deepak Gaur	**Vill-**Kaviltha **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 9897813793**
15.	Smt. Asha Devi	Shri Anil Singh Rana	**Vill-**Kaviltha **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-8476833017**
16.	Smt. Priyanka Gaur	Shri Subhash Gaur	**Vill-**Kaviltha **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 8979399748**
17.	Smt. Shanta Devi	Shri Bhagat Singh	**Vill-**Kaviltha **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 9758268906**
18.	Smt. Shashi Devi	Shri Sarvesh Singh Rawat	**Vill-**Kaviltha **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 8588929568**
19.	Smt. Sarita Devi	Shri Kalam Singh	**Vill-**Kaviltha **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 9639343056**
20.	Shri Yogendra Singh	Lt. Shri Balak Singh Rawat	**Vill-**Kaviltha **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 7466875457**
21.	Smt. Chaita Devi	Late Shri Shambhu Prasad	**Vill-**Kaviltha **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 7895670295**
22.	Smt. Sushila Devi	Shri Pradeep Chauhan	**Vill-**Kaviltha **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 7451983629**
23.	Shri Sudanand	Lt. Shri Purosotatam	**Vill-**Kaviltha **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 8171467246**
24.	Shri Abbal Singh	Lt. Shri Shyam Singh	**Vill-**Kaviltha **Block &Distt.-**Ukhimath, Rudraprayag

			Contact No.- 8958239777
25.	Shri Sanjay Singh	Lt. Uday Singh	**Vill-**Kaviltha **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 9627004558**
26.	Smt. Roshani Devi	Shri Diwakar Gairola	**Vill-**Kaviltha **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 9759723629**
27.	Smt. Mukhari Devi	Shri Prabal Singh	**Vill-**Kaviltha **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 9634346751**
28.	Shri Dinesh Rawat	Shri Dev Singh Rawat	**Vill-**Kaviltha **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 7895037902**
29.	Smt. Vijaya Devi	Lt. Shri Govind Singh Rawat	**Vill-**Kaviltha **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 7037402781**
30.	Smt. Anita Devi	Shri Abbal Singh	**Vill-**Kaviltha **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-9719568284**
31.	Smt. Sarla Devi	Shri Kunwar Singh Rawat	**Vill-**Kaviltha **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 8057139089**
32.	Shri Jaidev Chauhan	Shri B.S.Chauhan	**HAPPRC, Contact No.-8126211560**
33.	Shri Kailash Kandpal	Shri Bhagwati Prasad	**HAPPRC, Contact No.- 7302808941**
34.	Shri Vipin Rawat	Shri P.S.Rawat	**HAPPRC, Contact No.- 9458113893**
35.	Shri Ajay Hemdan	Shri Ajay Hemdan	**HAPPRC, Contact No.- 8272820207**
36.	Shri Mukesh	Shri U.S. Karasi	**HAPPRC, Contact No.- 9675418245**

Figure 5. Photographs of the one day On-farm farmers workshop cum training/plant distribution programme for promotion of cultivation of MAP's at Village Kaviltha Block, Ukhimath, Rudraprayag on 19/July/2022 under J.W.C.T. Project. Registration of participants (A), diffusion pf technical knowledge to farmers (B-C), chief guests address to the farmers (D), distribution of *P. Kurrooa* seedlings plants to farmers (E) and group photo of participants (F).

Table 11. List of villagers/farmers participated in one day On-farm farmers workshop cum training/plant distribution programme for promotion of cultivation of MAP's at Village Jaal Malla Block, Ukhimath, Rudraprayag on 19/7/2022 under J.W.C.T. Project.

Sr.No.	Villagers Name	Father/Husband Name	Address
1.	Shri Chandra Singh Rawat	Lt. Shri Balak Singh Rawat	**Vill-**Jaal Malla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 7217433742** **Aadhar No.- 304548552222**
2.	Shri Trilok Singh	Shri Baiker Singh	**Vill-**Jaal Malla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 8006346583** **Aadhar No.-690891288502**
3.	Shri Madan Singh Rawat	Lt. Shri Gokal Singh	**Vill-**Jaal Malla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-7830966432**
4.	Shri Mangal Singh	Shri Ghanshyam Singh	**Vill-**Jaal Malla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-7302161380**
5.	Shri Madhavar Singh	Lt. Shri Dhoom Singh	**Vill-**Jaal Malla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-8650805288**
6.	Shri Dinesh Singh	Shri Ghansyam Singh	**Vill-**Jaal Malla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-7060165953** **Aadhar No.-369431198374**
7.	Shri Vipin Singh Rawat	Shri Lakhan Singh Rawat	**Vill-**Jaal Malla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-7043449663** **Aadhar No.-573410422324**
8.	Shri Mohan Singh Rawat	Lt. Shri Bhopal Singh	**Vill-**Jaal Malla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-7895399593**
9.	Shri Daulat Singh Rawat	Lt. Shri Gokal Singh Rawat	**Vill-**Jaal Malla **Block &Distt.-**Ukhimath, Rudraprayag
10.	Smt. Mangsiri Devi	Lt. Shri Thepad Singh Rawat	**Vill-**Jaal Malla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 7895026624**
11.	Smt. Anita Rawat	Shri Rajendra Singh Rawat	**Vill-**Jaal Malla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-8755725353**
12.	Smt. Gaytri Devi	Lt. ShriJaman Singh Rawat	**Vill-**Jaal Malla **Block &Distt.-**Ukhimath, Rudraprayag
13.	Km. Bhavna Panwar	Shri Shivraj Singh Panwar	**Vill-**Jaal Malla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 7310888055**
14.	Smt. Anusuya Devi	Shri Vikram Singh	**Vill-**Jaal Malla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 8449986190**
15.	Smt. Laxmi Devi	Shri Trilok Singh Rawat	**Vill-**Jaal Malla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-8006346583** **Aadhar No.- 854811279271**
16.	Smt. Asha Devi	Shri Dinesh Singh	**Vill-**Jaal Malla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 7302161373**
17.	Smt. Pushpa Devi	Shri Pramod Singh	**Vill-**Jaal Malla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 8791837310**
18.	Smt. Anita Devi	Shri Jaspal Singh	**Vill-**Jaal Malla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-9068192370**

19.	Smt. Deepa Devi	Shri Arvind Singh Panwar	**Vill-**Jaal Malla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 8755587122**
20.	Smt. Sunita Devi	Shri Sate Singh	**Vill-**Jaal Malla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 7302163977**
21.	Smt. Prema Devi	ShriBhagat Singh Panwar	**Vill-**Jaal Malla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-9557443334**
22.	Shri Virendra Singh Panwar	Lt. Shri Jeth Singh	**Vill-**Jaal Malla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-8006491086**
23.	Smt. Hema Devi	Shri Shivraj Singh Panwar	**Vill-**Jaal Malla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-7310888055**
24.	Shri Shivraj Singh	Lt. Shri Jagat Singh Panwar	**Vill-**Jaal Malla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 7310888055**
25.	Smt. Kushma Devi	Shri Bheem Singh Panwar	**Vill-**Jaal Malla **Block &Distt.-**Ukhimath, Rudraprayag
26.	Shri Surendra Singh	Shri Daulat Singh Rawat	**Vill-**Jaal Malla **Block &Distt.-**Ukhimath, Rudraprayag
27.	Smt. Vinita Devi	Shri Umed Singh	**Vill-**Jaal Malla **Block &Distt.-**Ukhimath, Rudraprayag
28.	Smt. Vimla Devi	Shri Dev Singh	**Vill-**Jaal Malla **Block &Distt.-**Ukhimath, Rudraprayag
29.	Smt. Ranju Devi	Lt. Shri Dhan Singh Rawat	**Vill-**Jaal Malla **Block &Distt.-**Ukhimath, Rudraprayag
30.	Smt. Kunwari Devi	Shri Suraj Singh	**Vill-**Jaal Malla **Block &Distt.-**Ukhimath, Rudraprayag
31.	Shri Puran Singh Rana	Shri Ram Singh	**Vill-**Jaal Malla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 7895026803**
32.	Shri Jaidev Chauhan	Shri B.S.Chauhan	**HAPPRC, Contact No.-8126211560**
33.	Shri Kailash Kandpal	Shri Bhagwati Prasad	**HAPPRC, Contact No.- 7302808941**
34.	Shri Vipin Rawat	Shri P.S.Rawat	**HAPPRC, Contact No.- 9458113893**
35.	Shri Ajay Hemdan	Shri Ashok Kumar Hemdan	**HAPPRC, Contact No.- 8272820207**
36.	Shri Mukesh	Shri U.S. Karasi	**HAPPRC**

Figure 6. Photographs of the one day On-farm farmers workshop cum training/plant distribution programme for promotion of cultivation of MAP's at Jaal Malla, Block, Ukhimath, Rudraprayag on 19/7/2022 under J.W.C.T. Project. Registration of participants (A), diffusion of technical knowledge to farmers (B), distribution of *P. Kurrooa* plants to farmers(C-E), and group photo of participants (F).

Table 13. List of Villagers/Farmers participated in one day On-farm farmers workshop cum training/plant distribution programme for promotion of cultivation of MAP's at Village Jaal Talla Block, Ukhimath, Rudraprayag on 19/7/2022 under J.W.C.T. Project.

Total participants: 41 (male- 13, female-28)

Sr.No.	Villagers Name	Father/Husband Name	Address
1.	Shri Pradeep Rana	Shri Chandra Singh	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 8755932742** **Aadhar No.- 633462305263**
2.	Shri Hukum Singh	Lt. Shri Narayan Singh	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag
3.	Smt. Kusum Devi	Shri Pradeep Singh Rana	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-7895089752**
4.	Smt. Anita Devi	Shri Pramod Singh Rawat	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-7302236522**
5.	Smt. Ritu Devi	Shri Sandeep Singh	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-9997821325**
6.	Smt. Sateshwari Devi	Shri Ranjit Singh	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-8791803662**
7.	Smt. Indra Devi	Shri Suraj Singh	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-8126387274**
8.	Smt. Deepa Devi	Shri Tejpal Singh	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-8979485245**
9.	Smt. Vijaya Devi	Shri Prakash Singh	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 8273527695**
10.	Smt. Surji Devi	Shri Virendra Singh	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 8532880434**
11.	Smt. Pushpa Devi	Shri Bhagat Singh	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-8755873318**
12.	Smt. Mitla Devi	Shri Rakesh	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 9119041988**
13.	Smt. Vimla Devi	Shri Virendra	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 8923347857**
14.	Smt. Permila Devi	Shri Suresh Singh	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 8755644676**
15.	Smt. Vinita Devi	Shri Prakash Singh	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-8954612563**
16.	Km. Monika	Shri Prem Singh	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 9997373876**
17.	Smt. Kamla Devi	Shri Puran Singh	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 8532801988**
18.	Smt. Hema Devi	Shri Kunwar Singh	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-9634783051**
19.	Smt. Maheshi Devi	Shri Prabal Singh	**Vill-**Jaal Talla

			Block &Distt.-Ukhimath, Rudraprayag **Contact No.- 7060502073**
20.	Smt. Uma Devi	Shri Suraj Singh	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 8923346387**
21.	Smt. Guddi Devi	ShriDinesh Singh	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-8755615887**
22.	Smt. Umesha Devi	Shri Keshar Singh	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-9759485205**
23.	Smt. Puja Devi	Shri Sunil	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-8393027440**
24.	Smt. Jasoda Devi	ShriDaulat Singh	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 8650761282**
25.	Smt. Amra Devi	Lt. Shri Makani Singh	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 8393895891**
26.	Smt. Beena Devi	Shri Prem Singh	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 8954022101**
27.	Smt. Mukhari Devi	Shri Rajendra	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 8393895891**
28.	Km. Siya	Shri Shiv Singh Siya	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 9897867708**
29.	Smt. Amra	Shri Mangal Singh	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-7830265350**
30.	Smt. Vimla Devi	Shri Ramchandra Singh	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 8393055336**
31.	Shri Amit Negi	Shri O.P.Negi	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 8057890309**
32.	Shri Anoop	Shri Abbal Singh	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-7078508293**
33.	Shri Sandeep Singh	Lt. Shri Jaspal Singh	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 7060549815**
34.	Shri Pramod Singh	Lt. Shri Shivraj Singh	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 9068831984**
35.	Shri Dharmendra Singh	Shri Hayat Singh	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 9634630265**
36.	Shri Surat Singh	Shri Jauna Singh	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 8923346387**
37.	Shri Trilok Singh	Shri Gabbar Singh	**Vill-**Jaal Talla **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-8954950231**
38.	Shri Jaidev Chauhan	Shri B.S.Chauhan	**HAPPRC, Contact No.- 8126211560**
39.	Shri Kailash Kandpal	Shri Bhagwati Prasad	**HAPPRC, Contact No.- 7302808941**
40.	Shri Vipin Rawat	Shri P.S.Rawat	**HAPPRC, Contact No.- 9458113893**
41.	Shri Ajay Hemdan	Shri Ashok Kumar Hemdan	**HAPPRC, Contact No.-8272820207**

Figure 7. Photographs of the one day On-farm farmers workshop cum training/plant distribution programme for promotion of cultivation of MAP's at Jaal Talla, Block, Ukhimath, Rudraprayag on 19/7/2022 under J.W.C.T. Project. Delivered technical knowledge by Mr. Jaidev Chauhan to farmers/participants (A-B), distributed plant material to farmers (C-E), group photograph farmers/participants (F).

Table 14. List of Villagers/Farmers participated in one day On-farm farmers workshop cum training/plant distribution programme for promotion of cultivation of MAP's at Village Chaumasi Block, Ukhimath, Rudraprayag on 19/7/2022 under J.W.C.T. Project.

Total participants: 38 (male- 18, female-20)

Sr.No.	Villagers Name	Father/Husband Name	Address
1.	Shri Praveen	Shri Vikram Singh	**Vill-**Chaumasi **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 7830543661**
2.	Shri Rahul	Shri Bhagat Singh	**Vill-**Chaumasi **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 7302175567**
3.	Shri Vipin Singh	Shri Ranjeet Singh	**Vill-**Chaumasi **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-9997330540**
4.	Shri Naveen	Shri Mahipal Singh	**Vill-**Chaumasi **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-8755153669**
5.	Shri Mulayam Singh	Shri Suraj Singh	**Vill-**Chaumasi **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-8859125618**
6.	Shri Badri	Shri Rajendra Singh	**Vill-**Chaumasi **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-7302228369**
7.	Shri Mohan Singh Tindori	Lt. Shri Chandra Singh	**Vill-**Chaumasi **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-9410145575**
8.	Shri Jay Singh Rawat	Shri G.S.Rawat	**Vill-**Chaumasi **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-9412949214**
9.	Smt. Kamla Devi	Shri Gabbar Singh	**Vill-**Chaumasi **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 7830261039**
10.	Smt. Chhoti Devi	Lt. Shri Jeet Singh	**Vill-**Chaumasi

			Block &Distt.-Ukhimath, Rudraprayag **Aadhar No.-**
11.	Smt. Katgi Devi	Shri Jeet Singh	**Vill-**Chaumasi **Block &Distt.-**Ukhimath, Rudraprayag
12.	Smt. Prabha Devi	Shri Ravindra Singh	**Vill-**Chaumasi **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 9557065755**
13.	Smt. Uma Devi	Shri Akhilesh Singh	**Vill-**Chaumasi **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 8791104542**
14.	Smt. Anita Devi	Lt. Shri Jaspal Singh	**Vill-**Chaumasi **Block &Distt.-**Ukhimath, Rudraprayag
15.	Smt. Kamla Devi	Shri Vijay Singh	**Vill-**Chaumasi **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-8979052373**
16.	Smt. Mamta Devi	Shri Pramod Singh	**Vill-**Chaumasi **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 8755163645**
17.	Smt. Anita Devi	Shri Rai Singh	**Vill-**Chaumasi **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 9458945941**
18.	Smt. Madhu Devi	Shri Sarvesh Singh	**Vill-**Chaumasi **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-8755847580**
19.	Smt. Roshani Devi	Shri Yogember Singh	**Vill-**Chaumasi **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 8445974761**
20.	Smt. Shanta Devi	Shri Katig Singh	**Vill-**Chaumasi **Block &Distt.-**Ukhimath, Rudraprayag
21.	Smt. Soni Devi	ShriRajendra Singh	**Vill-**Chaumasi **Block &Distt.-**Ukhimath, Rudraprayag
22.	Smt. Gaini Devi	Shri Gulab Singh	**Vill-**Chaumasi **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-8979835767**
23.	Smt. Narvada Devi	Shri Rajpal Singh	**Vill-**Chaumasi **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.-9068512373**
24.	Shri Ajay Singh	Shri Virendra Singh	**Vill-**Chaumasi **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 8755847845**
25.	Shri Anil	Shri Prabal Singh	**Vill-**Chaumasi **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 8979823801**
26.	Smt. Babita Devi	Shri Mulayam Singh	**Vill-**Chaumasi **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 8859125618**
27.	Smt. Vijaya Devi	Lt. Shri Dayal Singh	**Vill-**Chaumasi **Block &Distt.-**Ukhimath, Rudraprayag
28.	Smt. Shakha Devi	Shri Prabal Singh	**Vill-**Chaumasi **Block &Distt.-**Ukhimath, Rudraprayag
29.	Smt. Vimala Devi	Shri Mahesh Singh	**Vill-**Chaumasi **Block &Distt.-**Ukhimath, Rudraprayag
30.	Smt. Laxmi Devi	Shri Devendra Singh	**Vill-**Chaumasi **Block &Distt.-**Ukhimath, Rudraprayag
31.	Shri Gajpal Singh	Shri Dayal	**Vill-**Chaumasi **Block &Distt.-**Ukhimath, Rudraprayag **Contact No.- 9084412374**
32.	Shri Jaidev Chauhan	Shri B.S.Chauhan	**HAPPRC** **Contact No.-8126211560**
33.	Shri Kailash Kandpal	Shri Bhagwati Prasad	**HAPPRC** **Contact No.- 7302808941**

34.	Shri Vipin Rawat	Shri P.S.Rawat	**HAPPRC** **Contact No.- 9458113893**
35.	Shri Ajay Hemdan	Shri Ashok Kumar Hemdan	**HAPPRC** **Contact No.- 8272820207**
36.	Shri Mukesh	Shri U.S. Karasi	**HAPPRC** **Contact No.-**

Figure 8. Photographs of the one day On-farm farmers workshop cum training/plant distribution programme for promotion of cultivation of MAP's organized at Chaumasi, Ukhimath, Rudraprayag on 19/7/2022 under J.W.C.T. Project. Distribution of plant material to farmers (A-B), group photograph of farmers/participants (C-D).

Table 15. List of Villagers/Farmers participated in one day On-farm farmers workshop cum training/plant distribution programme for promotion of cultivation of MAP's organized at at Village Kulpudi, Block, Tharali, Chamoli on 16/7/2022 under J.W.C.T. Project.
Total participants: 21 (male- 16, female-05)

Sr.No.	Villagers Name	Father/Husband Name	Address
1.	Shri Jaiveer Singh	Shri Bhawan Singh	**Vill- Kulpudi** **Block &Distt.-**Tharali, Chamoli **Contact No.- 9119047850** **Aadhar No.- 720575991078**
2.	Shri Gaur Singh	Shri Khilaph Singh	**Vill- Kulpudi** **Block &Distt.-**Tharali, Chamoli **Contact No.- 9568888047** **Aadhar No.- 765905017402**
3.	Smt. Laxmi Devi	Shri Kalyan Singh	**Vill- Kulpudi** **Block &Distt.-**Tharali, Chamoli
4.	Smt. Deepa Devi	Shri Dilwar Singh Negi	**Vill- Kulpudi** **Block &Distt.-**Tharali, Chamoli **Contact No.-7454879012**
5.	Smt. Rekha Devi	Shri Amar Singh Negi	**Vill- Kulpudi** **Block &Distt.-**Tharali, Chamoli **Contact No.-9068514501**
6.	Smt. Aruni Devi	Lt. Shri Ram Singh	**Vill- Kulpudi** **Block &Distt.-**Tharali, Chamoli
7.	Smt. Laxmi Devi	Shri Gaur Singh Negi	**Vill- Kulpudi** **Block &Distt.-**Tharali, Chamoli **Contact No.-8755810416**
8.	Shri Rajendra Singh	Shri Avtar Singh	**Vill- Kulpudi**

			Block &Distt.-Tharali, Chamoli **Contact No.-7248475239**
9.	Shri Mahipal Singh	Shri Daulat Singh	**Vill- Kulpudi** **Block &Distt.-**Tharali, Chamoli **Contact No.- 9634453637**
10.	Shri Kundan Singh	Shri Himmat Singh	**Vill- Kulpudi** **Block &Distt.-**Tharali, Chamoli
11.	Shri Paar Singh	Shri Baag Singh	**Vill- Kulpudi** **Block &Distt.-**Tharali, Chamoli **Contact No.-8979748967**
12.	Shri Pushkar Singh	Shri Paan Singh	**Vill- Kulpudi** **Block &Distt.-**Tharali, Chamoli **Contact No.- 8865040384** **Aadhar No.- 260181124259**
13.	Shri Parvendra Singh Rawat	Lt. Shri Digpal Singh Rawat	**Vill- Kulpudi** **Block &Distt.-**Tharali, Chamoli **Contact No.- 7895789059**
14.	Shri Laxman Singh	Shri Avtar Singh	**Vill- Kulpudi** **Block &Distt.-**Tharali, Chamoli **Contact No.- 9755076466** **Aadhar No.- 473694514402**
15.	Shri Subhash Chandra	Shri Avtar Ram	**Vill- Kulpudi** **Block &Distt.-**Tharali, Chamoli **Aadhar No.- 467790326187**
16.	Dr.Vijay Kant Purohit	Shri A.P.Purohit	**HAPPRC** **Contact No.- 94565317115**
17.	Shri Mahaveer Singh Rawat	Shri Raghuveer Singh	**HAPPRC**
18.	Shri Ajay Hemdan	Shri A.K.Hemdan	**HAPPRC** **Contact No.- 8272820207**
19.	Shri Bhawani Dutt Kothari	Lt. Shri Bhairav Dutt Kothar	**HAPPRC** **Contact No.- 8979525629**
20.	Shri Kamal Singh Pundir	Shri G. S. Pundir	**HAPPRC** **Contact No.- 9540468782**
21.	Shri Arun Singh Gusain	Shri Kalam Singh Gusain	**HAPPRC** **Contact No.-9548194033**

Table 16. List of villagers/farmers participated in one day On-farm farmers workshop cum training/plant distribution programme for promotion of cultivation of MAP's Cultivation organised at Village Ratgaov, Taalger Block, Tharali, Chamoli on 22/7/2022 under J.W.C.T. Project.

Total participants: 18 (male- 18, female-0)

Sr.No.	Villagers Name	Father/Husband Name	Address
1.	Shri Gajendra Prasasd	Shri Khilaph Ram	**Vill-Ratgaov Taalger** **Block &Distt. -**Tharali, Chamoli **Contact No.- 8859673676**
2.	Shri Bhawani Dutt Kothari	Shri Bhairav Dutt Kothari	**Vill- Ratgaon Taalger** **Block &Distt.-**Tharali, Chamoli
3.	Shri Arun Singh Gusain	Shri Kamal Singh Gusain	**Vill- Ratgaon Taalger** **Block &Distt.-**Tharali, Chamoli **Contact No.- 9548194033**
4.	Shri Prithvi Singh	Shri Kedar Singh Pharshwar	**Vill- Ratgaon Taalger** **Block &Distt.-**Tharali, Chamoli **Contact No.-8449855389** **Aadhar No.-668123293888**
5.	Shri Balwant Ram	Shri Kalam Ram	**Vill- Ratgaon Taalger** **Block &Distt.-**Tharali, Chamoli
6.	Shri Rahul Singh	Shri Devendra Singh	**Vill- Ratgaon Taalger** **Block &Distt.-**Tharali, Chamoli **Contact No.- 7895322396**

7.	Shri Avtar Singh Rawat	Shri Kanak Singh	**Vill- Ratgaon Taalger** **Block &Distt.-**Tharali, Chamoli
8.	Shri Manohar Singh	Shri Mohan Singh	**Vill- Ratgaon Taalger** **Block &Distt.-**Tharali, Chamoli **Contact No.-8630154715** **Aadhar No.-443445748901**
9.	Shri Chandramohan Mishra	Shri Dayakrishna Mishra	**Vill- Ratgaon Taalger** **Block &Distt.-**Tharali, Chamoli **Contact No.- 7335051277** **Aadhar No.-518282191269**
10.	Shri Mahaveer Singh	Lt. Shri Chandra Singh	**Vill- Ratgaon Taalger** **Block &Distt.-**Tharali, Chamoli **Contact No.- 9639402314** **Aadhar No.- 872769453018**
11.	Shri Narendra Singh	Lt. Shri Darban Singh	**Vill- Ratgaon Taalger** **Block &Distt.-**Tharali, Chamoli **Contact No.-8938907106**
12.	Shri Pushkar Singh	Lt. Shri Narayan Singh	**Vill- Ratgaon Taalger** **Block &Distt.-**Tharali, Chamoli **Contact No.- 9084911891**
13.	Shri Madan Singh	Shri Gopal Singh	**Vill- Ratgaon Taalger** **Block &Distt.-**Tharali, Chamoli **Contact No.- 9927609759**
14.	Shri Jaiveer Singh	Shri Balwant Singh	**Vill- Ratgaon Taalger** **Block &Distt.-**Tharali, Chamoli **Contact No.- 9520245030**
15.	Shri Mahaveer Singh Rawat	Lt. Shri Kishan Singh	**Vill- Ratgaon Taalger** **Block &Distt.-**Tharali, Chamoli **Contact No.-8979815419** **Aadhar No.- 467790326187**
16.	Dr.Vijay Kant Purohit	Shri A.P.Purohit	**HAPPRC SRINAGAR GARHWAL** **Contact No.- 9456531715**
17.	Shri Kamal Pundir	Shri G.S.Pundir	**HAPPRC SRINAGAR GARHWAL** **Contact No.-9540468782**
18.	Shri Ajay Hemdan	Shri A.K.Hemdan	**HAPPRC SRINAGAR GARHWAL** **Contact No.-8272820207**

Table 17. List of villagers/farmers participated in one day On-farm farmers workshop cum training/plant distribution programme for promotion of cultivation of MAP's organsied at Village Rushyan Block, Tharali, Chamoli on 22/7/2022 under J.W.C.T. Project.
Total participants: 13 (male- 13, female-0)

Sr.No.	Villagers Name	Father/Husband Name	Address
1.	Shri Bharat Singh	Shri Narayan Singh	**Vill-Rusiyan** **Block &Distt. -**Tharali, Chamoli **Contact No.- 7060449964**
2.	Shri Kuldeep Singh	Shri Raghuveer Singh Bisht	**Vill- Rusiyan** **Block &Distt. -**Tharali, Chamoli **Contact No.- 9718591046**
3.	Shri Mohan Singh Rawat	Shri Balwant Singh	**Vill-Rusiyan** **Block &Distt. -**Tharali, Chamoli **Contact No.- 7500677806**
4.	Shri Digamber Singh	Shri Ishwari Dutt	**Vill-Rusiyan** **Block &Distt. -**Tharali, Chamoli **Contact No.-7060081661** **Aadhar No.- 777651358872**
5.	Shri Manoj Singh	Shri Mahipal Singh	**Vill-Rusiyan** **Block &Distt. -**Tharali, Chamoli
6.	Shri Sudarshan Singh	Shri Kedar Singh	**Vill-Rusiyan** **Block &Distt. -**Tharali, Chamoli **Contact No.- 7456966732**

7.	Shri Duli Ram	Shri Trimanu Ram	**Vill-Rusiyan** **Block &Distt. -**Tharali, Chamoli
8.	Shri Mohan Singh Rawat	Shri Balwant Singh	**Vill-Rusiyan** **Block &Distt. -**Tharali, Chamoli **Contact No.- 7500677806**
9.	Shri Bharat Singh	Shri Narayan Singh	**Vill-Rusiyan** **Block &Distt. -**Tharali, Chamoli **Contact No.-7080449964**
10.	Shri Manoj Rana	Shri Mahipal Singh	**Vill-Rusiyan** **Block &Distt. -**Tharali, Chamoli **Contact No.- 9953271800**
11.	Dr.Vijay Kant Purohit	Shri A.P.Purohit	**HAPPRC** **Contact No.- 94565317115**
12.	Shri Ajay Hemdan	Shri A.K.Hemdan	**HAPPRC** **Contact No.- 8272820207**
13.	Shri Kamal Singh Pundir	Shri G. S. Pundir	**HAPPRC** **Contact No.- 9540468782**

Table 18. List of villagers/farmers participated in one day On-farm farmers workshop cum training/plant distribution programme for promotion of cultivation of MAP's organized at Village Taal, block, Tharali, Chamoli on 23/7/2022 under J.W.C.T. Project.
Total participants: 28 (male- 20, female-08)

S.N.	Villagers Name	Father/Husband Name	Address
1.	Smt. Munni Devi	Shri Balwant Singh Gariya	**Vill- Taal** **Block &Distt. -**Tharali, Chamoli **Contact No.- 9568662231** **Aadhar No.- 878076804085**
2.	Smt. Babli Devi	Shri Anil Singh Gariya	**Vill- Taal** **Block &Distt. -**Tharali, Chamoli **Contact No.- 9971353648**
3.	Smt. Renu Devi	Shri Devendra Singh Gariya	**Vill- Taal** **Block &Distt.-**Tharali, Chamoli **Contact No.- 7063934339**
4.	Smt. Rajeshwari Devi	Shri Mahaveer Singh	**Vill- Taal** **Block &Distt.-**Tharali, Chamoli **Contact No.-9520235664**
5.	Smt. Kalpeshwari Devi	Shri Darshan Singh Gariya	**Vill- Taal** **Block &Distt.-**Tharali, Chamoli **Contact No.-8445613358**
6.	Shri Prem Singh Gariya	Shri Balwant Singh Gariya	**Vill- Taal** **Block &Distt.-**Tharali, Chamoli **Contact No.- 9012292138**
7.	Shri Khushal Singh Gariya	Shri Balwant Singh Gariya	**Vill- Taal** **Block &Distt.-**Tharali, Chamoli **Contact No.-8193056373**
8.	Shri Anil Singh	Shri Bhupal Singh Gariya	**Vill- Taal** **Block &Distt.-**Tharali, Chamoli **Contact No.-9568340283** **Aadhar No.- 918967545019**
9.	Shri Indra Singh Gariya	Lt. Shri Kedar Singh	**Vill- Taal** **Block &Distt.-**Tharali, Chamoli **Contact No.- 9568639595** **Aadhar No.- 811537110324**
10.	Shri Devu Lal	Lt. Shri Chotanu Lal	**Vill- Taal** **Block &Distt.-**Tharali, Chamoli **Contact No.- 7055564762** **Aadhar No.- 619440175381**
11.	Shri Raghuveer Singh	Shri Darvaan Singh	**Vill- Taal** **Block &Distt.-**Tharali, Chamoli **Contact No.- 9997339615**

12.	Shri Ranjeet Lal	Shri Hayat Lal	**Vill- Taal** **Block &Distt.-**Tharali, Chamoli **Contact No.- 9997348799** **Aadhar No.- 404955092168**
13.	Shri Ratan Singh	Lt. Shri Narayan Singh	**Vill- Taal** **Block &Distt.-**Tharali, Chamoli **Contact No.- 7078425063** **Aadhar No.- 823859962940**
14.	Shri Ganesh Lal	Shri Shyam Lal	**Vill- Taal** **Block &Distt.-**Tharali, Chamoli **Contact No.- 8958720581** **Aadhar No.- 551239041503**
15.	Shri Mohan Singh	Shri Narayan Singh	**Vill- Taal** **Block &Distt.-**Tharali, Chamoli **Aadhar No.- 652902849566**
16.	Shri Govind Lal	Shri Shankar Lal	**Vill- Taal** **Block &Distt.-**Tharali, Chamoli **Contact No.- 8445613230** **Aadhar No.- 596771896121**
17.	Smt. Beena Pandey	Shri Katika Prasad Pandey	**Vill- Taal** **Block &Distt.-**Tharali, Chamoli **Contact No.- 7037693744**
18.	Shri M.L.Dhuniyal	Shri J.L.Dhuniyal	**Vill- Taal** **Block &Distt.-**Tharali, Chamoli **Contact No.- 97609633397**
19.	Smt. Urmila Rawat	Shri Shiv Singh	**Vill- Taal** **Block &Distt.-**Tharali, Chamoli **Contact No.- 8057220898**
20.	Smt. Baleshwari Devi	Shri Himat Singh Gariya	**Vill- Taal** **Block &Distt.-**Tharali, Chamoli **Contact No.- 7500231750**
21.	Shri Balwant Singh	Shri Netra Singh	**Vill- Taal** **Block &Distt.-**Tharali, Chamoli **Contact No.- 8755618748** **Aadhar No.- 813348420521**
22.	Shri Maheshanand Pandey	Lt. Shri Ratnamani Pandey	**Vill- Taal** **Block &Distt.-**Tharali, Chamoli **Contact No.- 9760289538** **Aadhar No.- 954767722001**
23.	Shri Pradhuman Singh Gariya	Shri Gopal Singh	**Vill- Taal** **Block &Distt.-**Tharali, Chamoli **Contact No.- 9897652396** **Aadhar No.- 980751802318**
24.	Shri Anil Agri	Shri Kayar Agri	**Vill- Taal** **Block &Distt.-**Tharali, Chamoli **Contact No.- 7457818032** **Aadhar No.- 418282538036**
25.	Shri R.P.Joshi	Lt. Shri Dharmdutt Joshi	**Vill- Taal** **Block &Distt.-**Tharali, Chamoli **Contact No.- 7055859304** **Aadhar No.- 839067955697**
26.	Dr.Vijay Kant Purohit	Shri A.P.Purohit	**HAPPRC** **Contact No.- 94565317115**
27.	Shri Ajay Hemdan	Shri A.K.Hemdan	**HAPPRC** **Contact No.- 8272820207**
28.	Shri Kamal Singh Pundir	Shri G. S. Pundir	**HAPPRC** **Contact No.- 9540468782**

Figure 9. Photographs of the one day On-farm farmers workshop cum training/plant distribution programme for promotion of cultivation of MAP's organized at village Taal, Tharali, Chamoli on 23/07/2022. Delivered technical knowledge by Dr. V.K. Purohit (SSO) to farmers/participants (A-C), distributed plant material to farmers (D-E), group photograph of farmers/participants (F).

Table 19. List of villagers/farmers participated in one day On-farm farmers workshop cum training/plant distribution programme for promotion of cultivation of MAP's organized at Village Syanri Bangali, Block, Ghat, Chamoli on 14/7/2022 under J.W.C.T. Project.

Total participants: 60 (male- 35, female-25)

Sr.No.	Villagers Name	Father/Husband Name	Address
1.	Shri Bharat Singh	Shri Pushkar Singh	**Vill-**Syanri Bangali **Block-**Ghat **Distt.-**Chamoli **Contact No.-**7351937845 **Aadhar No.-** 210836256127
2.	Shri Bharat Singh	Shri Ganga Singh	**Vill-**Syanri Bangali **Block-**Ghat **Distt.-**Chamoli **Contact No.-**9837436543 **Aadhar No.-**925456340322
3.	Shri Dinesh Singh	Shri Rajendra Singh	**Vill-**Syanri Bangali **Block-**Ghat **Distt.-**Chamoli **Contact No.-**9837550384 **Aadhar No.-**285678568481
4.	Shri Narendra Singh	Shri Gopal Singh	**Vill-**Syanri Bangali **Block-**Ghat **Distt.-**Chamoli **Contact No.-**8449801975 **Aadhar No.-**978851500093
5.	Shri Vikram Singh	Shri Puran Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 7055947688 **Aadhar No.-** 222061825187
6.	Shri Puran Singh	Shri Umed Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 7351246174 **Aadhar No.-** 626184504520

7.	Shri Surendra Singh	Shri Karan Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-**7535820929 **Aadhar No.-**370799476679
8.	Smt. Hema Devi	Shri Digpal Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 9917992566
9.	Smt. Shanta Devi	Lt. Shri Manbar Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 9568054901
10.	Smt. Pushpa Devi	Shri Vijendra Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 8958253295
11.	Smt. Kusum Negi	Shri K.S.Negi	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli
12.	Shri Darshan Singh	Shri Raghuveer Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 9756258483
13.	Shri Mahipal Singh	Shri Bhajan Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 9917696080
14.	Smt. Sarita Devi	Shri Bharat Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-**8650705542
15.	Smt. Geeta Devi	Shri Ganga Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 8958425426
16.	Smt. Chuchri Devi	Late Shri Mohan Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 9639012295
17.	Smt. Parvati Devi	ShriVirendra Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-**9917991611 **Aadhar No.-** 255269479523
18.	Smt. Basanti Devi	Shri Ranjeet Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-**7351263875 **Aadhar No.-** 952413843915
19.	Smt. Geeta Devi	Shri Sujan Singh Bisht	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-**8954512094 **Aadhar No.-**433274646110
20.	Smt. Anjali Devi	Shri Anand Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 7533967634
21.	Smt. Manisha devi	Shri Bhopal Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli

			Contact No.- 7536860181 **Aadhar No.-**347714931297
22.	Smt. Godambari Devi	Shri Surendra Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 8449936523 **Aadhar No.-** 305362407525
23.	Smt. Prema Devi	Shri Madan Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 9756886373
24.	Smt. Bhaguli Devi	Shri Mahendra Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 8981514121
25.	Shri Trilok Singh	Shri Chandra Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-**8057543042
26.	Shri Deepak Negi	Shri Jay Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 8449971048
27.	Smt. Kamla Devi	Shri Vilok Singh Bisht	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 9927572633
28.	Smt. Leela Devi	Shri Vilok Singh Negi	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-**8958018871
29.	Smt. Basanti Devi	Shri Bhupal Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 7351959762
30.	Shri Chandramohan Bisht	Shri Vikram Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 9756320022
31.	Shri Shishupal Singh	Shri Sulabh Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli
32.	Shri Bhopal Singh	Shri Dilbar Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 8057887339
33.	Shri Narendra Singh	Shri Anand Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 7465920280
34.	Shri Khushal Negi	Shri Bhupal Negi	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 7351279292 **Aadhar No.-** 368096331489
35.	Shri Deewan Singh	Shri Kishan Singh Bisht	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 8057063819 **Aadhar No.-** 655234571967
36.	Smt. Parvati Bisht	Shri Virendra Singh	**Vill-**Syanri Bangali **Block-**Ghat,

			Distt.-Chamoli **Contact No.-** 9917991611
37.	Shri Manoj Bisht	Shri Uday Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 8449358686
38.	Shri Mahipal Negi	Shri Khilaf Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-**7088681501 **Aadhar No.-** 833503750036
39.	Shri Avtar Singh	Shri Hoyan Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No**.- 9690028938 **Aadhar No.-** 503346143780
40.	Shri Trilok Singh	Shri Kanchan Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 7533859264
41.	Shri Trilok Singh	Shri Gaur Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 8449607826
42.	Smt. Vimla Devi	Shri Virendra Negi	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 7252805607
43.	Shri Himmat Singh	Shri Rupchandra Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 9690057249
44.	Shri Mohan Singh	Shri Dev Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli
45.	Smt. Shakuntala Devi	Shri Anand Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 8755369106
46.	Smt. Deepa Devi	Shri Virendra Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 8192043924
47.	Smt. Sunita Devi	Shri Rajendra Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 9527287630
48.	Smt. Surati Devi	Shri Prem Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli
49.	Shri Lakshman Singh	Shri Kheem Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-**8936991997
50.	Shri Gaur Singh	Shri Beer Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-**7467021996
51.	Smt. Deepa Negi	Shri Vijay Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 8439157977

52.	Shri Sanjay Negi	Shri Gabbar Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 9417663033
53.	Shri Mahipal Negi	Shri Khilap Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 7088681501
54.	Shri Rajendra Singh	Shri Prem Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli **Contact No.-** 9690028937
55.	Smt. Basanti Devi	Shri Dilwar Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli
56.	Shri Trilok Singh	Shri Balwant Singh	**Vill-**Syanri Bangali **Block-**Ghat, **Distt.-**Chamoli
57.	Shri Pradeep Dobhal	Shri Rudramani Dobhal	**HAPPRC** **Contact No.-** 8650843550 **Aadhar No.-** 420085133327
58.	Shri Rajeev Ranjan Kumar	Shri Dharmnath Singh	**HAPPRC** **Contact No.-** 9412974451 **Aadhar No.-**415953645662
59.	Shri Ajay Hemdan	Shri Ashok Kumar Hemdan	**HAPPRC** **Contact No.-**8272820207
60.	Shri Kuldeep Rawat	Shri Mahaveer Singh Rawat	**HAPPRC** **Contact No.-**9760944027 **Aadhar No.-**944171489054

Figure 10. Photographs of the one day On-farm farmers workshop cum training/plant distribution programme organized for promotion of cultivation of MAP's at village Syanri Bangali, Block, Ghat, Chamoli on 14/7/2022. Registration of participants (A), Difussion of technical knowledge to farmers (B), chief guests address to the farmers (C-E), distribution of plants of *P. kurrooa* (G-H), *N. jatamansi* (I) and *A. heterophyllum* (J) to farmers amd group photograph of participants (K-L).

Table 20. List of villagers/farmers participated in one day On-farm farmers workshop cum training/plant distribution programme organized for promotion of cultivation of MAP's at Village Pagna Block, Nandanagar, Chamoli on 27/7/2022 under J.W.C.T. Project.
Total participants: 51(male-30, female-21)

Sr.No	Villagers Name	Father/Husband Name	Address
1.	Smt. Saraswati Devi	Shri Madho Ram	**Vill- Kanol** **Block & Distt. -**Nandanagar, Chamoli **Contact No.- 9927115094** **Aadhar No.- 798908278461**
2.	Smt. Bharti Pharswan	Shri Tribhuwan Pharswan	**Vill- Pagna** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 7500673346**
3.	Smt. Nandita Rawat	Shri Karendra Rawat	**Vill- Malkot** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 80778421769**
4.	Shri Yashpal Agri	Shri Mahaveer Singh	**Vill- Guladi** **Block &Distt.-**Nandanagar, Chamoli **Contact No.-9012045708**
5.	Shri Vijay Mendoli	Shri Sundarmani	**Vill- Sainti Nandanagar** **Block &Distt.-**Nandanagar, Chamoli **Contact No.-9568035833**
6.	Shri Rakesh Kumar	Shri Shriram	**Vill- Bhesaj Bhawan** **Block & Distt. -**Kranprayag, Chamoli **Contact No.- 9927571214** **Aadhar No.-669051011254**
7.	Shri Umrav Negi	Shri Balwant Singh	**Vill- Sitel** **Block & Distt. -**Nandanagar, Chamoli **Contact No.-7500216430**
8.	Shri Jitendra Rawat	Shri Nandan Singh Rawat	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Contact No.-7060319014** **Aadhar No.- 90883718063**
9.	Smt. Deepa Negi	Shri Vijay Singh	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 8439157977**
10.	Shri Sandeep Singh	Shri D.S.Sajwan	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 8279808581**
11.	Smt. Kamla Devi	Shri Pushkar Singh	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 9520218041**
12.	Smt. Rameshwari Devi	Shri Abbal Singh	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 9520218062** **Aadhar No.- 616701084383**
13.	Smt. Kanti Devi	Shri Sujan Singh	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 7533895526**
14.	Smt. Laxmi Devi	Shri Abbal Singh	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 7351439477**
15.	Smt. Savitri Devi	Shri Khilap Singh	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Contact No.-8791778908** **Aadhar No.- 263687921886**
16.	Smt. Geeta Devi	Shri Indra Singh	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 7453967537**
17.	Smt. Anshi Devi	Lt. Shri Harsh Singh	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli

			Contact No.- 8923032403
18.	Smt. Budli Devi	Shri Kedar Singh	**Vill- Gairi** **Block &Distt.-**Nandanagar, Chamoli
19.	Smt. Urmila Devi	Shri Laxman Singh	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 8449854799** **Aadhar No.- 497032590843**
20.	Smt. Sunita Devi	Shri Yogendra Singh	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 9084325218** **Aadhar No.- 818330837236**
21.	Smt. Heera Devi	Shri Narendra Singh	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 7037554612** **Aadhar No.- 460088923545**
22.	Smt. Jamuna Devi	Shri Jitendra Singh	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 7500323660**
23.	Km. Mathura	Shri Dev Singh	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 8477082468**
24.	Smt. Gaytri Devi	Shri Rai Singh	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 7500363213**
25.	Smt. Deepa Devi	Shri Deepak Singh	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 8057219226**
26.	Smt. Parvati Devi	Shri Surendra Singh	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 7088756474** **Aadhar No.- 489277086965**
27.	Smt. Ganeshi Devi	Shri Sanjay Singh	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 8979307219**
28.	Smt. Janki Devi	Shri Chandra Singh	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 7819012477** **Aadhar No.- 417905779520**
29.	Smt. Sulochana Devi	Shri Narayan Singh	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 9520218013** **Aadhar No.- 945725865692**
30.	Shri Pradeep Singh	Shri Narendra Singh	**Vill- Prandmati** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 8193945422** **Aadhar No.- 929693693343**
31.	Shri Sabar Singh	Shri Alam Singh	**Vill- Pairi** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 7253939628** **Aadhar No.- 364091627838**
32.	Shri Surendra Singh	Shri Kedar Singh	**Vill- Pairi** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 7983715406** **Aadhar No.- 957847336456**
33.	Smt. Kalli Devi	Shri Kanchan Singh	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 7500870532**
34.	Smt. Nandi Devi	Shri Bakhtawar Singh	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 8937808436**
35.	Shri Kanchan Singh	Shri Meharban Singh	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli

			Contact No.- 8868056409
36.	Shri Sachin Singh	Shri Pushkar Singh	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 7453967305** **Aadhar No.- 713407125416**
37.	Shri Gaur Singh	Shri Umrav Singh	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 7500750841** **Aadhar No.- 472258959007**
38.	Smt. Dhamti Devi	Shri Diwan Singh	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 9837150806**
39.	Smt. Nandi Devi	Shri Pushkar Singh	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 8474944989** **Aadhar No.- 215251248943**
40.	Shri Pratap Singh	Shri Kotwal Singh	**Vill- Guladi** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 7417572885** **Aadhar No.- 372552996423**
41.	Shri Suraj Singh	Shri Amar Singh	**Vill- Waduk** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 9837805538** **Aadhar No.- 886362898160**
42.	Shri Rajendra Singh	Shri Laxman Singh	**Vill- Waduk** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 9568035927** **Aadhar No.- 645215975101**
43.	Shri Virendra Kumar	Shri Dulpi Ram	**Vill- Prandmati** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 8958169069** **Aadhar No.- 349166612193**
44.	Shri Jagdish Prasad	Shri Vidya Dutt	**Vill- Guladi** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 8958155523** **Aadhar No.- 910665786672**
45.	Shri Anand Singh	Shri Chuyya Singh	**Vill- Gairi** **Block &Distt.-**Nandanagar, Chamoli **Aadhar No.- 724853295119**
46.	Shri Balwant Singh	Shri Meharwan Singh	**Vill- Guladi** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 7351264118** **Aadhar No.- 552315404069**
47.	Shri Kamal Singh	Shri Deewan Singh	**Vill- Gairi** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 9837805442** **Aadhar No.- 953006035660**
48.	Shri Kunwar Singh	Shri Balwant Singh	**Vill- Kanol** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 7500841277** **Aadhar No.- 944316304493**
49.	Shri Veer Singh	Shri Khilap Singh	**Vill- Kanol** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 8192858022** **Aadhar No.- 632872334704**
50.	Shri Alam Singh	Shri Hukum Singh	**Vill- Pairi** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 9639741400** **Aadhar No.- 840529247896**
51.	Shri Ranjit Singh	Shri Dulap Singh	**Vill- Guladi** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 7453927478**

			Aadhar No.- 653174801062
52.	Shri Alam Ram	Shri Ashad Ram	**Vill- Prandmati** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 8958539960** **Aadhar No.- 510783640548**
53.	Shri Pratap Singh	Shri Deewan Singh	**Vill- Guladi** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 9012769602**
54.	Smt. Pushpa Devi	Shri Balwant Singh	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 7037257267** **Aadhar No.- 359202351701**
55.	Smt. Saruja Devi	Shri Kunwar Singh	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 8791135542**
56.	Shri Seri Ram	Shri Banwa Ram	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 9756266375**
57.	Shri Kanchan Negi	Shri Ganga Singh	**Vill- Kanol** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 9568186162** **Aadhar No.- 703164638014**
58.	Shri Nanda Gaur	Shri Bhawani Dutt Gaur	**Vill- Sainti** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 8191978328** **Aadhar No.- 232325848714**
59.	Shri Kalpeshwar Prasad Sati	Shri Peetambar Prasad Sati	**Vill- Sainti** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 8192012865**
60.	Shri Daulat Singh	Shri Sabbal Singh Bisht	**Vill- Aala** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 89419896307** **Aadhar No.- 627960890461**
61.	Shri Khilap Singh	Shri Balwant Singh	**Vill- Kanol** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 9690528062** **Aadhar No.- 267949322010**
62.	Shri Sanjay Singh	Shri Alam Singh	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 7078891174** **Aadhar No.- 635586366937**
63.	Shri Balwant Singh	Shri Dhan Singh	**Vill- Gairi** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 8958662515** **Aadhar No.- 497494469674**
64.	Shri Alam Singh	Shri Hari Singh	**Vill- Prandmati** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 7351624159** **Aadhar No.- 391544560153**
65.	Shri Abbal Negi	Shri Alama Singh	**Vill- Morav Malla** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 9690404341** **Aadhar No.- 449242522329**
66.	Shri Mangal Singh	Shri Hayat Singh	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Aadhar No.- 723551807678**
67.	Shri Vikram Singh	Shri Sarup Singh	**Vill- Waduk** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 9639453953**
68.	Shri Umed Singh Panwar	Shri Gulab Singh	**Vill- Gairi** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 9997637660**

			Aadhar No.- 263043645429
69.	Shri Gabbar Singh	Shri Ratan Singh	**Vill- Pairi** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 8958661718**
70.	Shri Rajendra Singh	Shri Daulat Singh	**Vill- Sitel** **Block &Distt.-**Nandanagar, Chamoli **Contact No.- 9756256210** **Aadhar No.- 488785576830**
71.	Dr. V. K. Purohit	Shri A.P. Purohit	**HAPPRC** **Contact No.- 9456531715**
72.	Shri Pradeep Dobhal	Shri R. M. Dobhal	**HAPPRC** **Contact No.- 8650843550**
73.	Shri Jaidev Chauhan	Shri B. S. Chauhan	**HAPPRC** **Contact No.- 8126211560**
74.	Shri Kailash Kandpal	Shri B. P. Kandpal	**HAPPRC** **Contact No.- 7302808941**
75.	Shri Ajay Hemdan	Shri Ashok Kumar Hemda	**HAPPRC** **Contact No.- 8272820207**
76.	Shri Kamal Pundir	Shri G. S. Pundir	**HAPPRC** **Contact No.- 9540468782**
77.	Shri Kuldeep Rawat	Shri Mahaveer Singh	**HAPPRC** **Contact No.- 9760944027**

Figure 11. Photographs of the one day On-farm farmers workshop cum training/plant distribution programme organized for promotion of cultivation of MAP's at Sitel Block, Nandanagar (Ghat), Chamoli on 28/7/2022. Registration of participants (A), Difussion of technical knowledge to farmers by Dr. V.K. Purohit Senior Scientific Officer (B-C), address of chief guests to the farmers (D-F), distribution of plants of *P. kurrooa* to farmers (G-J) and group photograph of participants (K-L).

Figure 12. Photographs of the one day On-farm farmers workshop cum training/plant distribution programme organized for promotion of cultivation of MAP's at village Pagna Block, Nandanagar, Chamoli on 27/7/2022. Registration of participants (A), Difussion of technical knowledge to farmers (B), chief guests address to the farmers (C-E), distribution of plants of *P. kurrooa* to farmers (D-E), and group photograph of participants (F).

Table 21. List of villagers/farmers participated in one day On-farm farmers workshop cum training/plant distribution programme organized at village Syanri Bhainti, Nandanagar, Chamoli on 04/08/2022 under J.W.C.T. Project.
Total participants: 62 (male- 43, female-19)

Sr.No.	Villagers Name	Father/Husband Name	Address
1.	Smt. Manisha Kaithait	Shri Surendra Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 8194024496 **Aadhar No.-** 644156741861
2.	Shri Ram Bisht	Shri Digambar Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 7351500201 **Aadhar No.-** 455294685807
3.	Shri H.N. Mainduli	Shri M.R. Mainduli	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 7500300112
4.	Smt. Pushpa Devi	Shri Vikram Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli
5.	Smt. Anjani Devi	Shri Jaspal Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 8449438950
6.	Smt. Anita Devi	Shri Gopichand	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 8958187479

			Aadhar No.-981996582558
7.	Smt. Anusuya Devi	Shri Digamber Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 7500057436 **Aadhar No.-**857094032313
8.	Smt. Radha Devi	Shri Surendar Rawat	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli
9.	Smt. Dhanuli Devi	Shri Mahendar Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 9758654605
10.	Smt. Radha Devi	Shri Khilaf Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 7248585265
11.	Shri Surendra Singh	Shri Dayal Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 9639321778
12.	Shri Amar Singh	Shri Khem Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli
13.	Shri Harendra Singh	Shri Diwan Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 9837757467
14.	Shri Narendra Singh	Shri Mahipal Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 9639634242
15.	Shri Pushkar Singh	Shri Raghubir Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli
16.	Shri Pradeep Kumar	Shri Raghubir Ram	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 7055905956
17.	Shri Himmat Singh	Shri Gyan singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 9927941430
18.	Shri Vikram Ram	Shri Hukumi Ram	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 6399226328
19.	Shri Vikram Singh	Shri Mahipal Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 9670354242 **Aadhar No.-**608070662137
20.	Shri Dilbar Singh	Shri Balak Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 7500639926
21.	Shri Manoj Singh	Shri Mahendar Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 7618619006 **Aadhar No.-** 207739449507
22.	Shri Vikram Singh	Shri Dalbeer Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 9690267796

23.	Shri Akshay Kumar	Shri Raj Kumar	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-**7618354621 **Aadhar No.-** 386441198214
24.	Shri Sanju Ram	Shri Bhajni Ram	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 9105625742 **Aadhar No.-** 275358745229
25.	Shri Anand Singh	Shri Harak Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 7248646629
26.	Shri Kamal Singh	Shri Gopal Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 8193915761 **Aadhar No.-** 851002575508
27.	Shri Vipin Singh	Shri Digpal Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 7351959466 **Aadhar No.-**313627468887
28.	Shri Devendra Singh	Shri Kuwar Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 8958583396 **Aadhar No.-** 739208719361
29.	Shri Kamleshwar	Shri Indra Ram	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Aadhar No.-** 615953914223
30.	Shri Padmi Ram	Shri Jagdish Ram	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-**7534084861 **Aadhar No.-** 931215619444
31.	Shri Mukesh Ram	Shri Chaitu Ram	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 8476924561 **Aadhar No.-**707316614730
32.	Shri Kalyan Singh	Shri Prem Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 7618529037 **Aadhar No.-** 846725012176
33.	Shri Vijay Ram	Shri Gandhi Ram	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 9927176755 **Aadhar No.-** 658896307409
34.	Shri Ratan Singh	Shri Tan Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli
35.	Shri Karan Singh	Shri Khyati Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 7535977745
36.	Smt. Hema Devi	Shri Vinod Singh Bisht	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 9690020172
37.	Smt. Pooja Devi	Shri Deepak Singh	**Vill-** Syanri Bhainti

			Block-Nandanagar, **Distt.-**Chamoli
38.	Shri Raghuveer Singh	Shri Fathe Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 8958675358 **Aadhar No.-** 622765820727
39.	Smt. Kalawati Devi	Shri Sishupal Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli
40.	Smt. Ghulli Devi	Shri Khilaf Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli
41.	Smt. Dhanuli Devi	Shri Matendar Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli
42.	Smt. Naumi Devi	Shri Mahipal Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli
43.	Shri Mahipal Ram	Shri Kutti Ram	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 7500956263
44.	Shri Vinod Kumar	Shri Hukumi Ram	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 7088327762
45.	Shri Ratan Singh	Shri Prem Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 9690122621
46.	Shri Sunil Singh	Shri Kamal Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 8449440898
47.	Shri Gopal Ram	Shri Kamal Ram	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 8941067172 **Aadhar No.-**402049466343
48.	Shri Gabbar Singh	Shri Dholya Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Aadhar No.-** 347952718954
49.	Smt. Basanti Devi	Shri Shankar Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli
50.	Smt. Gomti Devi	Shri Girdhari Ram	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Aadhar No.-** 919002102139
51.	Smt. Savitri Devi	Shri Jagdish Ram	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Aadhar No.-** 218934905873
52.	Shri Balwant Singh	Shri Thuni Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 7055527591 **Aadhar No.-** 355187853635
53.	Shri Ranjeet Singh	Shri Puran Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 7351928523
54.	Smt. Vimla Devi	Shri Sobhan Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Aadhar No.-** 540329684015
55.	Shri Pushkar Singh	Shri Umed Singh	**Vill-** Syanri Bhainti

			Block-Nandanagar, **Distt.-**Chamoli **Contact No.-** 7500015449
56.	Smt. Bhaduli Devi	Shri Mohan Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 8057542318 **Aadhar No.-** 351857574202
57.	Shri Dheeraj Pal	Shri Shri Feti Ram	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 8191824510 **Aadhar No.-** 450390409346
58.	Shri Bhajan Singh	Shri Shri Thepad Singh	**Vill-** Syanri Bhainti **Block-**Nandanagar, **Distt.-**Chamoli **Contact No.-** 8938953748 **Aadhar No.-** 539319209892
59.	Shri Pradeep Dobhal	Shri R. M. Dobhal	HAPPRC, **Contact No.-** 8650843550
60.	Shri Kailash Kandpal	Shri B. P. Kandpal	HAPPRC, **Contact No.-** 7302808941
61.	Shri Ajay Hemdan	Shri A. K. Hemdan	HAPPRC, **Contact No.-** 8272820207
62.	Shri Kuldeep Rawat	Shri Mahaveer Singh	HAPPRC, **Contact No.-** 9760944027

Figure 13. Photographs of the one day On-farm farmers workshop cum training/plant distribution programme organized for promotion of cultivation of MAP's at Syanri Bhainti, Nandanagar, Chamoli on 04/08/2022. Registration of participants (A), Difussion of technical knowledge to farmers (B), address of chief guests to the farmers (C-D), distribution of plants of *N. grandiflora* and *P. kurrooa* to farmers (E), group photograph of participants (F).

Table 22. List of villagers/farmers participated in one day On-farm farmers workshop cum training/plant distribution programme organized for promotion of cultivation of MAP's at Village Teela, Block Thalisain, District Pauri Garhwal on 5/7/2022.

Total participants: 64 (male-50, female-14)

Sr.No.	Villagers Name	Father/Husband Name	Address
1.	Shri Belam Singh	Shri Jaswant Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-** 9690923649 **Aadhar No.-** 593324158176
2.	Shri Satye Singh	Shri Chetriya Singh	**Vill-**Teela

			Block-Thalisain, **Distt.-**Pauri Garhwal **Contact No.-** 8879482627
3.	Shri Umed Singh	Shri Ghwan Singh	**Vill-**Teela **Block-**Thalisain, **Distt.-** Pauri Garhwal
4.	Shri Kartik Singh	Shri Jomal Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal
5.	Shri Guman Singh	Shri Chetrya Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal
6.	Shri Gagan Singh	Shri Kartik Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal
7.	Shri Hansa Singh	Shri Gudal Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal
8.	Shri Uday Singh	Shri Matbar Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal
9.	Shri Govind Singh	Shri Morkhala Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-** 8475860031
10.	Shri Bharat Singh	Shri Uday Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-** 9654729406 **Aadhar No.-** 694119868318
11.	Smt. Ganeshi Devi	Shri Vijay Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal
12.	Shri Madan Singh	Shri Darshan Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-** 8302788058 **Aadhar No.-** 210751927693
13.	Shri Chhora Singh	Shri Gabar Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal
14.	Shri Virendra Singh	Shri Darshan Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-** 9917568377
15.	Shri Ram Lal	Shri Kala Lal	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Aadhar No.-** 657259955374
16.	Shri Narayan Singh	Shri Nathi Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-** 9690732048
17.	Shri Sangram Singh	Shri Chhota Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-** 7500566744
18.	Shri Bhupal Lal	Shri Kala Lal	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Aadhar No.-** 382715992946
19.	Shri Barjan Lal	Shri Jangali Lal	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-** 6395677901 **Aadhar No.-** 414115825286
20.	Smt. Usha Devi	Shri Kala Lal	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-** 7298105622 **Aadhar No.-** 805040324898
21.	Shri Prem Lal	ShriFagunu Lal	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Aadhar No.-** 255269479523
22.	Shri Kunjpal Lal	Shri Idhala Lal	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Aadhar No.-** 329852275768
23.	Shri Khushal Singh	Shri Darshan Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal

24.	Shri Madan Singh	Shri Akal Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-** 9627431890
25.	Shri Matbar Singh	Shri Gabar Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-** 8791891712
26.	Shri Chakraveer Singh	Shri Kutal Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-** 7055152628 **Aadhar No.-** 916334742489
27.	Shri Digambar Singh	Shri Thep Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-** 9917568095
28.	Shri Alam Singh	Shri Darman Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-** 8392848231
29.	Shri Raje Singh	Shri Chandra Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal
30.	Shri Kunwar Singh	Shri Jagat Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal
31.	Shri Harendra Singh	Shri Gaje Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-** 9193329875
32.	Shri Gaur Singh	Shri Pancham Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal
33.	Shri Suraj Singh	Shri Jeewan Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-** 7536867047
34.	Shri Meharban Singh	Shri Prem Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-** 9720510171 **Aadhar No.-** 958970279282
35.	Shri Virendra Negi	Lt. Shri Gaina Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-** 8447107954 **Aadhar No.-** 394908301287
36.	Shri Mahaveer Singh	Shri Kunwar Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-** 8279947131 **Aadhar No.-** 603693354694
37.	Shri Surendra Lal	Shri Shishpal Lal	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Aadhar No.-** 677220545252
38.	Shri Suresh Lal	Shri Mohiya Lal	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-** 9557976041 **Aadhar No.-** 386528503518
39.	Shri Vikram Singh	Lt. Shri Shyam Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-** 9389183695 **Aadhar No.-** 593397476580
40.	Shri Sobat Singh	Lt. Shri Saupa Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-** 9557211771
41.	Smt. Srimati Devi	Shri Darban Lal	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Aadhar No.-** 545010081427
42.	Smt. Savitri Devi	Shri Dhol Lal	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal

			Aadhar No.- 901396618325
43.	Smt. Sureshi Devi	Shri Radhe Shyam	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-** 8126302115 **Aadhar No.-** 740601188704
44.	Smt. Bhama Devi	Shri Mahesh Lal	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-** 9037342983 **Aadhar No.-** 503341004878
45.	Smt. Usha Devi	Shri Narendra Tamta	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-** 9557968795 **Aadhar No.-** 714768632245
46.	Smt. Choma Devi	Shri Harish Lal	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Aadhar No.-** 973260071236
47.	Smt. Guddi Devi	Shri Mani Lal	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-** 9761667599 **Aadhar No.-** 201892968325
48.	Shri Pravesh Lal	Shri Chandri Lal	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Aadhar No.-**529599159654
49.	Shri Hari Prasad Pant	Shri Tulsiram Pant	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-** 9990035816 **Aadhar No.-**976217962575
50.	Smt. Meena Devi	Shri Jagdish Aagre	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Aadhar No.-**528700365765
51.	Shri Vinod Lal	Shri Vinta Lal	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Aadhar No.-**258666362292
52.	Shri Dinesh Singh	Shri Rajendra Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-**9068532267 **Aadhar No.-**469159184518
53.	Smt. Kusum Devi	Shri Balwant Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-**9917029919
54.	Smt. Dupa Devi	Shri Chand Lal	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-**8859933882 **Aadhar No.-**534058368553
55.	Shri Kalam Singh	Lt. Shri Dham Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-**939412375
56.	Smt. Sarita Devi	Shri Dinesh Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-**7900712264
57.	Smt. Sarojani Devi	Shri Kundan Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Aadhar No.-**651833412252
58.	Shri Padam Singh	Shri Bhawan Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal **Contact No.-**7088574637
59.	Shri Darshan Singh	Shri Jagat Singh	**Vill-**Teela **Block-** Thalisain, **Distt.-**Pauri Garhwal
60.	Dr. Vijay Kant Purohit	Shri A. P. Purohit	HAPPRC (Senior Scientific Officer) **Contact No.-** 9456531715
61.	Shri Pradeep Dobhal	Shri R.M. Dobhal	HAPPRC, **Contact No.-** 8650843550

62.	Shri Kailash Kandpal	Shri Bhagwati Prasad	HAPPRC, **Contact No.-** 7302808941
63.	Shri Jaidev Chauhan	Shri B.S.Chauhan	HAPPRC, **Contact No.-** 8126211560
64.	Shri Kuldeep Rawat	Shri Mahaveer Singh	HAPPRC, **Contact No.-** 9760944027

Figure 14. Photographs of the one day On-farm farmers workshop cum training/plant distribution programme organized for promotion of cultivation of MAP's at Teela village, district Pauri Garhwal on 05/07/2022. Diffusion of technical knowledge by Dr. V.K. Purohit (SSO) to farmers/participants (A-C), distribution of planta of *P. kurooa* to farmers (D-E) and group photograph of farmers/participants (F).

19. Monitoring of the project progress by JWCT nominee/representative: To assess the on spot progress of the JWCT project running by HAPPRC, the JWCT nominee Dr C. S. Rana (Senior Scientist – Bioresource), Mr. Aman deep (Scientist-Bioresource), Smt. Sakshi Sharma (Scientist-Bioresource), Surendra Singh Bhagat (Scientist- Bioresource), Mr. Yasveer Singh Negi (Scientist-Bioresource) and Mr. Amit Bhatt (Field Supervisor - Bioresource) visited the farmers field (Tyuni, Setail, Gairi and Rusiayan) in Rudraprayag and Chamoli District and in field stations of Pothivasa, Nature Interpretation Centre Baniyakund and Alpine Research Centre at Tungnath and Model nursery, Kulsari of HAPPRC from 23 July 2022 to 30 July 2022. The entire expert team physically monitors the seedling development activity to cultivation in farmers field under the project and critically examines the progress on other aspects of the project with face to face interaction with farmers, project staff and director of the Centre (HAPPRC). They also suggest the solutions of the difficulties, particularly low germination and high mortality of seedlings in some species (**Figure**).

Dr. CS Rana, ream leader of the monitoring team suggested that the, HAPPRC need to prepare a separate block under JWCT project for seed production of *N. grandiflora* at Tungnath. To consider the suggestion provided by the mnonitoring team, a work on development of separate block for seed production was estabilihed at Tungnath in the month of September-October 2023.

Figure 15. Monitoring of field stations (A), farmers fields at Rudraprayag and Chamoli district (B-F) and interaction with Prof. M.C. Nautiyal, Director, HAPPRC and Dr. Vijay Kant Purohit, PI, JWCT (G-J) project about the future work plan and fund disbursement.

Figure 16. Preparation of nursery bed's for estabilihement of separate block for seed development of Jatamansi (*Nardostachys grandiflora*) seedling at Alpine Research Centre Tungnath, recommendations by Dr. C. S. Rana (Principal Scientist-Bioresource) and their teams for Dabur Research & Development Centre.

Figure 17. Plantation of Jatamansi (*Nardostachys grandiflora*) seedling in separate block developed for seed production of jatamansi at Alpine Research Centre Tungnath (3400 m asl) under JWCT project.

Table 23. Seed collected (gm) from different field sites during the current report period (October-November, 2022) for seedling dvelopment.

Sr.No.	Name of species	Seed collection sites	Approx. seeds collected (gm)
1.	*Picrorhiza kurrooa*	Tungnath	200gm
2.	*Nardostachys grandiflora*	Tungnath	70 gm
3.	*Aconitum balfourii*	Tungnath(49.66gm), Baniyakund (17.8gm) and Kilpur (19.57gm)	87.03gm
4.	*Aconitum heterophyllum*	Tungnath (8gm), Baniyakund (22gm) and Kilpur (4.59gm)	34.59gm
5.	*Sassurea costus*	Pothivasa	10000 gm
		Total weight of collected seeds	**1391.62 gm**

Figure 18. Drying of collected seeds of different species at HAPPRC, Srinagar (Garhwal, 550m asl).

Figure 19. Packed and labeled seeds of selected species for storage and further use. *A. balfourii* (A-C), *A. heterophyllum* (D-F), *P. kurrooa* (G), *N. grandiflora* (H), and *S. costus* (I)

20. Seedling development and Transfer to Field for Further growth and distribution to farmers:

To fulfill the demand of seedlings under project, the collected seeds were sowed inside the green house condition and approximate 80000 seedlings of selected species (2500-*A. balfouri*, 8000-*A. heterophyllum*, 30000-*P. kurrooa*, 195000- *N. grandiflora*, and 20000-*S. costus*) has been developed and transfered to field station Pothibasa (2200m asl) for further growth.

Figure 20. Photographs of seedlings development of selected species and transfered of seedlings to field station Pothibasa (2200 m asl) for further growth.

21. Establishment of satellite nursery: Keeping in view the development and maintenance of seedlings of selected species in nearby areas of farmers village/ land, establishment work of one satellite nursery in 0.5ha land has been done at Lumkundi, Kulsari under project. The land preparation and construction of polyhouse, shadehouse work and bed preparation work is completed (**Figure**). This year onwards the seedlings development and maintenance work of the selected species in JWCT project and other medicinally important species will be start.

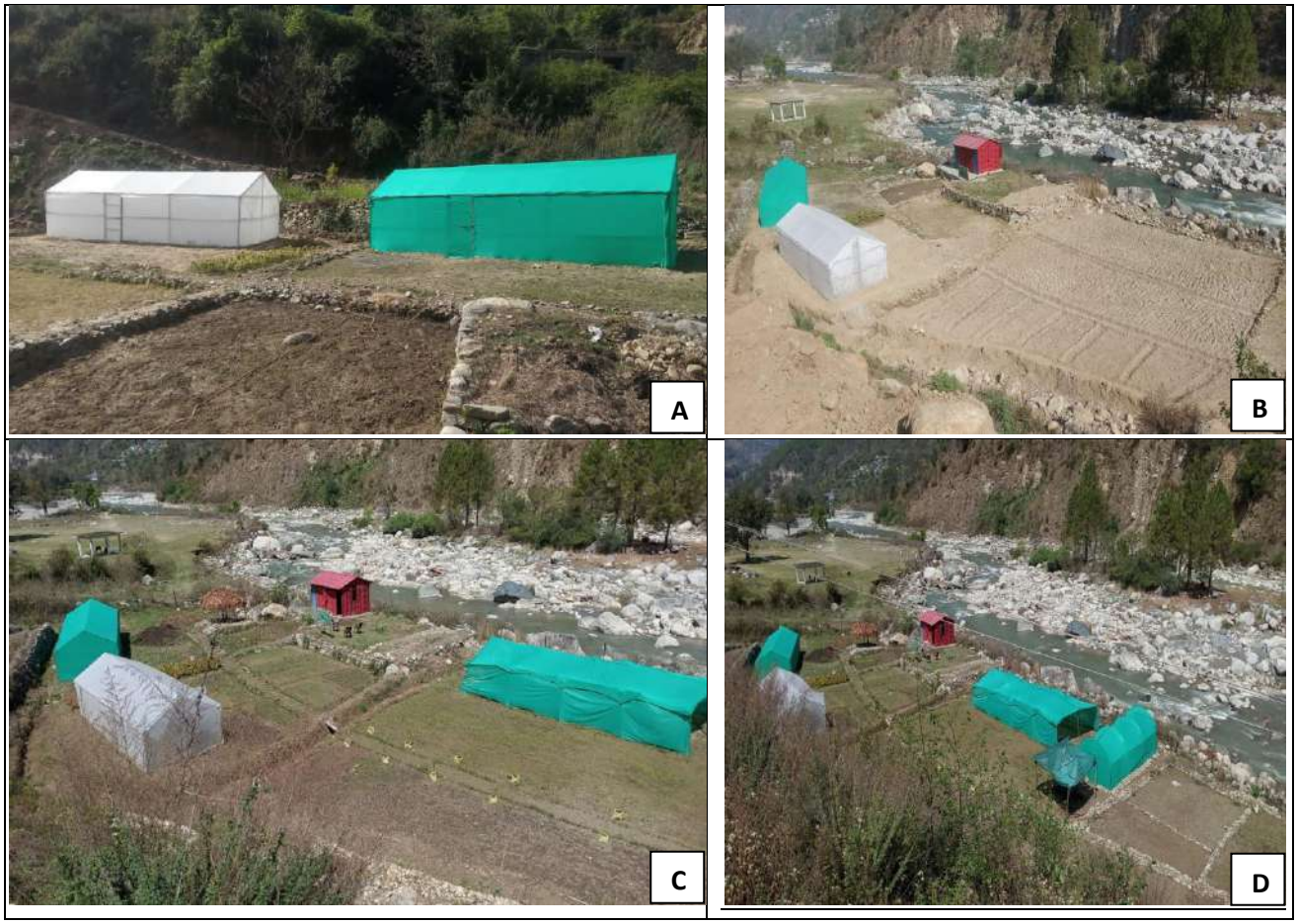

Figure 21. View of satellite Nursery Established Under JWCT, Dabur India Ltd. Project at Lumkundi, Kulsari (1200 m asl), Chamoli.

22. <u>Work has been done under JWCT Project (2020-2023)</u>

- **Collection of seeds (4652.8 gm) of selected species from different high altitude region/field nursery of HPPRC**
- **Development and maintenance of 6,20,000 seedlings in nursery condition and their transfer in farmers fields.**
- **Organisation of 15 farmers meeting/workshop/training/plant distribution programme.**
- **Sensitiztion and cultivation of selected species in three districts, 18 villages and four developmental blocks of Uttarakhand with 720 villagers/farmers.**
- **Promotion of cultivation of selected species in 6.16 ha (312.07 nali) of farmers land.**
- **Estabilishment of one satellite nursery in 0.2ha of land for future use.**
- **Estabilishment of one separate block for seed production of Jatamansi in 0.1 ha (5.0 nali) at Tungnath**
- **Regular monitoring of project work, data collection, report writing and submission to funding agency (JWCT) – Quaterly (June, September, December, March) and Annualy (April).**

Close view of Satellite Nursery at Lumkundi (1200 m asl), Kusari, Chamoli

Close view of Separate Block for Seed Production of Jatamansi at Tungnath (3400 m asl)

23. Justification/Remarks: The **JIVANTI WELFARE AND CHARITABLE TRUST (JWCT)** is working as a part of Dabur India Ltd. with focus on fulfilment of welfare and charitable obligations towards society at large through advancement of equal opportunities for education, providing food, healthcare, medical care, ensuring environmental sustainability, enhanced vocational skills and advancement of any other objects of general public welfare. Simultaneously, **Dabur India Ltd. is a leading organization in the field of herbal medicine and therefore the firm a**dopted conservation and sustainable development of biological diversity as part of Corporate Social responsibility and has designed an integrated programme through a community centric Project based approach. Under this approach JWCT, Dabur India Ltd. and High Altitude Plant Physiology Research Centre (HAPPRC) is collaboratively working for promotion of cultivation and conservation of high value medicinal herbs in different parts of Uttarakhand. The role of HAPPRC is clearly defined as production of planting materials, their distribution to NGOs/farmers and promotion of cultivation in farmers field so that the produce raw materials will be easily available to Dabur India Ltd. and other concern firms of herbal medicine and livelihood opportunities for local farmers/villagers.

24. Media released/Publication: The work done under JWCT project has been highlighted through writing and publishing of scientific research papers and news publishing through print as well as electronic media for public domain.

25. Final observations from farmers field

To take up the cultivation of medicinal and aromatic plants as option/source of additional income to local inhabitants, numbers of villagers/farmers are interested to do the cultivation of selected species, but there are some concern about irrigation facility during the summer months particularly April to June, planting materials of the important species and intime marketing of the raw produce. To address all these concerns of the farmers, the cultivation of medicinal and aromatic plants can boost the local economy with conservation of RET species in natural habitats.

Dr. V. K. Purohit
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Prof. M.C. Nautiyal

(Director/HOD)

एक्सटेंशन सेंटर (विस्तार केन्द) ऋषिकेश योग पीठ
हेमवती नंदन बहुगुणा गढवाल विश्वविद्यालय, श्रीनगर गढवाल
(केन्द्रीय विश्वविद्यालय)

रिपोर्ट

ऋषिकेश योग पीठ व ह0न0ब0ग0वि0वि0 श्रीनगर,गढवाल के मध्य दिनांक – 16 मार्च, 2021 में हुए एम0ओ0यू0 के आधार पर तथा 28 मई 2021 विभागीय (बी0ओ0एस0), 30 जून 2021 विश्वविद्यालय विद्या परिषद व 23 अगस्त 2021 विश्वविद्यालय कार्य परिषद की बैठक में मिली स्वीकृति के पश्चात् ऋषिकेश योग पीठ को विश्वविद्यालय का एक्सटेंशन सेंटर (विस्तार केन्द), स्वीकृत किया गया है तथा योग में प्रमाण पत्र/डिप्लोमा/योग प्रशिक्षण कार्यक्रम का संचालन प्राकृतिक चिकित्सा एवं योग विभाग, चौरास परिसर की देख–रेख में करने की स्वीकृति ऋषिकेश योग पीठ को दी गई है। इस कार्य को सुचारू रूप से संचालन करने हेतु डॉ0 विनोद प्रसाद नौटियाल, योग प्रशिक्षक, योग विभाग को विभागीय कार्यो के साथ–साथ ऋषिकेश योग पीठ का अतिरिक्त कार्यभार देकर संपर्क अधिकारी, नियुक्त किया गया है। योग प्रशिक्षण कार्यक्रम (15, 28 व 30 दिवस) में विदेशी नागरिक का शुल्क प्रति रू0 10,000 तथा भारतीय नागरिक का शुल्क प्रति रू0 3000 निर्धारित है। इनसे प्राप्त 40 प्रतिशत शुल्क वित्तअधिकारी,ह0 न0 ब0 ग0 वि0 वि0, श्रीनगर के नाम योग फन्ड 585, 526002011015013 यूनियन बैक, विश्वविद्यालय, चौरास शाखा मे जमा किया जाता है। वर्तमान समय तक उपरोक्त कार्यक्रम से प्राप्त कुल आय रू0 3,45,600.00 (रू0 तीन लाख पैतालिस हजार छ' सौ मात्र) उपरोक्त एकाउन्ट मे जमा है। 60 प्रतिशत शुल्क एक्सटेंशन सेंटर छात्र/छात्राओ से अपने द्वारा देय व्यवस्था जैसे रहने–खाने, शिक्षण, भवन इत्यादि पर व्यय के लिए लेता है। विभाग द्वारा योग प्रशिक्षण कार्यक्रम में प्रतिभाग करने वाले छात्र/छात्राओ को योग प्रशिक्षण प्रमाण–पत्र प्रदान किया जाता है। भविष्य में प्रमाणपत्र/ डिप्लोमा पाठयक्रम एक्सटेंशन सेंटर में शीघ्र प्रारम्भ किए जाने है। विदेशी छात्र/छात्राओ से इस कार्यक्रम के पंजीकरण शुल्क के रूप में वर्तमान समय तक प्रति 20 डॉलर लगभग रू0 1,30,000.00 विश्वविद्यालय के Foreign Students कार्यालय में जमा है। योग प्रशिक्षण कार्यक्रम एक माह के छात्र/छात्राओ का वर्षवार विवरण –

BATCH	DATE	STUDENT		TOTAL STUDENT	FEES
		FOREIGN	INDIAN		
Ist	3 January 2022 to 28 January 2022	02	02	04	Rs 10,400.00
2nd	7 March to 3 April 2022	05	02	07	Rs.22,400.00
3rd	10 April to 7 May 2022	07	02	09	Rs 30,400.00
4th	09 May to 04 June 2022	04	05	09	Rs.22,000.00
5th	11 July,2022 to 06 August 2022	02	03	05	Rs. 11,600.00
6th	14 August to 10 September 2022	05	01	06	Rs.21,200.00
7th	12 September to 15 October 2022	02	NIL	02	Rs. 8,000.00
8th	17 October to 12 November 2022	04	NIL	04	Rs. 16,000.00
9th	14 November to 17 December, 2022	03	NIL		Rs 12,000.00
10th	19 December to 14 January 2023	04	NIL	04	Rs. 16,000.00
11th	26 Feb to 25 March 2023	NIL	02	02	Rs. 2,400.00
12th	3 April to 29 April 2023	09	01	10	Rs. 37,200.00
13th	12 June to 8 July 2023	NIL	01	01	Rs. 1,200.00
14th	14th 19 July to 02 August, 2023(15 Days Rs 1200)	01	NIL	01	Rs. 1,200.00
15th	17 July to 12 August 2023	02	01	03	Rs. 9,200.00
16th	21 August to 16 September 2023	NIL	03	03	Rs. 3,600.00
17th	26 September to 16 October 2023	07	NIL	07	Rs. 28,000.00
18th	04 October to 24 October 2023	07	03	10	Rs. 31,600.00
19th	27 October to 17 November 2023	05	NIL	05	Rs. 20,000.00
20th	19 November to 09 December 2023	09	01	10	Rs. 37,200.00
21	12 December to 02 January 2024	01	NIL	01	Rs. 4,000.00
		79	27	TOTAL	Rs. 3,45,600

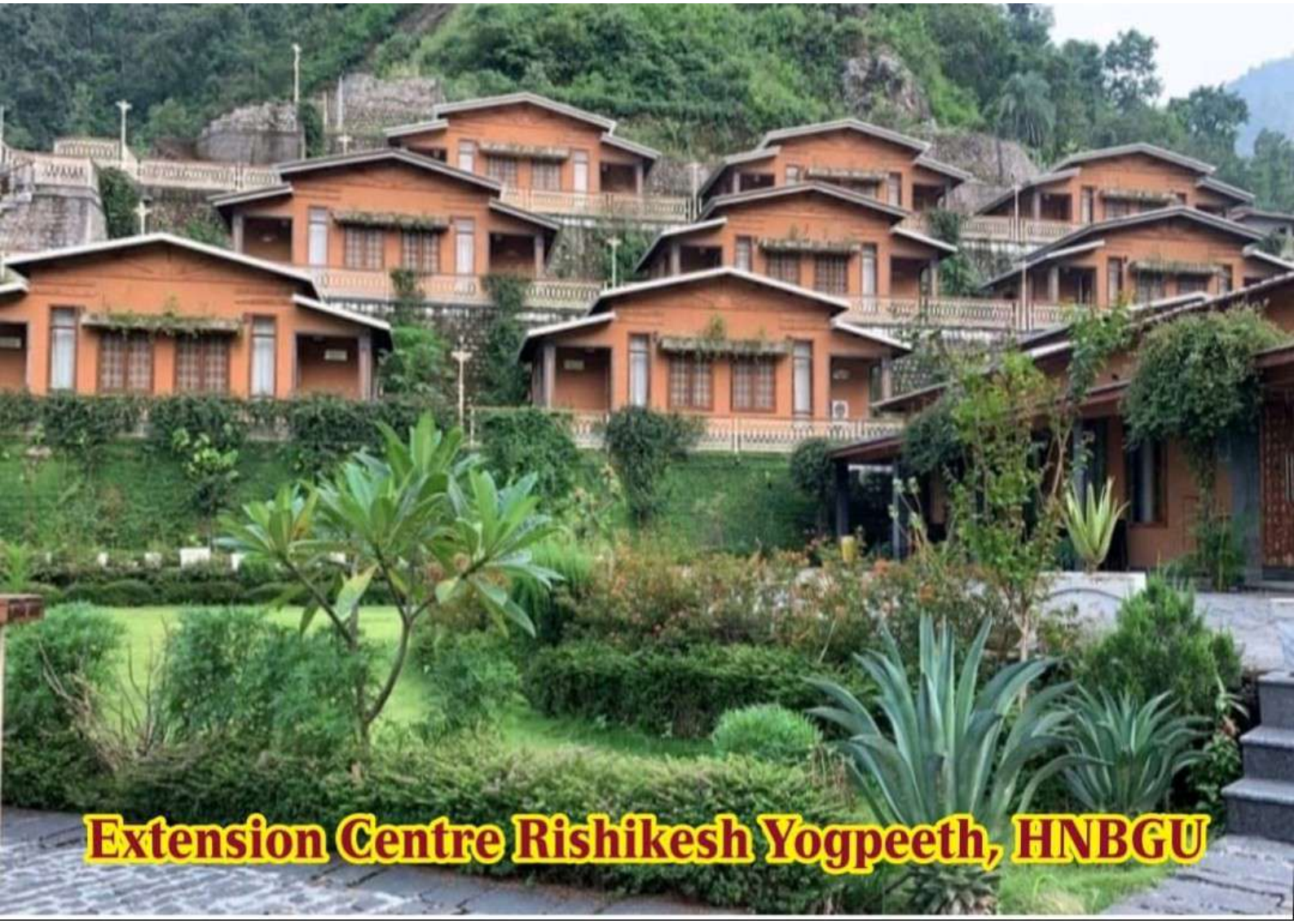
उपरोक्त योग प्रशिक्षण कार्यकम के छात्र/छात्राओ हेतु वर्कशॉप का आयोजन संख्या – 02

1. यौगिक चिकित्सा पर दिनांक 24 एवं 25 मार्च 2022
2. यौगिक चिकित्सा पर दिनांक 15,16 एवं 17 मार्च 2023

वर्चुवल तीन दिवसीय अन्तराष्ट्रीय बेबिनार का आयोजन संख्या – 01

दिनांक 23 से 25 जून 2021 विषय – "हॉलेस्टिक हेल्थ थ्रू योगा ड्यूरिंग कोविड 19"

प्रत्येक माह विभाग की फैक्लटी के द्वारा ऑफ व वर्चुवल स्तर पर अतिथि शिक्षक के रूप में योग पर व्याख्यान व प्रशिक्षण उपरोक्त कार्यकम के छात्र/छात्राओ को दिया जाता है तथा एक्सटेंशन सेंटर व योग विभाग के छात्र/छात्राओ के मध्य योग विद्या पर व शोध कार्यों पर विचार विमर्श समयानुसार चलता रहता है।



International Webinar on Yoga Organized by Naturopathy and Yoga Dept HNBGU With Rishikesh Yoga Peeth, 23 June 2021

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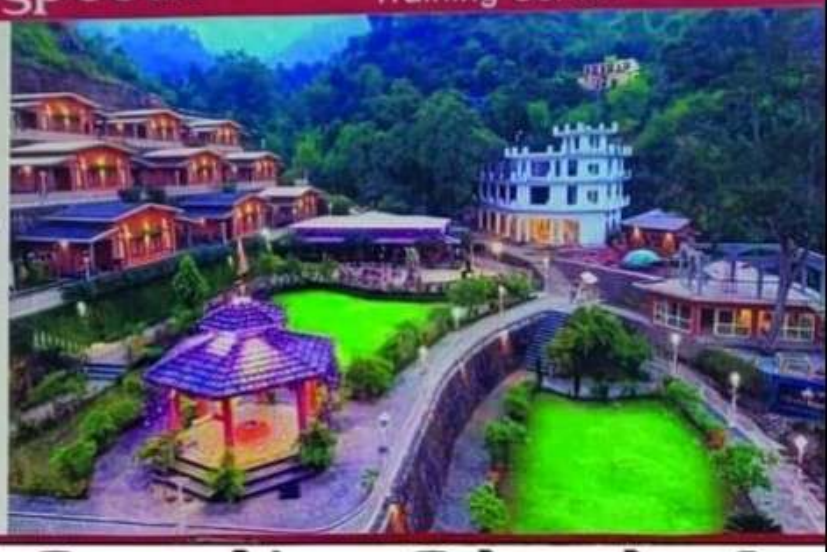
Message

कोरोना काल में योग के महत्व पर किया मंथन

गढ़वाल विवि के योग विभाग की ओर से आयोजित अंतरराष्ट्रीय योग वेबिनार में आगंतुकों का आभार जताने के साथ प्रतिभागी कनाडा इटली के सिसीलिया शहर की योग शिक्षिका टिन्निया विटर • जागरण

जागरण संवाददाता, बैनगर गढ़वाल: गढ़वाल केंद्रीय विश्वविद्यालय की कुलपति प्रो. अन्नपूर्णा नौटियाल ने कहा कि कोरोना महामारी से बचाव को लेकर शरीर की रोग प्रतिरोधक क्षमता बढ़ाने के लिए योग और प्राणायाम बहुत प्रभावी होने के साथ ही लाभकारी भी है। प्रो. नौटियाल ने बुधवार को गढ़वाल केंद्रीय विश्वविद्यालय श्रीनगर के योग विभाग की ओर से योग पीठ ऋषिकेश स्थित विश्वविद्यालय एम्बेडेशन योग सेंटर के सहयोग से तीन दिवसीय अंतरराष्ट्रीय योग वेबिनार का उद्घाटन करते हुए यह बात कही।

समग्र स्वास्थ्य को लेकर 'होलिस्टिक हेल्थ थ्रू योगा ड्यूरिंग कोविड 19' विषय पर आयोजित अंतरराष्ट्रीय वेबिनार में पहले दिन देश-विदेश के 300 से ज्यादा प्रतिभागी जुड़े। वर्चुअल माध्यम से प्रतिदिन 25 जून तक दोपहर एक बजे से अपराह्न तीन बजे तक वेबिनार का संचालन किया जाएगा। योग की विभिन्न विधाओं से शरीर को मिलने वाले लाभों को चर्चा करते हुए कुलपति प्रो. नौटियाल ने कहा कि भारत ने पूरे विश्व को योग जैसा अनुपम उपहार देकर संपूर्ण मानव जगत कल्याण के लिए ऐतिहासिक कार्य भी किया है। अंतरराष्ट्रीय वेबिनार के प्रथम रिसोर्स पर्सन और हिमाचल विवि योग विभाग के पूर्व अध्यक्ष प्रो. जीती शर्मा ने योगिक जीवन जीते हुए कोरोना काल में स्वस्थ रहने को लेकर व्याख्यान दिया। दूसरे रिसोर्स पर्सन और फैकल्टिक विवि राजस्थान के प्रो. नरेंद्र कुमार ने योग की विभिन्न कलाओं का आकर्षक प्रदर्शन किया। प्रो. नरेंद्र ने शरीर की रोग प्रतिरोधक क्षमता बढ़ाने में योग के महत्व के बारे में बताया। गढ़वाल केंद्रीय विवि के योग विभाग की अध्यक्ष डा. अनुराधा ने वेबिनार के उद्देश्यों पर विस्तार से प्रकाश डाला। आयोजक सचिव और गढ़वाल केंद्रीय विवि योग विभाग के मुख्य प्रशिक्षक डा. विनोद नौटियाल ने



विश्वविद्यालय के विस्तार केंद, ऋषिकेश योग पीठ में आयोजित योग प्रशिक्षण व कार्यशाला

स्पष्टएक्सप्रेस।

ऋषिकेश (20 जून 2023): विश्वविद्यालय कुलपति महोदया प्रोफेसर अन्नपूर्णा नौटियाल के मार्गदर्शन में विस्तार केंद्र में योग पर कार्यशाला व प्रशिक्षण संचालित किए जा रहे हैं।

संचालन के लिए प्राकृतिक चिकित्सा एवं योग विभाग के डॉ विनोद नौटियाल को संपर्क अधिकारी, विस्तार केंद्र हेतु अतिरिक्त कार्यभार देकर नियुक्त किया गया। 16 मार्च 2021 से वर्तमान समय जून 2023 तक योग विभाग द्वारा आयोजित एक माह का योग प्रशिक्षण कार्यक्रम में विदेशी नागरिकों ने बढ़ चढ़कर प्रतिभाग किया। जून 2023 तक 49 विभिन्न देशों के नागरिकों और 21 भारतीय नागरिको ने एक माह के योग प्रशिक्षण कार्यक्रम में प्रतिभाग किया, जिससे लगभग 2 लाख रुपए शुल्क के रूप में प्राप्त हुए और विश्वविद्यालय के विदेशी नागरिकों के रजिस्ट्रेशन शुल्क में लगभग 75 हजार रुपए के रूप में प्राप्त हुए। विश्वविद्यालय के प्राकृतिक चिकित्सा एवं योग विभाग और विस्तार केंद्र के समन्वय से दिनांक 23 से 25 जून 2021 तक तीन दिवसीय, द्वितीय अंतरराष्ट्रीय स्तर पर समग्र स्वास्थ्य हेतु योग पर वेबीनार का भी आयोजन किया गया तथा विभिन्न प्रकार की योग चिकित्सा पर कार्यशाला और योग प्रशिक्षण कार्यक्रम प्रत्येक माह डॉ विनोद नौटियाल, डॉ रजनी नौटियाल के माध्यम से एवं विभागाध्यक्ष डॉ अनुजा रावत की देखरेख में आयोजित किए जा रहे हैं।

विश्व के विभिन्न देशों से आए हुए नागरिकों ने इन कार्यशाला व प्रशिक्षण में भाग लेकर विश्वविद्यालय के प्रति अपना आभार और धन्यवाद ज्ञापित किया।

पावक पदम सिंह • साभार: स्वयं

योग के प्रति विदेशी छात्रों का रुझान

जागरण संवाददाता, श्रीनगर गढ़वाल: गढ़वाल केंद्रीय विश्वविद्यालय श्रीनगर के योग विभाग के विषय विशेषज्ञों से योग प्राणायाम सीखने को लेकर विदेशी छात्र-छात्राओं की संख्या में अब हर वर्ष इजाफा होता जा रहा है। विदेशी छात्रों के लिए गढ़वाल केंद्रीय विवि से संचालित योग सर्टिफिकेट कार्यक्रम में पिछले वर्ष जहां पांच विदेशी छात्रों ने प्रवेश लिया वहीं अब आगामी अप्रैल महीने से शुरू होने वाले कोर्स के लिए अब तक 22 विदेशी छात्र-छात्राएं संपर्क कर चुके हैं।

विदेशों के छात्र-छात्राओं को योग प्राणायाम पाठ्यक्रम के प्रति आकर्षित करने के लिए गढ़वाल केंद्रीय विश्वविद्यालय की कुलपति प्रो. अन्नपूर्णा नौटियाल की पहल पर पिछले वर्ष विश्वविद्यालय ने यह कार्ययोजना शुरू की। जिसमें योगपीठ ऋषिकेश के साथ एमओयू कर योग प्राणायाम को लेकर विस्तार केंद्र संचालित किया जा रहा है। कुलपति ने इस केंद्र के लिए गढ़वाल विवि योग विभाग के वरिष्ठ डा. विनोद नौटियाल को प्रभारी की जिम्मेदारी दी है। डा. विनोद नौटियाल ने कहा कि योग में अल्पकालिक पाठ्यक्रम संचालन के साथ ही अब विस्तार केंद्र में योग डिप्लोमा पाठ्यक्रम भी शुरू करने पर गंभीरता से विचार किया जा रहा है।

जिससे अधिक से अधिक विदेशी छात्र-छात्राएं योग में डिप्लोमा हासिल कर सकें। डा. नौटियाल ने कहा कि अप्रैल माह से शुरू हो रहे नए सत्र में ऋषिकेश योगपीठ में प्रशिक्षित हो रहे विदेशी छात्रों को गढ़वाल केंद्रीय विवि योग विभाग का भी भ्रमण कराने के साथ ही उन्हें यहां भी प्रशिक्षण दिया जाएगा।

गढ़वाल केंद्रीय विवि के योग विभाग के तत्वावधान में योगपीठ ऋषिकेश में संचालित योग केंद्र में डा. विनोद नौटियाल से योग प्रशिक्षण लेते विदेशी छात्र • जागरण

गढ़वाल विवि के विस्तार केन्द्र में सोमवार को योग की शिक्षा लेते विदेशी छात्र।

विदेशी छात्रों ने सीखे योग के गुर

श्रीनगर। गढ़वाल विवि के विस्तार केंद्र ऋषिकेश में योग विभाग द्वारा विदेशी छात्रों हेतु योग शिविर का आयोजन किया गया। जिसमें योगाचार्य डॉ. विनोद नौटियाल द्वारा तीन दिवसीय योग चिकित्सा शिविर में विदेशी छात्रों को योग के गुर सिखाये गये। जिसमें विदेशी छात्र छात्राओं को विभिन्न रोगों पर किस प्रकार से योग क्रियाओं द्वारा निजात पाई जा सकती है यह विस्तार से बताया।

DR. DEVENDRA NEGI'S ITINERARY

Sunday, Sept 1	Monday, Sept 2	Tuesday, Sept 3rd	Wednesday, Sept 4th	Thursday, Sept 5th	Friday, Sept 6th
	Texas Tech Holiday Labor Day	8:30am Shelley will pick up Dr. Negi from Woodrow and deliver to Holden Hall	8:15am Dr. Duncan will pick up Dr. Negi from Woodrow and deliver to Chem. Eng.	8:15am Shelley will pick up Dr. Negi from Woodrow and deliver to Admin Bldg	8:45am Dr. Duncan will pick up Dr. Negi from Woodrow
			Chemical Engineering 8:30-8:55am Mahdi Malmali, MERC 212	8:30-8:55am **Dr. Galyean,** Admin, Room 107 Shelley will deliver Dr. Negi to Chemistry	9:00 – 11:00am Ranching Heritage Center tour with Dr. Duncan
Dr. Negi's flight arrives @ 7:50pm on American Airlines #5995	**Rest Day**	9:00-9:55am Dean Lindquist & Dr. Akchurin Holden Hall 202 *Deaven will escort Dr. Negi to Human Sciences, Room 407*	9:00-10:00am Dr. Siva Vanapalli, IMSE 202FA *Dr. Duncan will pick up Dr. Negi from Chem Eng.*	Chemistry 9:00 – 11:00am Chemistry 102 conference room (4-6 faculty members to meet with Dr. Negi) *Dr. Duncan will pick up Dr. Negi for transport to Animal Sciences*	
Check-In at Woodrow House Bed & Breakfast (806) 793-3330	Breakfast is served at Woodrow B&B (Tentative) Dinner with Dr. Cuikun Lin (Scientist in Dr. Duncan's lab) - Time and Place TBD Cuikun.lin@ttu.edu, or 605-659-4195	10:00-10:30am Dr. Naima Moustaid-Moussa Human Sciences, Room 407 *TBD will escort Dr. Negi to ESB 153*	10:00-10:30am OPEN 10:03-11:00am OPEN		
		10:45-11:45am Dr. Duncan –Tour of CEES	10:30-11:00am OPEN		
		12:00-1:30pm LUNCH @ Tech Club Drs. Negi Duncan Snow Lee *Dr. Duncan will deliver Dr. Negi to HSC*	11:30-1:00pmLUNCH TBD	11:15–11:45am Dr. Sarturi Animal & Food Sciences, Room 207 (West side of the United Supermarket Arena (right in front of the construction site). *Dr. Sarturi will bring Dr. Negi to ESB*	11:00am – 12:30pm LUNCH TBD
		TTUHSC 2:00 – 4:00pm Conference Room 2B158 (SVPR office) Drs. Leslie Shen Min Kang Sam Prien	1:30-2:15pm **Dr. Heppert**		
			2:15pm *Dr. Duncan will deliver Dr. Negi to BayerBldg*	12-1:30pm LUNCH TBD	1:00pm *TBD will Transport Dr. Negi to Airport*
		4:00pm Shelley will pick up Dr. Negi	Plant & Soil Science (Room 122F) 2:30-2:55pm Dr. Jyotsna Sharma 3:00-3:25pm Dr. Luis Estrella-Herrera 3:30-3:55pm Dr. Haydee Laza	1:30-2:15pm OPEN 2:30-3:00pm Coffee/Refreshments, ESB 120	Dr. Negi departs LBB at 2:29pm on American Airlines #5967
		DINNER at Café J's Dr. Negi, Drs. Duncan and Sobel	4:00pm *Pick up Dr. Negi from Bayer Bldg*	3:00-4:30pm Dr. Negi's Colloquium, ESB 120	
			DINNER at Duncan/Sobel Residence w/ Medical Community (Hendershots, and Walters)	DINNER at Triple J's Drs. Negi, Duncan, Sobel, Naima Moustaid-Moussa, Prien	

When I despair, I remember that all through history the way of truth and love have always won. There have been tyrants and murderers, and for a time, they can seem invincible, but in the end, they always fall. Think of it--always. **Mahatma Gandhi**

Web Panel Discussion

On

Understanding Gandhian way of life: A timeless lesson for everyone to emulate

Organized by

H.N.B. Garhwal University

In collaboration with

Texas Tech University, Texas, USA

Date: 18th August, 2020
Timings: 7:00 PM (IST)

Patron
Prof. Annpurna Nautiyal
Vice Chancellor
HNB Garhwal University

Chief Guest
Prof. Mehraj Uddin Mir
Vice Chancellor
Central University of Kashmir

Guest of Honour
Prof. Robert V. Duncan
Texas Tech University,
Lubbock Texas, USA

Special Guest
Prof. Michael San Francisco,
Texas Tech University,
Lubbock Texas, USA

Celebrating 150 Birth anniversary of Mahatma Gandhi

Abstract of the talk

Special Talk-1
A Man of His Time or a Man for Our Time? Mohandas Gandhi in Africa
Prof. Paul Bjerk

Mohandas Gandhi came of age in Natal in South Africa, at the turn of the 20th century. He came of age as both a global citizen, or more specifically as a subject of the British Empire, but also, quite literally as the representative of Indians now defined in relation to that empire. His life in Natal grew in parallel to his contemporary global citizen, the Zulu educator John Langalibalele Dube. Considering Gandhi's and Dube's lives in their Natal context, we find illumination for the birth of that dubious signifier: the "modern." Modernity is a 20th century cultural complex, bearing the birthmark of European Enlightenment, but only conceivable as something fundamentally global, and contentious.

Special talk-2
Gandhi's Experiments with Failure
Prof. Costica Bradatan

Mahatma Gandhi was one of the most successful men of his time. He came to be venerated as a political genius, secular saint, India's Messiah, among other things. At the same time, however, Gandhi had a life-long, intimate relationship with failure. Indeed, in a certain sense, his failures are more revealing and more fascinating than his successes. In my contribution I will examine some moments of Gandhi's complex relationship with failure.

Programme Schedule

Welcome by Prof. D.S. Negi
About the program by VC, HNBGU
Inaugural address by Chief Guest
Address by Guest of Honour
Address by Special Guest
Special talk-1 ***Prof. Paul Bjerk***
Special talk-2 ***Prof. Costica Bradatan***
Each special talk will be followed with a 5-7 minutes Q & A Session

Please Note

- Registration is essential for attending the lecture (kindly use the following link for registration)

Link for Registration: https://forms.gle/T2B8ST88ibn8SV877

- Meeting ID and Password will be provided to the registered participants by 17th August 2020 through E-Mail
- Last date of Registration : 17th August, 2020 till 5:00 PM

About the Guest Speakers

Prof. Paul Bjerk
Paul Bjerk is Professor of History at College of Arts and Sciences, Texas Tech University, Lubbock, Texas. He teaches African History, with a particular emphasis on the continuities across the ruptures of the twentieth century. Dr. Bjerk received a Fulbright Fellowship for dissertation research in Tanzania, and recently received a Fulbright Faculty Fellowship to teach at the University of Iringa, and do research on a second project that will look at the socialist economy of the 1960s and 1970s in Tanzania.

Professor Costica Bradatan
Professor Costica Bradatan is Professor of Humanities in the Honors College at Texas Tech University and an Honorary Research Professor of Philosophy at the University of Queensland, Australia. He has also held faculty appointments at Cornell University, University of Notre Dame, University of Wisconsin-Madison, Miami University, and Arizona State University, as well as at universities in Europe, South America, and Asia.

Convener & Moderator
Prof. D.S. Negi, MNASc, FRSC
Head, Department of Chemistry, HNBGU

Organizing Committee

- Dr. Prashant Kandari (Coordinator)
- Dr. Nagendra Rawat (Member)
- Dr. Rakesh Negi (Member)
- Dr. Shweta Verma (Member)
- Dr. Naresh Kumar (Member)

LIVE Facebook Live https://www.facebook.com/hnbgu.uttarakhand.3?epa=SEARCH_BOX

zoom https://us02web.zoom.us/j/85408128617?pwd=dm1NTWVhdWRPeXVpU3k1Z2hQWGR5UT09

Report of the activity conducted by HNBGU and Texas Tech University, USA

A webinar for web panel discussion was conducted on the occasion of 150th Birth anniversary year of Mahatma Gandhi on 18th August 2020. The topic of the discussion was "Understanding Gandhian way of life: A timeless lesson for everyone to emulate." **This webinar was jointly organized by H.N.B. Garhwal University and Texas Tech University, Texas, USA as a part of MoU between both institutions.** The Convener & Moderator of this this discussion, Prof. D.S. Negi welcomed all of the distinguished guests, speakers, and participants. Hon'ble Vice Chancellor, HNBGU, Prof. Annpurna Nautiyal briefly talked about the program and welcomed all of the esteemed delegates from India and abroad. The program started with the inaugural address by Chief Guest Prof. Mehraj Uddin Mir; Hon'ble Vice Chancellor, Central University of Kashmir followed by the address by Guest of Honor, Prof. Robert V. Duncan, Texas Tech University (TTU), Lubbock Texas, USA, and address by Special Guest Prof. Michael San Francisco, TTU, USA.

The first special talk was delivered by Prof. Paul Bjerk, a Professor of History at College of Arts and Sciences, Texas Tech University, Lubbock, Texas. His title of the talk was "A Man of His Time or a Man for Our Time? Mohandas Gandhi in Africa." He talked about that how Gandhi came of age as both a global citizen, or more specifically as a subject of the British Empire, but also, quite literally as the representative of Indians now defined in relation to that empire. Gandhi life in natal grew in parallel to his contemporary global citizen.

The second special talk was delivered by Prof. Costica Bradatan, a Professor of Humanities in the Honors College at Texas Tech University and an Honorary Research Professor of Philosophy at the University of Queensland, Australia. His topic of the discussion was "Gandhi's Experiments with Failure." Prof. Bradatan talked about the success of Gandhi and how he came to be venerated as a political genius, secular saint, India's Messiah, among other things. At the same time, however, Gandhi had a lifelong, intimate relationship with failure. Indeed, in a certain sense, his failures are more revealing and more fascinating than his successes. In his contribution, he examined some moments of Gandhi's complex relationship with failure.

This wonderful web panel discussion on Gandhi was witnessed by around 90 participants, which includes faculties, students, and staff members of various institutions. The recorded videos of the webinar can be found in the following Facebook and YouTube links:
https://www.facebook.com/hnbgu.uttarakhand.3?epa=SEARCH_BOX
https://www.youtube.com/watch?v=acmca9Tins0&ab_channel=HNBGarhwalUniversity%28officialchannel%29

Photos of the Event


Was live
Naresh Garg
s c sati
Surendra Singh Bis...
Dr.Dev Krishna
Paul Bjerk
Amit Parihar
GBPANT
Prof Negi
Michael San Francis...
Robert Duncan
iPhone
Prof. Annpurna Nau...
Costica Bradatan
zoom


Was live
Naresh Garg
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Paul Bjerk
HNBGU
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GBPANT
Prof Negi
Michael San Francis...
Robert Duncan
iPhone
Amit Parihar
Prof. Annpurna Nau...
zoom


Was live
HNBGU online
Dr Rakesh Negi
Naresh Garg
tawny
Paul Bjerk
HNBGU
ITSS Section CUK
Prof Negi
Michael San Francis...
Robert Duncan
iPhone
Prof. Annpurna Nau...
Costica Bradatan
Amit Parihar
zoom


Was live
Naresh Garg
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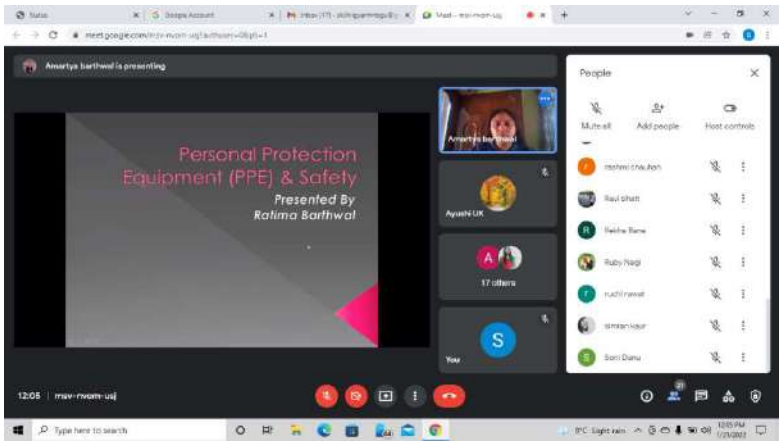
Dr.Dev Krishna
Paul Bjerk
ITSS Section CUK
Amit Parihar
GBPANT
Prof Negi
Michael San Francis...
Robert Duncan
iPhone
Prof. Annpurna Nau...
Costica Bradatan
zoom

Student Skill Training Program on 'Quality Control Chemist-Microbiology'

A 3-months Student Skill Training Program on 'Quality Control Chemist-Microbiology' was organized from 21 December 2021 in the Department of Biotechnology, HNB Garhwal University as per the MoA (Memorandum of Agreement) signed between UCOST and HNBGU. The training was conducted under the Skill Vigyan Program sanctioned to the University with Prof. G.K. Joshi as Program Coordinator, by Department of Biotechnology (DBT), Govt. of India and Uttarakhand Council of Science and Technology (UCOST). A total number of 18 participants with graduate degree in biological or related sciences underwent this training. Each trainee received a studentship of Rs. 5000 pm during the training. During the training, various internal and external subject experts as well as industry professionals from India as well as abroad have interacted with trainees and shared their knowledge and skills. In addition, prolonged hands on/practical training has been provided to the trainees in the domain area. On Job Training was also given to the trainees under the actual work environment in industries to gain required expertise and skills. The certification of this course was done by Life Sciences Sector Skill Development Council(LSSSDC). After having completed the training, many of the trainees got placement in industries and academic sectors.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Ratima Barthwal
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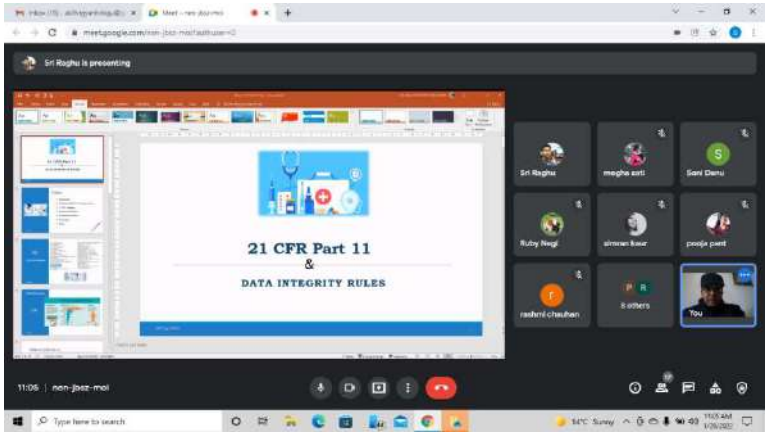
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Ruby Negi
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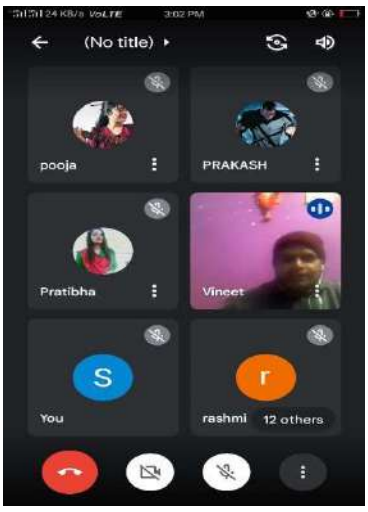
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Pratibha
Vineet
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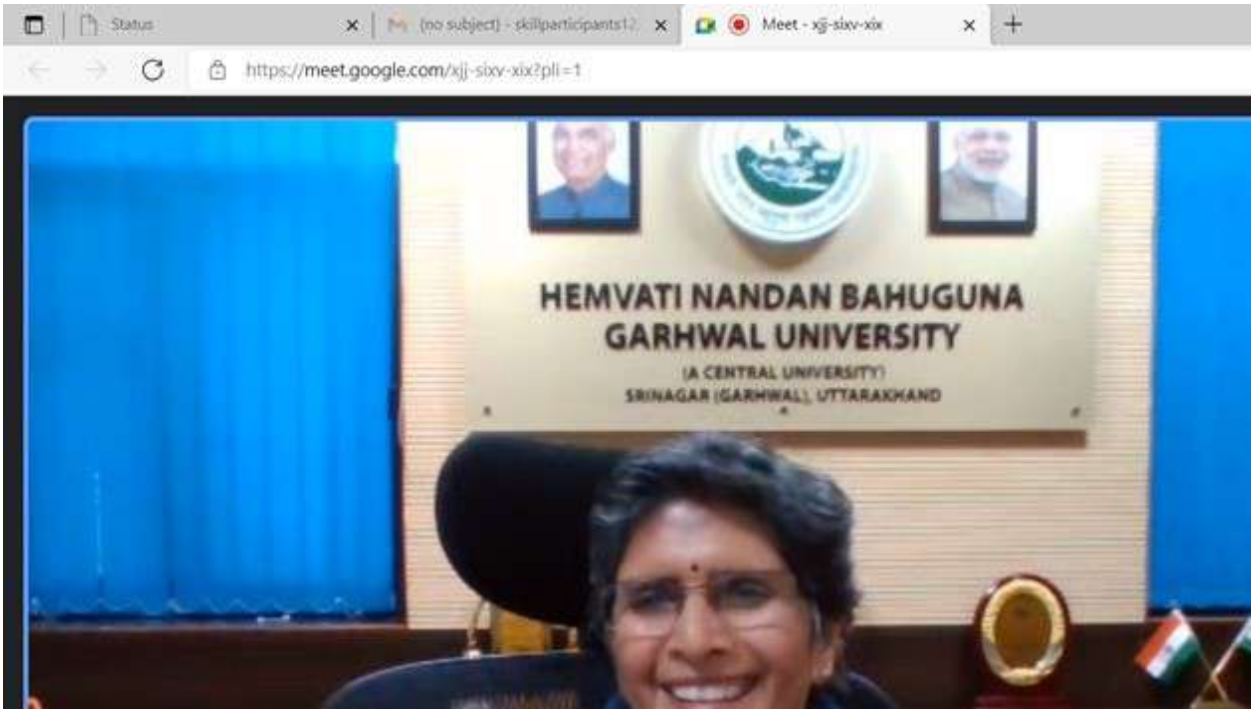
rashmi
12 others


QUALITY CONTROL CHEMIST-MICROBIOLOGY
SKILL VIGYAN PROGRAM


SKILL VIGYAN PROGRAM


QUALITY CONTROL CHEMIST-MICROBIOLOGY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HEMVATI NANDAN BAHUGUNA
GARHWAL UNIVERSITY
(A CENTRAL UNIVERSITY)
SRINAGAR (GARHWAL), UTTARAKHAND

गढ़वाल केंद्रीय विश्वविद्यालय के जैव प्रौद्योगिकी विभाग में आयोजित प्र

जागरण संवाददाता, श्रीनगर गढ़वाल : गढ़वाल केंद्रीय विश्वविद्यालय के जैव प्रौद्योगिकी विभाग में 'क्वालिटी कंट्रोल केमिस्ट-माइक्रोबायोलाजी' विषय पर आयोजित तीन महीने का प्रशिक्षण रविवार को संपन्न हो गया। उत्तराखंड के यूकोस्ट विभाग और डीबीटी के सहयोग से संचालित इस प्रशिक्षण कार्यक्रम में विभिन्न राज्यों से आए 18 प्रशिक्षणार्थियों ने प्रतिभाग किया। जिन्हें देश के विभिन्न विश्वविद्यालयों और उद्योग जगत से जुड़े प्रख्यात विषय विशेषज्ञों ने व्याख्यान देने के साथ ही विषय प्रशिक्षण दिया।

गढ़वाल केंद्रीय विवि के जैव प्रौद्योगिकी विभाग में क्वालिटी कंट्रोल कैमिस्ट माइक्रोबायोलाजी विषय पर आयोजित प्रशिक्षण में मंचासीन मध्य में यूकोस्ट के महानिदेशक डा. राजेंद्र डोभाल। साथ में (दायें) से विवि चौरास परिसर निदेशक प्रो. सीएम परिसर निदेशक प्रो. पीपी बडोनी • जागरण

गढ़वाल केंद्रीय विवि के चौरास परिसर के जैव प्रौद्योगिकी विभाग में आयोजित प्रशिक्षण शिविर के समापन समारोह को बतौर मुख्य अतिथि संबोधित करते हुए डोभाल ने वर्तमान समय में कौशल प्रशिक्षण कार्यक्रमों की उपयोगिता पर विस्तार से प्रकाश डाला। उन्होंने कोर्स पूरा करने पर विशेष रूप से बधाई देते हुए कहा कि कौशल प्रशिक्षण से कार्य की गुणवत्ता बढ़ती

हुए विवि चौरास प
प्रो. सीएम शर्मा ने
प्रशिक्षण कार्यक्रमें

Skill Vigyan Program Batch-1

Quality Control Chemist- Microbiology

at

Department of Biotechnology
HNB Garhwal University, Srinagar Garhwal

Prakash
Staff
Attendance
Register

Signature						at the time of Arrival					
10	11	12	13	14	15	16	17	18	19	20	21

Attendance Register

for the month of January 2022

Prakash

Sl. No.	Name	Signature															at the time of Arrival															Total No. of Working days	Total No. of days present	Casual leave for current month	C.L upto last month	C.L since commencement	Remarks
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31						
1.	Aniksha Rawat																																				
2.	Ankita Soni																																				
3	Ayushi S. Rana																																				
4.	Himanshu Bhatt																																				
5.	Kiti Negi																																				
6.	Megha																																				
7.	Puja Pant																																				
8	Pavitra																																				
9.	Pratibha																																				
10.	Preeti Pundir																																				
11.	Prakash Singh																																				
12.	Rashmi Chauhan																																				
13.	Rani Bhatt																																				
14.	Rekha																																				
15.	Ruby																																				
16.	Simran Kaur																																				
17.	Soni Dhanu																																				
12	Ruchi Rawat																																				

Online due to Corona Pandaic →

Attendance Register for the month of March 2022

Prakash

Sl. No.	Name	Signature 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	AMIKSHA RAWAT															
2	ANKITA SONI															
3	AYUSHI S. RANA															
4	HIMANSHU BHARTI															
5	KIRTI NEGI															
6	MEGHA SATI															
7	POOJA PANT															
8	PAVITRA															
9	PRATIBHA															
10	PREETI PUNDIR															
11	PRAKASH SINGH															
12	RASHMI CHAUHAN															
13	RAVI BHATT															
14	REKHA															
15	RUBY															
16	SIMRAN KAUR															
17	SONI DANU															
18	RUCHI RAWAT															

at the time of Arrival

16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total No. of Working days	Total No. of days present	Casual leave for current month	C.L. upto last month	C.L. since commencement	Remarks
←						→															

on job Training

Attendance Register

for the month of December 2021

Prakash

Sl. No.	Name	Signature													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Anuksha Rawat															
2	Ankita Soni															
3	Ayushi S Rana															
4	Himanshu Bhatti															
5	Kirti Negi															
6	Megha															
7	Raja Pant															
8	Pavitra															
9	Pratibha															
10	Preeti Pundir															
11	Prakash Singh															
12	Rashmi Chauhan															
13	Ravi Bhatt															
14	Rekha															
15	Ruby															
16	Simran Kaur															
17	Soni Dasu															
18	Ruchi Rawat															

at the time of Arrival

16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total No. of Working days	Total No. of days present	Casual leave for current month	C.L. upto last month	C.L. since commencement	Remarks
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