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SPECIAL ISSUE:
SUCCESS STORIES OF SCIENCE, TECHNOLOGY, AND INNOVATION OF THE DEPARTMENT OF SCIENCE AND TECHNOLOGY (DST)

NSM NATIONAL SUPERCOMPUTING MISSION

UNVEILING THE MOON'S SECRETS: REMARKABLE ACHIEVEMENTS OF CHANDRAYAAN 3

NATIONAL SUPERCOMPUTING MISSION: INDIGENOUSLY MADE SUPERCOMPUTERS

COMBATING CLIMATE CHANGE

PROGRESS IN SCIENCE AND TECHNOLOGY

NATIONAL MISSION ON INTERDISCIPLINARY CYBER-PHYSICAL SYSTEMS

ENSURING GENDER EQUITY IN SCIENCE

EMPOWERING SOCIETIES THROUGH S&T INTERVENTIONS

WATER TECHNOLOGY INITIATIVE OF DST

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A. DHANALAKSHMI

Atmanirbhar Bharat - Progress in Science and Technology

India has witnessed remarkable achievements in Science and Technology. The Department of Science and Technology (DST), Government of India is spearheading Research and Development in frontier Technologies and emerging areas covered under the Sustainable Development Goals (SDGs).

The country has witnessed significant progress in Interdisciplinary Cyber-Physical Systems (ICPS) across various sectors, including manufacturing, energy, transportation, and healthcare. Initiatives such as "Smart Cities Mission" and "Digital India" have boosted the adoption of ICPS technologies, with both, Government and private sectors investing in Research and Development. DST is implementing the National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS). As part of the Mission implementation, several Technology Innovation Hubs (TIHs) have been established which are working in the areas of Artificial Intelligence and Machine Learning, Internet of Things, Data Analysis, Robotics & Autonomous Systems, and Quantum Technologies. The Mission objectives are Technology Development, Entrepreneurship Development, Human Resource Development, and International Collaboration. To cater to the growing need for high computation power, DST, in collaboration with the Ministry of Electronics and Information Technology (MeitY) set up high-performance computing systems across the country under National Supercomputing Mission (NSM).

DST has implemented two National Missions on Climate Change - the National Mission for Sustaining the Himalayan Ecosystem (NMSHE) and National Mission on Strategic Knowledge for Climate Change (NMSKCC). Both focus on building national S&T capacities in climate change. Many R&D projects have been supported in climate change studies across India to assess the impact of climate change in sectors like Health, Agriculture, and water and to come up with adaptation strategies.

DST brought out policy formulation in some key areas including Scientific Social Responsibility (SSR) Guidelines, Science, Technology and Innovation (STI) Policy, National Geospatial Policy, and National Research Framework (NRF).

DST has been significantly contributing to strengthening the S&T infrastructure of the country by fostering well-equipped R&D labs in the Academic/ Research Institutes/ Universities as well as a strong culture of research collaboration between institutions and across disciplines. DST initiated programmes like KIRAN (Knowledge Involvement in Research Advancement through Nurturing) to encourage girls to pursue higher education and career in STEM (Science, Technology, Engineering, and Mathematics), especially in the areas where women's participation is low to balance the gender ratio across the streams.

The "Million Minds Augmenting National Aspirations and Knowledge (MANAK)" scheme was implemented by Department of S&T to attract young students to study science and pursue research careers and promote creative thinking and foster a culture of innovation among them. The programme launched in 2018 targets to bring one million ideas from middle and high schools across the country.

DST has been supporting a variety of schemes that constantly work for the socio-economic empowerment and development of the disadvantaged sections of the society viz. SC/ST, *Divyangjan*, elderly, Economically Weaker Section (EWS), and women besides encouraging young scientists & regular target groups to take up societally relevant Research and Development. Science and Engineering Research Board (SERB), a Statutory body of DST launches several new schemes to promote Science and Technology among all masses equitably.

As India is marching forward, researchers must carry out translational research with a focus on developing technologies/ technology products and commercialization of the same in line with the National priorities, to ensure sustainability.

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NATIONAL SUPERCOMPUTING MISSION: INDIGENOUSLY MADE SUPERCOMPUTERS

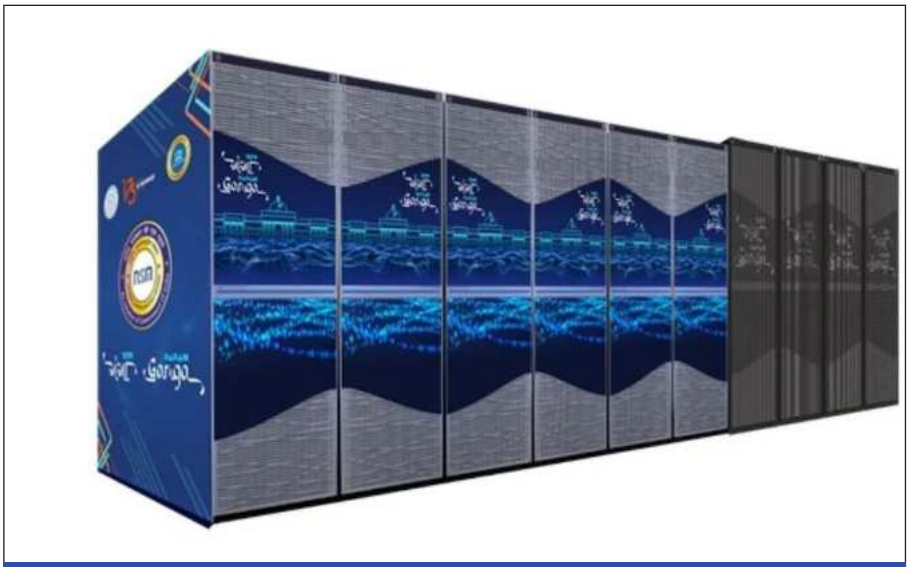
The Mission implementation would bring supercomputing within the reach of the large Scientific & Technology community in the country and enable the country with a capacity of solving multi-disciplinary grand challenge problems.

The National Supercomputing Mission (NSM) envisages empowering academia, researchers, MSMEs, and startups spread over the country with supercomputing infrastructure to meet the increasing computational demands. By installing a vast supercomputing grid comprising of more than 70 high-performance computing facilities, these supercomputers will also be networked on the National Supercomputing grid over the National Knowledge Network (NKN).

The NKN connects academic institutions and R&D labs over a high-speed network. Academic and R&D institutions as well as key user departments/ministries would participate by using these facilities and develop applications of national relevance. The Mission also includes development of highly professional High-Performance Computing (HPC) aware human resources for meeting challenges of development of these applications.

NSM is the first of its kind attempt to boost the country's computing power. National Super Computing Mission is steered jointly by the Department of Science and Technology (DST) and Ministry of Electronics and IT (MeitY) and implemented by the Centre for Development of Advanced Computing (C-DAC), Pune and the Indian Institute of Science (IISc), Bengaluru. The mission is expected to support and create High-Performance Computing (HPC) ecosystem in the country of about 60 PF (45000 TFs) through the revised build-approach. The mission envisions advanced Supercomputing R&D leading to next generation Exa-scale computing readiness, cutting edge Human Resource Development (~ 20,000 trained professionals to handle and spearhead HPC activities), and supercomputing application development of national priority through partnership with users, researchers, and developers. Academic and R&D institutions, as well as key user Departments/ Ministries would participate by way of using these facilities and developing applications of national importance. HPC applications in at least 5 major areas would be undertaken for production level development.

So far, NSM has commissioned 28 systems under build-approach across the nation. Among that, 7 systems are Petaflops (PF) machines, 8 mid-range (833 TF), 8 lower range (~150 TF) and 5 systems of 50 TF dedicated for training



PARAM Ganga *(image credit: PIB Release ID: 1803833)*

are under operation. All these systems are accessed by verified users with unique login credentials from anywhere in the country. Till today 74,44,920 computing codes have been executed and 6072 expert users are accessing the systems for solving their respective grant challenge domain problems with the support of 28 systems. NSM has trained 17,000 plus people so far in HPC & AI Awareness. To attract and train more students, five nodal training centres are created at CDAC Pune, IIT Kharagpur, IIT Palakkad, IIT Chennai and IIT Goa. Through IISc and JNCASR various domain specific workshops are scheduled in this calendar year to increase the expert pool of HPC users in the respective domains.

NSM
NATIONAL SUPERCOMPUTING MISSION

Mission Objectives

- To make India one of the world leaders in Supercomputing and to enhance India's capability in solving grand challenge problems of national and global relevance.
- To empower our scientists and researchers with state-of-the-art supercomputing facilities and enable them to carry out cutting-edge research in their respective domains.
- To minimize redundancies and duplication of efforts and optimize investments in supercomputing.
- To attain global competitiveness and ensure self-reliance in the strategic area of supercomputing technology.

How to access NSM HPC System

1. Each NSM site has a Super-computing Allocation committee for Access approval.
2. Users can approach HI/CDAC for NSM resource allocation for HI Internal /NSM Apps/external users a. Internal user allocation and policies will be decided by Host Institute.
3. Users will receive the NSM resource access form.
4. External users can approach C-DAC through nsmsupport@cdac.in for resource access.

Achievements of the NSM

A total capacity of 24.83 PF HPC machines are built locally and commissioned across the country. Development of Rudra server board 1.0, Trinetra HPC interconnects, HPC system software stack 1.1 and various benchmarks (cloud, HPC) applications.17500 people have been trained so far in High Performance Computing More than 5930 expert users from 100+ institutes are using the facilities routinely73,25,604 high performance computational queries have been executed till recently. visit https://nsmindia.in for further details.

Sr. No.	Institute Name	HPC System Name	Computing Power
1.	IIT(BHU), Varanasi	PARAM Shivay	838TF
2	IISER, Pune	PARAM Brahma	1.70PF
3	IIT, Kharagpur	PARAM Shakti	1.66PF
4	JNCASR, Bangalore	PARAM Yukti	1.8PF
5	IIT, Kanpur	PARAM Sanganak	1.66PF
6	C-DAC, Pune	PARAM Siddhi-AI	5.2PF/210PF (AI)
7	IIT, Hyderabad	PARAM Seva	838TF
8	NABI, Mohali	PARAM Smriti	838TF
9	IISc, Bangalore	PARAM Pravega	3.3PF
10	C-DAC, Bangalore	PARAM Utkarsh	838TF
11	IIT, Roorkee	PARAM Ganga	1.66PF
12	IIT, Gandhinagar	PARAM Ananta	838TF
13	NIT, Trichy	PARAM Porul	838TF
14	IIT, Guwahati	PARAM Kamrupa	838TF
15	IIT, Mandi	PARAM Himalaya	838TF

Some major applications are being developed to cater the (i) Oil exploration (ii) Early flood warning, (Mahanadi basin data is used as pilot study), (iii) Urban modelling, (iv) Drug molecules simulations and Bioinformatics etc. Various indigenous efforts and development are under progress to achieve the self-reliant and create HPC eco-system in the country. Application areas like Climate Modelling, Aerospace Engineering, Atomic Energy Simulations, National Security/ Defence Applications, Computational Material Science and Nanomaterials, Large Complex Systems Simulations and Cyber Physical Systems are at different stages of implementation.

NSM has successfully installed 24.83 PF of HPC machines across the country against 15- 20 PF originally envisioned. Also, 12 more machines with a total capacity of 41.17 PF is scheduled to be commissioned in a year time. The upcoming new installations will be based on indigenous Rudra server platform manufactured in India. This will provide a total computing power of 66 PF, which is 4.5 times higher than the intended computing capacity. The indigenous efforts resulted in the creation of Trinetra high-speed interconnects and Direct Liquid Cooling units. NSM has its server based on Intel Cascade platform called Rudra. These systems are cost efficient and power efficient in operation.

NATIONAL MISSION ON INTERDISCIPLINARY CYBER-PHYSICAL SYSTEMS

The National Mission on Interdisciplinary Cyber-Physical Systems aims at the development of technology platforms to carry out Research and Development, Translational Research, Product Development, Incubating, and Supporting start-ups as well as commercialization. Under this mission, 25 Technology Innovation Hubs (TIH) under four major categories a) Technology Development b) Entrepreneurship Development c) Human Resource Development & d) International collaborations have been established in reputed institutes across the country.

Mission Objectives:

- To promote translational research in Cyber-Physical Systems (CPS) and associated technologies.
- To develop technologies, prototypes and demonstrate associated applications pertaining to national priorities.
- To enhance high-end researchers base, Human Resource Development (HRD) and skill sets in emerging areas.
- To enhance core competencies, capacity building and training to nurture innovation and start-up ecosystem.
- To set up world-class interdisciplinary centers of excellence in several academic institutions across the country, that can become repositories of core expertise in CPS and related areas and serve as focal points for technology inputs for the industry and policy advice for the government.
- To involve Government and Industry R&D labs as partners in the collaboration centers. Incentivise private participation to encourage professional execution and management of pilot scale research projects.
- To set mission mode application goals and foundational themes for excellence for different centers. Set up CPS test beds at various centers.
- To tie up with incubation centers and accelerators to foster close collaboration with entrepreneurs.
- To address some of the National issues and development of sector-specific solutions.

Keeping in view the need of R&D in the emerging areas, Department of Science & Technology (DST) launched National Mission on Interdisciplinary Cyber-Physical Systems (NMICPS).

The key achievement of the mission

- IHUB NTIHAC Foundation (C3iHub) at IIT Kanpur is working in the Technology Vertical 'Cyber Security and Cyber Security for Physical Infrastructure.
- The hub has installed the first Security Operations Centre (SoC) based fully on open-source components and integration, C3iVazra, at the National Highway Authority of India (NHAI) headquarters Major benefits of SoC are increased efficiency, reduced potential security threats, reduced impact of security breaches, improved reporting and notification, and log
- Libera by IITM Pravartak Technologies Foundation at IIT Madras: It is a Menstrual Pulsed Electro-magnetic Field Pain Reliever Device (Pulsed Short-Wave Therapy-PSWT). The technology manages and relieves pain caused due to Primary Dysmenorrhea. The technology uses Pulsed Electromagnetic Short-Wave Energy that reduces pain levels of primary dysmenorrhea by enhancing nitric oxide (NO) release and reducing prostaglandin levels.
- E-Agris by TIH Foundation for IoT and IoE at IIT Bombay: It is a multi-parameter remote controlled energy autonomous smart agri-station to record soil, weather and crop

parameters.

- Divyang by IIT Bhilai Innovation and Technology Foundation at IIT Bhilai: It is an ATM for visually impaired people that provides Accessible banking functionalities for Divyang (Visually Impaired) using Smart ATM.
- Illuminate by BITS BioCyTiH Foundation at BITS Pilani: It is a first of its kind indigenously developed multispectral autofluorescence imaging device that aids in comprehensive wound management.
- TiHAN Testbed On Autonomous Navigation (Aerial & Terrestrial) by NMICPS Technology Innovation Innovation Hub On Autonomous Navigation Foundation (TiHAN) at IIT Hyderabad: It is a testbed on Autonomous Navigation (Aerial & Terrestrial) with facilities such as Proving Grounds, Test tracks, Mechanical integration facilities like Hangers, Command Control Stations, State of the art Simulation tools, Environment Emulators like Rainfall Simulators, V2X Communications, Drone Landing area, propulsion test stands etc.
- Blockchain-based Land Registry by IHUB NTIHAC Foundation at IIT Kanpur: This technology enables Tamper-proof, Secure, Transparent Management of Land Records. This land record management system has been integrated with Karnataka State Govt's Kaveri Portal for Online Property Registration in 2021 which strengthened the portal.
- The quantitative achievements of the Mission are given in the table below.

Currently, Interdisciplinary Cyber-Physical Systems (ICPS) is evolving at a fast pace in India. The country has witnessed significant progress in implementing ICPS across various sectors, including manufacturing, energy, transportation, healthcare, etc. Initiatives such as "Smart Cities Mission" and "Digital India" have boosted the adoption of ICPS technologies, with both, Government and private sectors investing in research, development and infrastructure to advance ICPS capabilities. Further, collaboration between academia, industry, and government entities is driving innovation and creating opportunities for ICPS deployment and growth in India.

NMICPS is a comprehensive mission aimed at complete convergence with all stakeholders by establishing strong linkages between academia, industry, government, and international organizations. The mission caters to the central ministries/ departments and state governments and the industry to effectively use the CPS technologies in their core mandate, projects, and schemes for the benefit of the society.

Sl. No.	Mission outcomes	Mission targets in Number for 5 years (as per Cabinet Note)	Achieved targets in Number
1.	Technologies	500	212
2.	Start-ups	800	339
3.	Increase in CPS and related researchers base	2000	1024
4.	Technology products	500	448
5.	Skill development	19618	51279
6.	Job creation	40000 (short term 3 years) and 200000 (in long term)	13349
7.	Publications, IPR and other intellectual activities	2698	1146

Future roadmap

National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS) was launched in 2018. The TIHs established are now running in full scale. The future roadmap for NM-ICPS is as follows:

- Facilitating, Mentoring & Reviewing all TIHs proactively to help them achieve the targets of the mission while focusing on translational research.
- Linking the TIHs directly with all stakeholders including Line Ministries, State Governments, industry, PSUs, Start-ups etc. through National level events including Workshops and Expos.
- Conducting frequent meetings of the Expert Committees of the Mission - Mission Governing Board (MGB), Scientific Advisory Committee (SAC) and Inter-Ministerial Co-ordination Committee (IMCC), to steer the mission at the right pace and suggesting the way forward.

- Showcasing the achievements of all TIHs through Quarterly Bulletin, NM-ICPS portal and various Social media platforms.
- Conducting on-site (physical) reviews of the activities of each TIH to continuously monitor their progress.
- Reviewing the progress of the TIHs through National Workshops on Technology Innovation in Cyber Physical Systems (TIPS) conducted annually. 1st National Workshop was organized in May, 2022 at Indian Institute of Technology (IIT), Madras and 2nd National Workshop was held in April 2023 at IIT, Delhi. The TIHs have also been facilitated and mentored during the workshop through sessions on Translational research/ entrepreneurship development and financial sessions by subject experts.
- Connecting the TIHs with industries and line ministries and facilitating inter-TIH collaborations, so that the TIHs can work collectively on the problem statements given by the stakeholders.

Challenges

The key challenges, as identified by the Department include mentoring the academicians to carry out translational research and focus their activities towards developing technologies/ technology products and commercialization of the same in line with the National priorities.

NM-ICPS Mission can accelerate technology translation and commercialization through TIHs spanning all over the country: experts at 2nd National Workshop on Technology Innovation in Cyber Physical Systems (TIPS) during 6-8 April, 2023

SCIENCE AND TECHNOLOGY FOR THE PROGRESS OF THE COUNTRY – AN INTERVIEW WITH DR. RAJESH S. GOKHALE

India has witnessed remarkable achievements in Science and Technology. Progress in basic research, technology innovations and its accessibility to the general population has made India one of most promising countries in the World. Science is a powerful instrument of growth and development, especially in the emerging scenario and competitive economy. In the wake of the recent developments and the new demands that are being placed on the S&T system, it is necessary for us to embark on some major science projects which have relevance to national needs, and which will also be relevant for tomorrow's technology. The Department of Science & Technology plays a pivotal role in promotion of science & technology in the country.

To know more about DST initiatives in the field of research in basic science, technology interventions and different national missions on S&T we have approached Dr. Rajesh S. Gokhale, Secretary, Department of Science and Technology, Government of India. He is also serving as the Secretary, Department of Biotechnology (DBT) since October 2021.

Dr Gokhale holds a doctorate degree from the Indian Institute of Science (IISc) and pursued his post-doctoral work at Stanford University. He is an immunologist. He has worked extensively on tuberculosis and is credited to have developed the Long-chain Fatty acyl-AMP ligases (FAAL). Dr Rajesh Gokhale is the winner of the Infosys Foundation Prize 2013 for Life Sciences.

Dream 2047: DST plays a key role in promoting S&T research in the country. It has coordinated and promoted several science and technology activities in the country and nurtured a strong ecosystem of research and academic base in every field of science. In your opinion, how much progress India has made in the field of basic scientific research?

RSG: India is recognized globally for its scientific rigour and potential. We are amongst the top countries in scientific research. With a modest percentage of GDP share for science and technology, DST has introduced various policies and research funding strategies that empower the nation to improve its scientific research and technology innovations.

Dream 2047: In one of your earlier interviews, you said students' interest in research needs to be encouraged at a very early stage in their education. Please tell us how DST encourages students and motivates them to take up carrier in science.

RSG: Excitement and appreciation for science are the key enablers for pursuit of scientific discoveries and inventions. We need to reach out to young students, encourage and motivate them to take up scientific research as a career. DST has a programmes MANAK (Million Minds Augmenting National Aspirations and Knowledge) with an objective to attract young students to study science and pursue research. MANAK also promotes creative thinking and fosters a culture of innovation.

Augmenting Writing Skills for Articulating Research (AWSAR) is another initiative of DST that encourages young researchers to communicate their research findings to a wider audience. AWSAR is open to all researchers who are pursuing PhD and Post-Doctoral Fellowship from various R&D institutions, including universities, research centers, and laboratories.

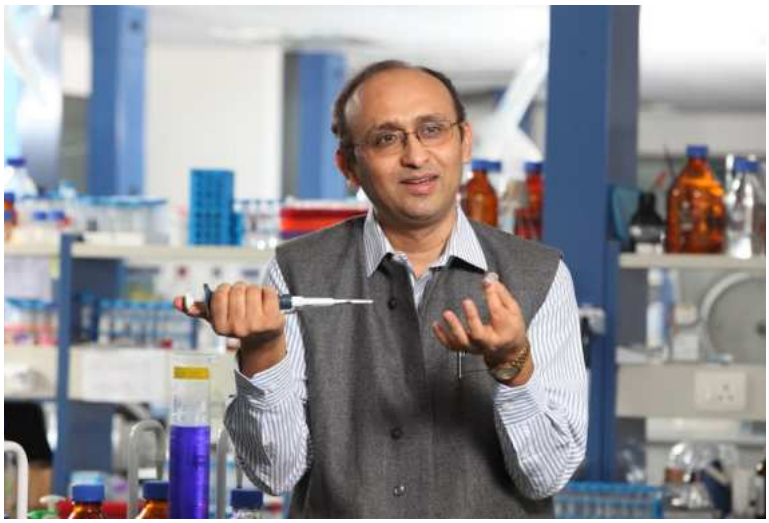
Dream 2047: Strengthening the S&T infrastructure of the country is essential. Well-equipped R&D labs with research fundings for the Academic/ Research Institutes/ Universities are essential. Should DST be seen as a research funding agency? What is your view?

RSG: Funding is an important part to further research and innovation. But DST should not be seen only as a research funding agency. DST makes S&T policies, decides key research areas,

and leads national missions on S&T, in addition to research funding and technology interventions.

Dream 2047: DST is leading several national missions in science and technology. How will these missions help in the growth of the Nation?

RSG: National Missions on S&T are decided based on national need, sustainability, peoples' involvement, national and global scenario. Any national mission is a complex eco-system that considers budget, availability of manpower, involvement of institutions, benchmarking parameters, expected output and long-term outcome. National missions are for the overall growth of the country.



DST is leading several national missions, including National Supercomputing Mission (NSM), National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS), National Mission for Sustaining the Himalayan Ecosystem (NMSHE), National Mission on Strategic Knowledge for Climate Change (NMSKCC).

Dream 2047: In your view, how important is to do research with a focus on developing technologies/ technology products and commercialization of the same?

RSG: Research in basic science is very important for the advancement of science and, I must say, for the advancement of mankind. In addition to basic science research, innovations and technology interventions are important aspects to extend benefit of scientific research outcome to public. Hence translational research and subsequent commercialization are important.

Dream 2047: DST brought out policy formulation in some key areas including National Research Framework (NRF). What is the major take away from NRF?

RSG: NRF is one of the key recommendations of the National Education Policy (NEP), 2020. The NRF intends to act as a coordinating agency between researchers, various government bodies and industry, thus bringing industry into the mainstream of research. Science and Engineering Research Board (SERB) is a statutory body of DST that was established in 2008 to promote basic research in Science and Engineering and to provide financial assistance to persons engaged in R&D. With the introduction of NRF, SERB will be subsumed into NRF which has an expanded mandate and covers activities over and above the activities of SERB.

Dream 2047: India is emerging as creator and architect of new technology. This is a major shift from being a consumer of technology. Please tell us will DST be a part in creating an India centric ecosystem based on quantum technology?

RSG: Quantum Technology is a futuristic technology and has great potential for breakthroughs in many fields including computation efficiency and reduction in power consumption.

The Indian government has announced the National Quantum Mission, aiming to scale up scientific and industrial R&D, create a vibrant ecosystem for quantum technology-led economic growth, and leverage India as a leading nation in QT. The mission has been envisaged based upon the concept Note on National Mission on Quantum Technology & Applications (NM-QT) developed by the Technology Information Forecasting and Assessment Council (TIFAC), which is an Aided Institute of DST.

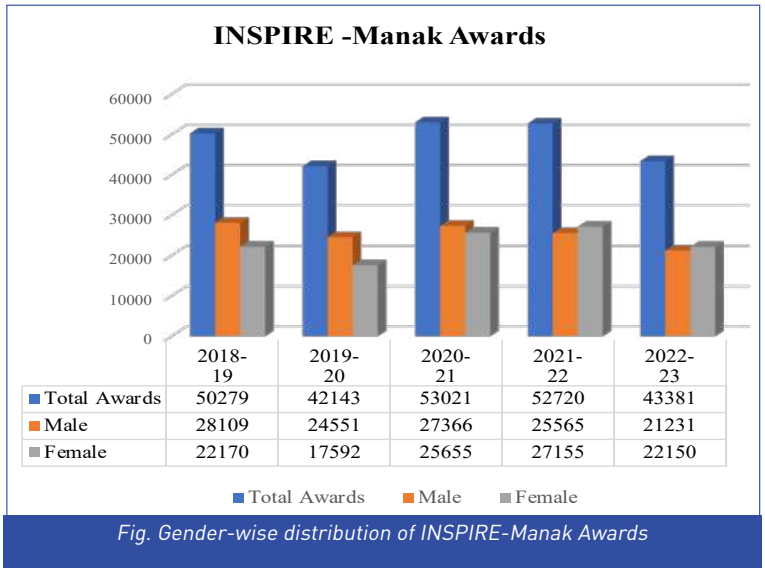
Dream 2047: Inculcating scientific temper and ability to think rationally by common people is important goal for overall growth of a nation. Even after making good progress in science and technology, we see beliefs in superstitions and pseudoscience in society. Your comments on this and how DST takes up science communication, popularisation and its extension among masses.

RSG: Growth of India is led by Science and Technology. Achieving scientific literacy among the general population is an important milestone. Since independence we have come a long way. Appreciation for science has increased in general. DST has science communication programmes for different target groups. Sensitisation and capacity building workshops, popular science publications, radio and television programmes are made for general population to convey importance of science and technology.

INCLUSIVE CAPACITY BUILDING INITIATIVES FROM SCHOOLCHILDREN TO RESEARCH SCHOLARS

The "Million Minds Augmenting National Aspirations and Knowledge (MANAK)" scheme was implemented by Department with the objective to attract young students to study science and pursue research careers and promote creative thinking and foster a culture of innovation among them. The programme launched in 2018 targets to bring one million ideas from middle and high schools across the country and the selected brilliant ones are being shortlisted for showcasing at district, state and then at the National Level Exhibition & Project Competition.

Innovation in Science Pursuit for Inspired Research (INSPIRE) is a flagship scheme of DST to attract talent to study science from an early age and build the required human resource pool for strengthening and expanding the R&D base in the country. The INSPIRE- Scholarship for Higher Education (SHE) component supported the fellowship to 10,108 candidates; 75,000 fellows benefitted through INSPIRE scholarships for university-level education; INSPIRE doctoral Fellowships supported 6800 young researchers and INSPIRE faculty to 1000 young researchers in last 5 years. A comparative study of fellowship distribution before and after 2014.



	2018-19	2019-20	2020-21	2021-22	2022-23
Total Awards	50279	42143	53021	52720	43381
Male	28109	24551	27366	25565	21231
Female	22170	17592	25655	27155	22150

Fig. Gender-wise distribution of INSPIRE-Manak Awards

Augmenting Writing Skills for Articulating Research (AWSAR):

The field of science and technology has long observed that the majority of research takes place within the confines of specific institutions or organizations. As a result, the findings of such research are often shared exclusively within the scientific community due to their complexity and specialized language. However, there is a growing concern that this approach makes it challenging for individuals without a scientific background to interpret and understand the significance of such research. To address this issue, there has been an increased focus on the necessity of presenting scientific research in a more accessible and comprehensible manner for the general public.

Genesis

In response to these challenges, the Department of Science & Technology (DST), in collaboration with Vigyan Prasar, an autonomous institute of the DST, conceived the "Augmenting Writing Skills for Articulating Research (AWSAR)" initiative in 2018. This program aims to encourage PhD and Post-Doctoral Fellows (PDFs) to communicate their research in a way that is engaging and easily understandable for non-scientific audiences.

The AWSAR Project: Objectives and Insights

The primary objective of the AWSAR project is to enhance the writing skills of Indian scientists and researchers, enabling them to effectively communicate their research findings to a wider audience. The project is open to all researchers who are pursuing PhD and Post-Doctoral Fellowship from various R&D institutions, including universities, research centers, and laboratories. One of the key components of the AWSAR initiative is the provision of monetary incentives to participants. In the PhD category, there are three cash prizes for the best entries, with amounts of ₹1,00,000, ₹50,000, and ₹25,000 respectively. Additionally, 100 other

outstanding entries in the PhD category are awarded a cash prize of ₹10,000 each along with a Certificate of Appreciation. Similarly, in the Post-Doctoral Fellow (PDF) category, there is a cash prize of ₹1,00,000 for the outstanding story. Furthermore, the next twenty best stories in this category receive a cash prize of ₹10,000 each, also accompanied by a Certificate of Appreciation.

Beyond the monetary incentives, the AWSAR project is designed to provide valuable training and support to researchers, helping them enhance their writing skills and encouraging them to present their research in a manner that is both informative and engaging for a non-specialist audience. Through this initiative, researchers are empowered to communicate the significance and impact of their work to the general public, fostering a greater understanding and appreciation for scientific advancements in society.

To facilitate the submission process and provide comprehensive information about the initiative, the AWSAR program has set up a dedicated website, www.awsar-dst.in. This platform serves as a central hub where researchers can find all the necessary details about the initiative and submit their science stories for consideration.

The implementation of the AWSAR project is multi-faceted, incorporating various initiatives:

1. **Workshops and Training:** The project organizes workshops and training programs conducted by experts in science communication and journalism. These workshops focus on honing writing skills, storytelling techniques, and the art of crafting engaging narratives for scientific research.
2. **Recognition:** The AWSAR project acknowledges outstanding science writing through its annual writing competition. Researchers submit their articles based on their research findings, and the best entries are recognized and awarded. This recognition incentivizes researchers to invest time and effort in science communication.
3. **Publication and Dissemination:** The selected stories are published as a compendium with ISBN. The winning articles and other notable submissions are also published in popular science magazines, newspapers, and digital

series of capacity building workshops on popular science writing were organized, along with interaction workshops, which attracted a total of 14,531 registered attendees. Till date, 650 scholars had received AWSAR recognition. The impact can be seen in various other aspects also:

Empowering Researchers: AWSAR has empowered researchers to step out of their academic comfort zones and communicate their work beyond scientific journals. It has fostered a sense of responsibility among scientists to engage with the public and demystify complex scientific concepts.

Strengthening Science Culture: By encouraging scientists to communicate their research effectively, AWSAR has contributed to building a robust science culture in India. Public awareness and appreciation for scientific research have grown, leading to increased support for scientific endeavours.

platforms. This extensive dissemination ensures that the research reaches a wider audience, igniting interest and encouraging dialogue around scientific discoveries.

Impact of AWSAR on Science Communication

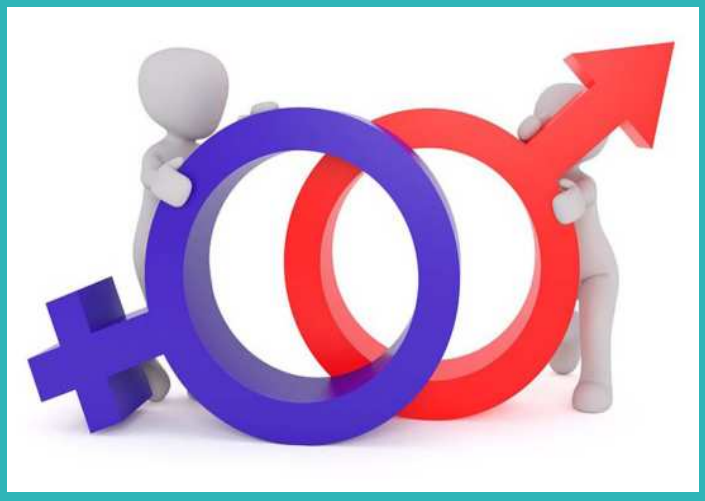
Since its inception, the Augmenting Writing Skills for Articulating Research (AWSAR) initiative received an overwhelming response, with 27,944 researchers registering for both the PhD and Post-Doctoral Fellow (PDF) categories. To support the participants, a

Amplifying Research Impact: The project has amplified the impact of research findings by making them accessible to policymakers, educators, and the general public. As scientific knowledge spreads, its potential to drive positive societal change increases significantly.

Future Science Communicators: The AWSAR project has inspired a new generation of science communicators who recognize the importance of bridging the gap between science and society. This influx of young communicators is crucial for the sustainability of science communication efforts in the country.

The Augmenting Writing Skills for Articulating Research (AWSAR) project, is a commendable initiative aimed at enhancing science communication in India. By equipping researchers with better writing skills and encouraging them to share their work with the public, AWSAR has significantly contributed to bridging the gap between science and society. As the project continues to evolve, it holds the promise of nurturing a thriving scientific community that is not only adept at research but also skilled in effectively communicating their discoveries to the world.

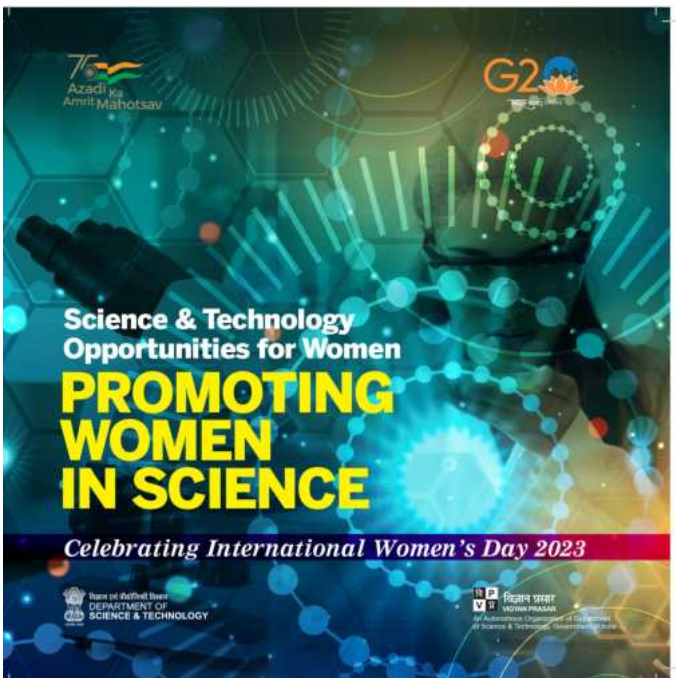
ENSURING GENDER EQUITY IN SCIENCE



With the increase in interest in Science Technology Engineering and Mathematics (STEM) disciplines, India is one of the few countries in the world, that has produced the highest number of scientists and engineers. However, there are considerable gender disparity exists when it comes to women's participation in STEM. The "Research and Development Statistics of 2019-2020 of the Department of Science & Technology (DST)" reports that only 16.6% of researchers who are directly involved in R&D activities are women.

Women are underrepresented in R&D for several reasons. The ascribed stereotyped gender roles are the most obvious. Women frequently opt out of advanced jobs in science and technology because of patriarchal views, a lack of infrastructure and resources, and restricted access to high-quality education. In addition, social pressure and expectations to act by stereotypical gender norms frequently deter girls from choosing STEM fields. This disparity in career choices not only emphasizes a lost opportunity but also the imbalance in a society where one gender is held back by constraints and limits.

However, in recent years, there is a change visible in science education and research with the coordinated efforts of the Government of India to support women and reduce gender disparity in science and technology. As a result, India now has a large number of successful who have made and continue to make significant contributions to the advancement of science and technology. Women are breaking the glass ceiling in the scientific community opening the way for others to follow.



In the larger interest of scientific progress and society, gender equality in science is an important consideration, and the Government of India has taken several initiatives to address this. The Science and Technology Policies of the government also stress gender inclusivity and equity in science and technology. These initiatives aim to increase the number of women working in STEM fields and to inspire more girls and women to seek professions in science, improving the nation's overall scientific and technological capabilities.

Here are some notable efforts of the Department of Science and Technology (DST) that have made a substantial impact:

The Women Scientists Programmes of DST support an inclusive and diverse STEM landscape in India by encouraging women to seek advanced degrees and actively participate in research. The Programmes and Schemes are carried out under the umbrella programme KIRAN (Knowledge Involvement in Research Advancement through Nurturing) and have made it possible for women to participate in research and development initiatives and innovation.

Women Scientists Schemes

Department of Science and Technology offers hoards of fellowship programmes for well-qualified women who often get left out of science and technology activities due to various circumstances that arise out of motherhood and family responsibilities. These fellowships aimed at providing opportunities to women scientists and technologists between the age group of 27-57 years who had a break in their career but desired to return to the mainstream.

As part of the schemes, women scientists are being encouraged to pursue, research in the frontier area of science technology, and engineering and also promote to take up S&T-based internships followed by self-employment.

Women Scientist Scheme-A (WOS-A): For pursuing Research in Basic/ Applied Science. The scheme open throughout the year places an important role in gender mainstreaming and also trains and retains women in the S&T system.

Women Scientist Scheme-B (WOS-B) focuses on S&T interventions for Societal Benefit. WOS-B scheme invites proposals that deliver possible solutions to address a well-identified societal challenge through viable technology/technique, its adaptation and scaling up. The scheme that is open throughout the year has the potential for sustainable income generation and enhancement of quality of life along with capacity building of women at the grassroots level.

Women Scientist Scheme-C (WOS-C) provides an Internship in Intellectual Property Rights (IPRs) for Self-Employment. WOS-C scheme provides training to women in the field of and their management for one year to develop a pool of women scientists for creating, protecting, and managing intellectual property.

DST also supports the **Consolidation of University Research for Innovation and Excellence in Women Universities (CURIE),** which helps women's universities improve their research and development (R&D), develop modern infrastructure to draw in, prepare, and keep talented girl students in the sciences and technologies. The programme launched in the year 2008-200 has been successful in enhancing the enrollment of girl students right from the undergraduate, graduate, till doctoral levels. The increase in extramural funding to women universities, and advanced labs has increased publications in high-impact journals. Currently, the CURIE programme is extended to nine women universities in the country. To stimulate Artificial Intelligence (AI) innovations and create AI-friendly infrastructure, DST built AI labs in six CURIE beneficiary universities in 2019 to train skilled human resources to increase the employability of women in this emerging industry.

Mobility Scheme

As the name suggests, the mobility scheme of DST addresses the relocation issue of women scientists working in regular positions in Government organizations/R&D labs/ Universities to enable them to continue and remain active in scientific research while fulfilling their domestic responsibilities. The scheme initiated in the year 2016-2017 is open to women up to the age limit of 50 years and the grant is awarded for a total period of five years to women who want to relocate themselves by resigning or taking leave from their regular positions to avail the fellowship. After the completion of the tenure, they would return to their parent organisation.

Vigyan Jyoti, a unique programme of DST was introduced in the year 2019-2020 at the school level to encourage rural girls to take up higher education and research in Science, Technology, Engineering and Mathematics (STEM) and pursue education and career in science and technology. The programme is implemented by the Navodaya Vidyalaya Samiti (NVS), an autonomous organization of MHRD, which has a network of Jawahar Navodaya Vidyalayas (JNVs) in more than 600 districts of India and at present, 250 JNVs are acting as 'Vigyan Jyoti Knowledge Centres' to cater for girls from JNVs, KVs, Govt. schools, army schools of small cities and rural areas for more diversity in STEM.

WISE Fellowship for Ph.D (WISE-PhD), is another fellowship programme of the DST that aims to provide an opportunity to carry out PhD in Basic and Applied Sciences. The fellowship is offered to women of the age group between 27-45 years with 3 years of relaxation in upper age for women belonging to SC/ ST/ PH category. The support is available for a maximum of 5 years duration.

WISE Post-Doctoral Fellowship (WISE-PDF), a newly announced programme of DST, WISE-PDF aims to provide an opportunity for women scientists and technologists between the age group of 27-60 years who want to continue their research as bench-level scientists in basic and applied science. The programme started in January 2023 provides support for a maximum period of three years. and is open throughout

the year to women having PhD in Basic/ Applied Science or equivalent degrees like MD, MS, MDS, etc.

Gender Advancement for Transforming Institutions (GATI) an innovative pilot project of DST launched in the year 2020, steers a novel intervention programme for promoting gender equity in scientific institutions. It is a sustainable self-assessment and accreditation model that pushes institutions of higher education and research towards supporting diversity, inclusion and progression. GATI aspires to create an enabling environment for equal participation of women in institutions in the STEMM disciplines at all levels addressing the gender disparity. GATI brings together a large number of stakeholders that create a pear network of participating institutions and transform them towards a gender-sensitive and inclusive system. In the pilot phase, around 25 scientific institutions and institutions of higher education participated and worked towards transformative change over several cycles of accreditation.

INDO-U.S Fellowship for Women in STEMM provides opportunities to Indian women scientists, engineers, and technologists to undertake international collaborative research in premier institutions in U.S.A to enhance their research capacities and capabilities. The fellowship is open to women students in the age group of 21 to 35 years who are pursuing Ph.D. degree in Basic Sciences, Engineering, or Technology on a full-time basis. The selected bright women students get exposed to world-class research facilities in U.S academia and labs for a period of 3 to 6 months and get an opportunity to build long-term R&D linkages and collaborations.

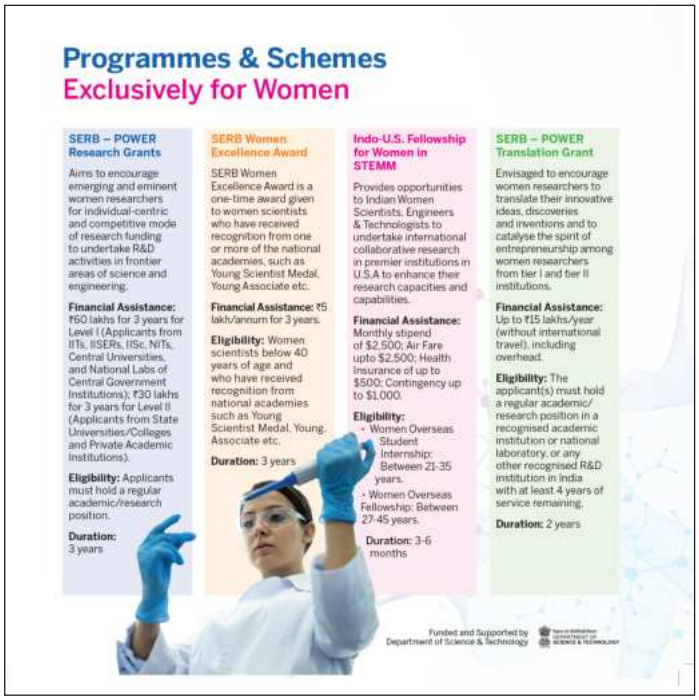
To reduce the gender gap in science and engineering research funding in various S&T programmes in academic institutions and R&D Laboratories, the **SERB-POWER (Promoting Opportunities For Women in Exploratory Research)** programme was initiated in the year. The programme is supported in two categories; SERB-POWER Research Grants and SERB-POWER Fellowship.

The first one encourages emerging and eminent women researchers to undertake R&D activities in frontier areas of science and engineering. The research grants aims to empower women researchers by funding them on two levels with a scale of funding for three years duration. The SERB-Power Fellowship rewards women researchers and innovators working in academic institutions and R&D laboratories, holding Ph.D.degree in any branch of science and engineering at the age of 35-55 years working in a scientific institution.

SERB-POWER Translational Grant is another programme of SERB that is intended to support women researchers as PIs in translating their original concepts, discoveries, and inventions. This inspires women scholars from Tier I and Tier II institutions to pursue their entrepreneurship. The grant is awarded to select women PIs who have established contact with industrial partners for fast-track graduation to a prototype stage and beyond.

These programmes and schemes embrace women exclusively intending to bring gender parity in science and technology to balance the gender ratio across the STEMM disciplines.

The continued efforts of the Government of India particularly the Department of Science and Technology are ensuring sustained progress and creating equal opportunities and representations of women in the science and technology ecosystem by breaking down gender barriers and empowering women. In India, the future is bright for women in STEM education and research. There will be more opportunities for girls to pursue STEM careers as the nation invests in STEM education and programmes transforming their lives.



WATER TECHNOLOGY INITIATIVE OF DST

To strengthen the R&D capacity and capability to develop research-based solutions in the areas of water quality, quantity, and water reuse and recycling, the Water Technology Initiative (WTI) of DST was launched. The project is in line with SDG 6 (Clean Water and Sanitation), which seeks to guarantee universal access to and sustainable management of water and sanitation. The program is also pertinent to the national "Swachh Bharat," "NamamiGange," and "Jal Jeevan Mission" initiatives.

Water Technology Initiatives started with an emphasis on the detection, monitoring, and mitigation of arsenic, iron, and fluoride. Many technologies, particularly low-cost home filters, were created in this field. The Water Technology Initiative also paid attention to identifying the numerous difficulties that exist in the country's diverse cities and regions. DST then intensified its water-related efforts by focusing on a variety of issues. This included developing sensors for early detection and monitoring of water quality, desalination, river rejuvenation, industrial wastewater solutions, the nexus of water with energy, food, and health, and the establishment of water technology innovation centres. More recently, the emphasis has shifted to managing urban water systems and responding to water emergencies while integrating an innovative systemic approach to water management at the local level to ensure water availability, quality, distribution, and supply for the general population. Along with the knowledge transfer to many industries, these efforts were strengthened by the proof of concept (pilot scale), lab, and field demonstration solutions that resulted in demand-driven convergent solutions. This effort of national importance has been advanced by national research institutions like IISc, IITs, IISERs, universities like JNU, Delhi, PAU, TERI, and Amity, as well as national research laboratories like CSIR, ICAR, DRDO, and NIH.

Recent noteworthy achievements

- Technologies developed for wastewater treatment for textile and leather industry
- Kit for detection of chromium and other heavy metals in water
- Real-time sensors for water quality monitoring
- Development of membranes for water purification
- Deployment of river bank filtration technology
- IoT based smart water distribution and management of water, rejuvenation of aquifers, etc.

The future is likely to see increased use of remote sensing, IoT, AI, ML, ICT techniques as well as wireless communication systems and more versatile sensors to improve Water Use Efficiency (WUE) in irrigation, ZLD (Zero Liquid Discharge) approach for wastewater purification and recycling leaving zero discharge at the end of the treatment cycle, Hydroponics, low Cost/affordable technologies for clean water, adoption of global technologies in Indian context, focus on emerging contaminants, urban flooding and drought management for cities and capacity building and capability development through both national and international collaborations between R&D institutes, Start-ups, industries and other stakeholders for the upcoming challenges in the area of water.

WTI PROGRAMMES

1. Research, Development & Demonstration (RD&D) and Demand Driven convergent solutions

The emphasis is on obtaining water from sustainable sources, improving the quality of the water for particular applications, and recycling and reusing the water. This is a need-based, demand-oriented theme program that spans the full technology development chain, moving from research through technology and ultimately to sustainable solutions as it progresses to higher technology readiness levels.

2. Water Technology Research and Innovation Centres (WATER-IC)

Through supporting research and development for water quality, quantity, and recycle and reuse, virtual networked centres seek to build a knowledge foundation to address the numerous water-related concerns. Through institutional and human capacity building of water researchers, professionals, community members, etc., these Joint Virtual Networked Centres are expected to foster knowledge, innovation, expertise, and to address the gaps in water technology research, development,

demonstration, adaptation, adoption, and commercialization.

3. Collaborations

Development of collaborative research partnerships leading to innovative bilateral and multilateral programmes for promoting R&D on various water issues brings in new perspective and taps global expertise. Research programmes with United Kingdom and Netherlands in the area of Water aim to understand diverse perspectives to understand the problems and develop customised approach for addressing them following holistic approach based on scientific investigations.

3.1 DST-NERC Collaboration on Water Quality Research

Recognising the importance of clean water, safe and portable water, India (through DST) and UK (through Natural Environment Research Council-NERC &Engineering and Physical Sciences Research Council -EPSRC) are implementing a collaborative research programme on improving Water Quality with a committed investment of £ 4.2 million from each side, having special thrust on addressing threats due to emerging contaminants (PPCP), online river water quality monitoring and sensor technology. The bilateral programme join forces on improving Water Quality by providing a better understanding of the transport, transformation and fate of different pollutants by supporting the development of management strategies and technologies to reduce water pollution levels.

3.2 DST-NWO Joint Programme on Urban Water Systems

India (through DST) and Netherlands (through Netherland Organisation for Scientific Research-NWO) are jointly implementing Indo-Dutch bilateral cooperation programme to address the complex challenges for urban water management in fast growing cities resulting from population growth, rapid urbanisation, pollution and the effects of climate change.

IoT in agriculture/irrigation

4. Desalination Mission

The Mission on Desalination (NMD), was conceptualised in 2017 by the Department in partnership with concerned ministries and departments at the behest of NITI Aayog, to ensure water security of the country and provide clean and safe drinking water to water-scarce areas of the country by identifying desalination technologies (developed and commercialized, developed and awaiting commercialization, and likely to be developed in the coming years) and enrolling Indian and Global desalination technology Solution Providers.

5. Water Advanced Research & Innovation (WARI) Fellowship

Capacity building of Water researchers and professionals has been one of the key objectives of the Water Technology Initiative Programme. DST and the University of Nebraska, Lincoln, USA are implementing Water Advanced Research & Innovation (WARI) Fellowship (Phase -I) programme in the year 2015 to nurture cooperation, capacity building, and provide opportunities and exposure for the students and scientists from both the countries. WARI in its first phase completed its duration and objectives successfully and the programme has been continued as WARI (Phase - II). The programme is being implemented and coordinated by Indo-US Science &Technology Forum (IUSSTF). More information on WARI fellowship is available at: https://iusstf.org/water-advanced-research-innovation-fellowship

Jal Jeevan Mission

India has a major problem with water supply and sanitation. A 2014 assessment by the United Nations Environment Programme (UNEP) placed the nation as

(HHJY) to provide safe drinking water by 2025. The objective of the mission is to provide piped water supply and sanitation services to all households by 2025. The first phase of HHJY was launched in 2014 across 13 states and union territories, covering more than 30% of the country's population. The second phase covers four additional states and union territories.

Details at: https://jaljeevanmission.gov.in/

The initiative will be implemented through a nationwide program comprising three components: Urban-focused programmes & Rural-focused programmes. For urban areas, the focus would be on providing piped water connections for all households, and improving existing household toilets or constructing new ones. In rural areas, the focus would also be on ensuring that all households have access to improved sanitation facilities. Rural-focused programmes include improving the quality of existing community tap stands, providing an incentive scheme to encourage communities to install their own taps and developing awareness campaigns about sanitation.

Har Ghar Jal
Jal Jeevan Mission

the second most afflicted by water scarcity globally, behind China. According to government estimates from 2012, 1.2 billion people lacked access to better drinking water sources. The World Bank reports that access to clean water has increased since 2000, but only marginally by 5%. The Government of India, in partnership with States, is implementing **Jal Jeevan Mission-Har Ghar Jal Yojana**

Desalination plant

COMBATING CLIMATE CHANGE

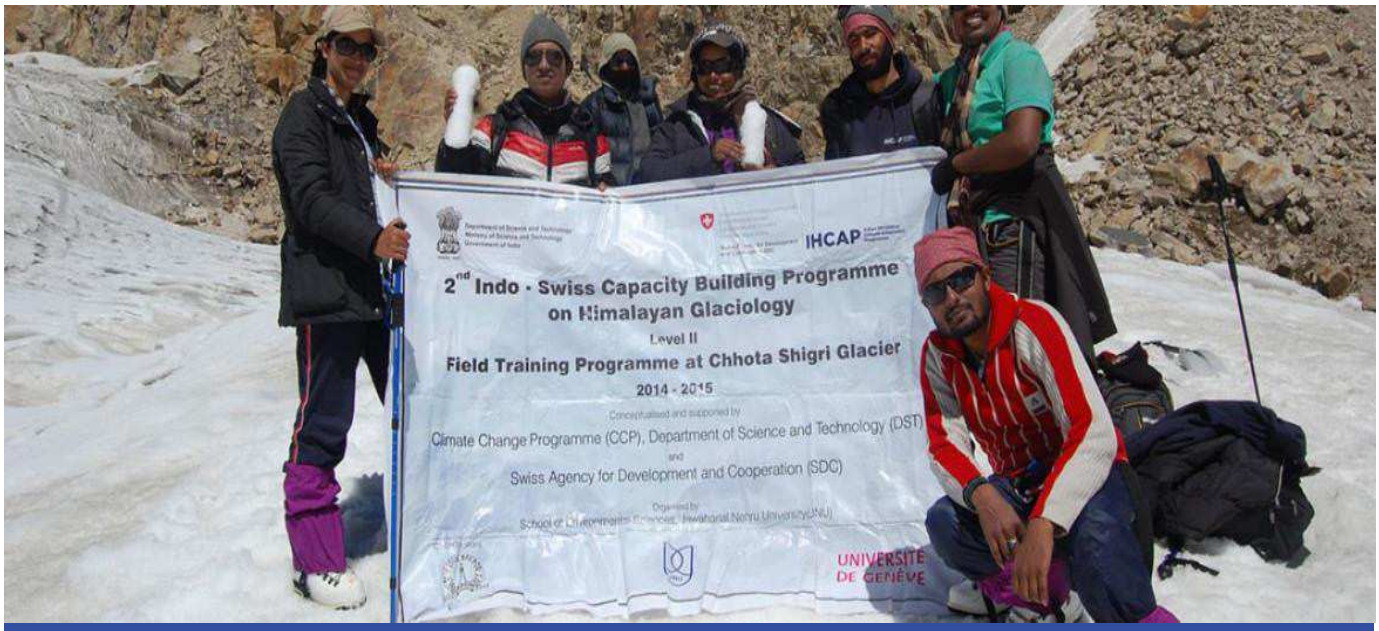
Department of Science & Technology has been implementing two national missions on Climate Change - the National Mission for Sustaining the Himalayan Ecosystem (NMSHE) and National Mission on Strategic Knowledge for Climate Change (NMSKCC). Both focus on building national S&T capacities in climate change

The Indian government is committed to combating the worldwide challenge of climate change. In August 2022, India amended its Nationally Determined Contributions (NDCs). In addition, India has created and submitted a second framework paper named 'India's Long-term Low Carbon Development Strategy' to the United Nations Framework Convention on Climate Change (UNFCCC) secretariat in November 2022, with the goal of reaching net-zero emissions by 2070. Many schemes and programs are being implemented by the government, including the National Action Plan on Climate Change (NAPCC), which includes missions in the areas of solar energy (National Solar Mission), energy efficiency (National Mission for Enhanced Energy Efficiency), water (National Water Mission), sustainable agriculture (National Mission for Sustainable Agriculture), Himalayan ecosystem (National Mission for Sustaining the Himalayan Eco-system), sustainable habitat (National Mission on Sustainable Habitat), green India (National Mission for a Green India), health, and strategic knowledge for climate change (National Mission on Strategic Knowledge for Climate Change).

Recognizing the importance of scientific and technological inputs required to sustain the fragile Himalayan Ecosystem, the Ministry of Science and Technology has been designated as nodal agency to implement two national missions to fight climate change -- National Mission for Sustaining the Himalayan Ecosystem (NMSHE) and National Mission on Strategic Knowledge for Climate Change (NMSKCC). Both focus on building national S&T capacities in the area of climate change (CC). The primary goal of NMSHE is to develop the capacity to scientifically assess the Himalayan region's vulnerability to climate change and to continuously assess the health of the Himalayan ecosystem. NMSKCC focuses on developing human and institutional S&T capacities in climate change and strategic knowledge in the key areas of climate change science, adaptation, and mitigation.

Human capacity building

28 specialised training programmes on adaptation planning in 12 Himalayan states have been undertaken in collaboration with Swiss Development Cooperation (SDC) wherein 1544 state officials and 323 media persons were trained. A Special Capacity Building Program in Glaciology at Kashmir University is launched targeting early-stage PhD students in Glaciology, Earth and Environmental Sciences from various institutes around the country.



(Image credit: Himalayas Climate Change Portal http://www.knowledgeportal-nmshe.in/)

National Mission for Sustaining the Himalayan Ecosystem (NMSHE)

NMSHE is a multifaceted cross-cutting mission that spans multiple sectors. It contributes to the country's long-term development by increasing understanding of climate change, its potential consequences, and the adaptation efforts required for the Himalayas, a region on which a major part of India's population depends. The Indian Himalayan Region covers approximately 5.3 lakh sq. km. area harbouring about 1,740 medicinal plants. NMSHE aims to support the development of suitable policy measures and time-bound action plans to maintain ecological resilience and the supply of important ecosystem services in the Himalayas. NMSHE aspires to establish appropriate management and policy mechanisms for sustaining and safeguarding the Himalayan ecosystem, as well as developing national capacities to regularly analyse its health status. To fulfil its objectives, the mission requires the important participation of Indian Himalayan States, the Planning Commission, and the Ministry of Environment, Forests, and Climate Change. For more information on NMSHE visit: http://www.knowledgeportal-nmshe.in

Awareness creation/ sensitisation

About 1.8 Lakh stakeholders including researchers, academicians, legislatures, Govt. officials, State Government Officers from line Departments, subject matter experts, representatives from civil society organizations, youth and women's organization, NGOs, etc and more than 6 lac school students have benefitted through various training/ awareness programmes.

National Mission on Strategic Knowledge for Climate Change (NMSKCC)

The National Mission on Strategic Knowledge for Climate Change (NMSKCC), implemented by the Department of Science and Technology under the NAPCC, encourages climate science research, knowledge development, and capacity building. The mission has been amended to better align its aims and priorities with the country's obligations. Due to regional and other local considerations, the effects of climate change on social systems are anticipated to vary around the globe. As a result, various geographic and socioeconomic circumstances would call for various

(Image credit: Himalayas Climate Change Portal http://www.knowledgeportal-nmshe.in/)

modelling studies, adaption techniques, and technological systems. Furthermore, because scientists currently lack a thorough knowledge of the mechanisms underlying climate change, it is difficult to disaggregate the consequences of global warming on various agroclimatic zones. By improving observational and modelling methods and systems, a strong competence in basic and applied climate science research can be developed. India is too big a nation to implement policies based on average global climate change. The National Mission on Strategic Knowledge for Climate Change's major objectives are to address these limits by strategic initiatives, including the creation of the necessary institutional and human resource capability. As a result, the Mission's goals have been determined to be the following.

Formation of knowledge networks among the existing knowledge institutions engaged in research and development relating to climate science and facilitate data sharing and exchange through a suitable policy framework and institutional support

Establishment of global technology watch groups with institutional capacities to carry out research on risk minimized technology selection for developmental choices

Development of national capacity for modelling the regional impact of climate change on different ecological zones within the country for different seasons and living standards

Establishing research networks and encouraging research in the areas of climate change impacts on important socio-economic sectors like agriculture, health, natural ecosystem, bio-diversity, coastal zones, etc

Providing an improved understanding and awareness of the key climate processes and the resultant climate risks and associated consequences

Building alliances and partnerships through global collaboration in research & technology development on climate change under International and bilateral S&T cooperation arrangements

A wide number of R&D initiatives in climate change studies have been financed across India to analyse the impact of climate change on sectors such as health, agriculture, and water and to develop coping adaptive measures. Climate change science and adaptation research and development (R&D) programs are carried out through 16 Centres of Excellence (CoEs), 6 Thematic Task Forces, 29 State Climate Change Centres (SCCCs), 23 Major R&D programmes, Human and Institutional Capacity Building Programmes (HICAB) with 10 Major R&D projects & 18 state network projects, 7 National Network Programmes on different areas of climate science and adaptation are being supported.

The programme includes the inventory of geological resources (glaciers) and exogenic processes, as well as IHR floral such as tree species, wild edibles, shrub and invasive alien naturalized species, and wild faunal biodiversity, as well as the creation of a database for hydro-meteorological processes and traditional knowledge practices of 60 identified local communities. Introduced 130 varieties of agricultural and horticultural crops; 17 breeds of cattle, poultry, and fish; and distributed to progressive farmers quality seeds of various crops seedlings and saplings, bamboo culms, and rooted slips of lemon grass.

The 29 State Climate Change Cells (SCCCs) are mandated to investigate vulnerability and risk assessment at the district and block levels. A paper is being written on *"Climate Vulnerability Assessment for Adaptation Planning in India Using a Common Framework."* The report emphasizes that all regions in India are vulnerable to the effects of climatic events; however, a few states with a relatively high vulnerability are Jharkhand, Mizoram, Odisha, Chhattisgarh, Assam, Bihar, Arunachal Pradesh, and West Bengal, which are mostly in the country's east, necessitating the prioritization of adaptation interventions.

Knowledge generation and dissemination

- More than 2000 research papers and 1000 Reports/Monogram/articles/ Conference proceedings/Brochure/ Posters have been published and 69 new techniques have been developed under various projects of Climate Change Programme.
- More than 250 PhD students have been enrolled and ~1000 Research fellows and ~ 600 staff are deployed.
- Under the Fulbright-Kalam Climate Fellowship program - 12 doctoral and 11 Postdoctoral researchers have successfully carried out R&D activities.

(Image credit: Himalayas Climate Change Portal http://www.knowledgeportal-nmshe.in/)

EMPOWERING SOCIETIES THROUGH S&T INTERVENTIONS

The Department of Science and Technology (DST) has consistently supported a variety of schemes for the socio-economic empowerment and development of the disadvantaged sections of society. These include Scheduled Caste (SC)/ Scheduled Tribes (ST), Divyangjan, the Elderly, the Economically Weaker Section (EWS), and Women, in addition to encouraging young scientists to engage in societally relevant Research and Development (R&D). These programmes are supported by DST through its division Science for Equity Empowerment and Development (SEED).

Many initiatives have been undertaken through appropriate STI interventions for improving the life and livelihood of the disadvantaged sections of society. Some of the notable programmes include Strengthening, Upscaling, and Nurturing Innovations for Livelihood (SUNIL), Scheme for Young Scientists and Technologists (SYST), Technology Intervention for Disabled and Elderly (TIDE), and S&T for Women. through appropriate interventions of Science, Technology and Innovation (STI).

Efforts are being made through its many schemes and programmes to empower the community by adopting technologies to solve locally defined needs and priorities that take into account available resources and the moral prosperity of society for sustainable development. The programmes are also being convergent with line function ministries/departments for last-mile delivery and national development programs to accomplish the Sustainable Development Goals (SDGs).

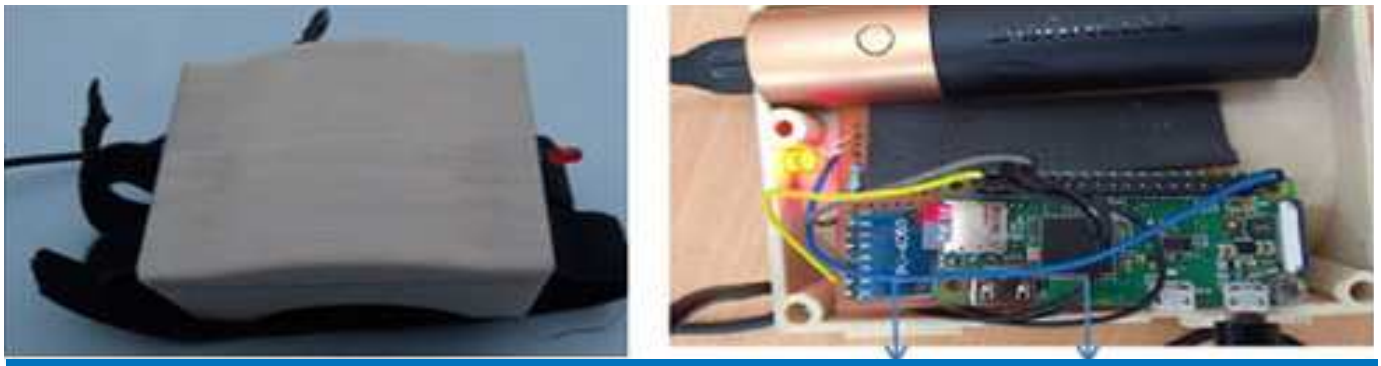
Bio-sand filters as an efficient means to obtain safe drinking water

The DST through the SEED division is providing grant-in-aid support to several Knowledge Institutions (KIs) and Science and Technology (S&T) based Non-Governmental Organizations (NGOs) for the holistic development of SC and ST communities in order to enhance their livelihood and economic condition. The support provided to these organisations that are working closely with these communities has enabled convergence among different stakeholders for the successful implementation of responsive and resilience strategies.

Scheduled Caste Sub Plan (SCSP) and Tribal Sub Plan (TSP)

The Scheduled Castes Sub Plan is a scheme to empower the SC population through the input of Science and Technology. To assist the scheduled caste community in their developmental aspirations, programmes focusing on enabling the community are being developed with empathy and sensitivity ensuring the supply of adequate resources. The priority areas of S&T interventions are Income generation amongst scheduled caste artisans/farmers; enhancing efficiency of artisans engaged in traditional occupations; Optimizing the design of commonly used equipment, machinery, and rural transport vehicles to increase income, reduce drudgery and improve general health and well being; Facilitating setting up of technology-driven micro-enterprises in rural areas. Sensitizing voluntary agencies, scientists of laboratories and related agencies to S & T approach for the development of scheduled castes through short-term brain-storming workshops and awareness generation to possible technology options

In order to improve the quality of life for SC/ST communities and integrate them into society, the SEED Division supported 500 S&T projects under the TSP and SCSP Schemes over the past two decades in various states in the areas of agriculture, resource management, microenterprise development, art and craft, post-harvest technologies, health and nutrition, engineering and allied aspects, training and skill development, drinking water and sanitation, and energy. Through a network of 16 NGOs, a coordinated program on people and protected areas (PPA) has been implemented for the development of 30,000 tribal people in the forest fringe areas and around protected areas/wildlife sanctuaries in 13 states and 1 UT by promoting site-specific interventions and use of affordable and viable technologies for livelihood augmentation, as well as conservation of natural resources.



Wearable device Sensor Configuration

Science Technology And Innovation (STI) Hubs For Development Of Scheduled Caste (SC) And Scheduled Tribe (ST) Communities

DST has established 75 STI hubs across the country to foster scientific talent and improve the socio-economic status of the disadvantaged sections. These hubs will exclusively be meant for the benefit of the scheduled caste and scheduled tribe communities. The DST supports these STI Hubs through various technological interventions to enhance their livelihood opportunities.

Although not limited, the thrust areas for interventions focus on the following themes :

- Endowment of natural and human resources for sustainable livelihood planning through science, know-how, and practices
- Promote appropriate and relevant technology research, development, and adaptation for the socioeconomic development of the target population.
- Promotion and documentation of traditional and indigenous knowledge, as well as skill upgrading, based on local innovation and local knowledge systems (including the integration of cutting-edge technologies with traditional and indigenous abilities).
- Creation of micro-enterprises and onward linkages of Science and Technology
- Capacity Building and Skill Development leading to sustainable livelihoods.

S & T Application for Weaker Sections (STAWS)

This initiative aims to develop economically weaker sections of society in both rural and urban locations. It focuses on specialized S&T inputs for the advancement of rural craftsmen, landless laborers, and so on. The emphasis is on a multi-sectoral approach that includes creative ideas based on locally accessible resources and includes direct beneficiary groups in decision-making.

Technological Interventions for Tribal Empowerment (TITE)

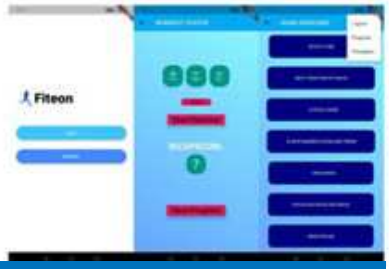
Under the Tribal Sub Plan (TSP) of the Department of Science and Technology (DST), the Technological Interventions for Tribal Empowerment (TITE) programme supports and implements technology-led demonstration projects for improving quality of life and empowerment of Scheduled Tribe (ST) communities based on sustainable Science and Technology (S&T) activities/ applications. The scheme's primary goal is to support research, development, and application of science and technology for improved living circumstances and increased livelihood prospects, as well as the launch of location-specific and need-based programs. Projects are primarily implemented as part of extension/research activities by S&T-driven/based voluntary groups and universities/R&D institutes, primarily in tough geographical areas.

Technology Interventions for Disabled and Elderly (TIDE)

The Science for Equity, Empowerment, and Development Division (SEED) of the Department of Science and Technology (DST) is implementing the "Technology Interventions for Disabled and Elderly (TIDE)" program to promote applied research and development of assistive technologies for the empowerment of the country's Elderly population and Divyangjan. TIDE Program provides Grant-in-Aid assistance to Knowledge Institutions, Recognized R&D Labs, and S&T-based Voluntary Organizations for the design and development of Assistive Devices, Processes, and Protocols to improve the Autonomy, Quality of Life, and Social Inclusion of target beneficiaries (Elderly and Divyangjan).

In addition to increasing their quality of life with appropriate and/or innovative

Wearable device



User interface of the mobile app

scientific technological treatments, TIDE aims to give the target population autonomy and independence through holistic development by creating the necessary enabling environment for their empowerment. Under this initiative, proposals are considered for financial assistance on R&D for technical solutions with a multidisciplinary approach to improving the quality of life of the elderly population and Divyanjan and making them self-sufficient .

S&T For Women

Focussing on women as a specific target group, the S&T For Women Scheme aims to promote research, development and adaptation of technology to improve the quality of life, and working conditions for women, provide newer opportunities for gainful employment of women, especially in rural areas and increase the contribution of women scientists to technology-based development.

One of its successful programme is Women Technology Parks which aims to improve the weakest link of the predominant livelihood system of women in an area and promote social entrepreneurship and women employment based on the strongest link of the livelihood system through interventions of Science, Technology and Innovations. WTP in short is a technology modulation and a training center to showcase livelihood and scientific technologies for women. The objective of Women Technology Park is to promote the development and adaptation of appropriate technologies, transfer of proven technologies and demonstration of live technology models to promote women's employment. Efforts are done that women in rural and peri-urban areas receive training in WTPs for skill development and capacity building as per National Skill Qualification Framework through S&T based interventions, using area-specific resources, with a goal of achieving local self-reliance for economic re-growth.

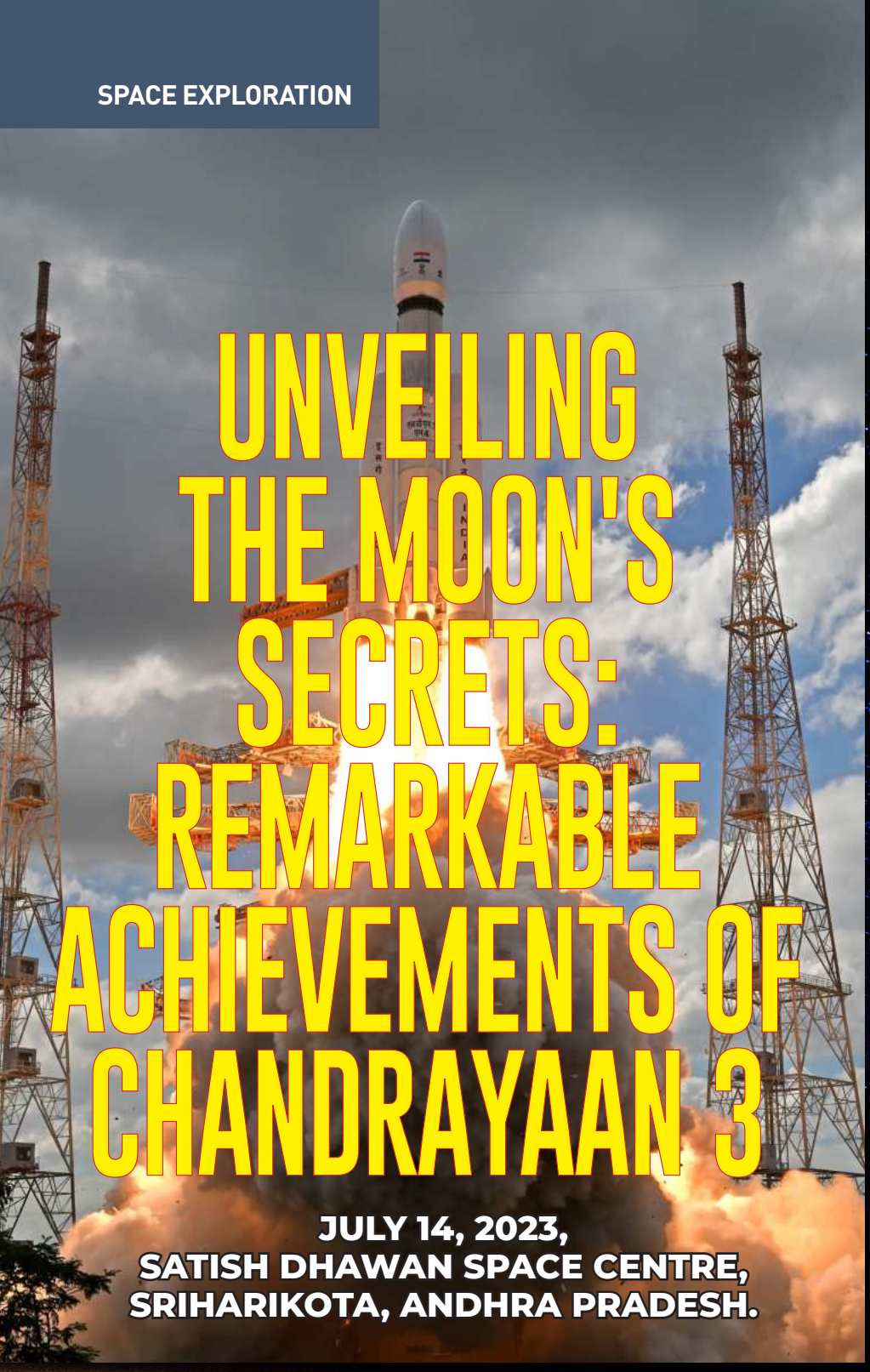
Scheme for Young Scientists and Technologists (SYST)

The scheme encourages young scientists and technologists (less than 35 years) to identify socially relevant challenges and provide S&T-based solutions using a lab-to-land approach. Innovative S&T ideas in the form of a proposal are invited from young researchers under the selected themes as Artificial Intelligence, Robotics, and IoT for Societal Applications in Agriculture, Rural Development, Disaster Management and Health, Natural Resource-Based Livelihood Systems, Income Augmenting Agricultural Practices, Environment Sustainability & Renewable Energy, Additive Manufacturing and so on.

Strengthening, Upscaling & Nurturing Local Innovations for Livelihood (SUNIL) Programme

The SUNIL initiative, which evolved from a previous programme known as TARA program, was created in 2022 with the goal of enhancing the technology delivery system and developing social entrepreneurial models for the Economically Weaker Section (EWS) of society. In order to deliver more complete solutions on the ground, the programme develops a collaborative implementation approach (Land-Lab-Land) that replaces NGOs as the only implementation partner and involves other CBOs/SHGs/ FPOs/Social ventures/ community to provide more comprehensive solutions at the ground level. The SUNIL initiative emphasizes enhancing citizens' S&T knowledge, skill upgrading, capacity building, and socio-economic situations in addition to the deployment of numerous field-tested models and location-specific technologies to fulfill citizens' requirements.

Bio-sand filters as an efficient means to obtain safe drinking water



UNVEILING THE MOON'S SECRETS: REMARKABLE ACHIEVEMENTS OF CHANDRAYAAN 3

JULY 14, 2023,
SATISH DHAWAN SPACE CENTRE,
SRIHARIKOTA, ANDHRA PRADESH.

As the clock struck 2.35 p.m., the finest of Indian scientists associated with the Chandrayaan 3 mission looked on with bated breath, holding on to their emotions, as Chandrayaan 3 was successfully launched and propelled into the space by a 640 tonne, 43.5 metre tall Launch Vehicle Mark 3 (LVM3) rocket. The spacecraft entered the lunar orbit on August 1 and made its power descent and subsequent soft landing on August 23 (now declared as National Space Day), become the first ever in the world to land near the Mutus crater in the south polar region (300 km. from the south pole at 70 degrees latitude), which is also the dark side of the Moon. None of the previous missions by other countries landed in this region, preferring the sunny, equatorial side.

The event is also a celebration time for the science fraternity around the world – as it is a collective endeavour that transcends borders, reminding us that the quest for knowledge is a universal endeavour, binding humanity together in its curiosity and ambition. The mission holds the promise of unveiling new lunar insights, inspiring future generations of scientists, and fostering international collaborations that will propel us further into the cosmos. The historic moment is also a matter of pride to millions of Indians around the world, and, a source of inspiration to the youth across the country dreaming to take up science as a career.

Humanity's fascination with the moon has persisted throughout the ages, beckoning us to uncover its hidden truths and unravel the mysteries of our universe. USA, Russia and China took the lead by sending manned and unmanned spaceships to the moon. The Indian story began when the Indian Academy of Sciences and the Astronautical Society of India advocated for a scientific mission to the moon in 1999, leading to the establishment of the National Lunar Mission Task Force by the Indian Space Research Organisation (ISRO) in 2000. Expertise and technical capabilities were assessed, paving the way for the approval of an Indian probe to the Moon by the government in November 2003. And thus began India's scientific romance with the moon marking a significant milestone in India's space program.

In 2008, Chandrayaan 1 propelled the nation into the league of countries venturing beyond Earth's boundaries and ignited the imagination of scientists and dreamers alike. Despite facing technical issues and ultimately ceasing communication after 312 days instead of the intended two-year mission, Chandrayaan-1 achieved significant milestones. It produced a complete map of the moon's chemical composition and topography, and one of its most ground-breaking discoveries was the widespread presence of water molecules in lunar soil.

The subsequent mission, Chandrayaan-2, launched in 2019, aimed to build upon these achievements and further explore the moon's mysteries. It comprised a lunar orbiter, a lander named Vikram, and the

Pragyan rover. The goal was to land on the moon's south polar region and conduct scientific experiments to study lunar surface variations and the abundance of water. Unfortunately, during the landing attempt, the lander deviated from its intended trajectory and crashed. A software glitch was identified as the cause of the failure. Despite the disappointment, it served as a catalyst for even greater determination and innovation. Scientists and engineers tirelessly analysed the mission's data and identified areas for improvement, fuelling the ambition to try once again.

Building upon the achievements of its predecessors, Chandrayaan-3 is poised to unravel the secrets of our celestial neighbour in even greater detail. In the Chandrayaan-3, lessons learnt from the previous mission have been incorporated into its design. The mission has refined the landing techniques. In contrast to the previous versions Chandrayaan 3 has been modelled to be failure-based, i.e. all possible failures have been considered and an in-built backup has been provided for it. One of the prime reason for crashing of the lander of Chandrayaan 2 was the limited area of 500m x 500 m, available to it for manoeuvring in case of errors. The marked landing area has now been expanded to 4km. x 2.5 km. In-addition, the chances of a successful touchdown on the Moon's surface have also increased by including advanced scientific instrumentation.

The mission set forth with a multifaceted approach, aiming to enhance our understanding of the lunar surface, its mineral composition, and the presence of water ice. By conducting extensive scientific experiments, Chandrayaan-3 aims to contribute to the global knowledge of lunar science, advancing our understanding of the moon's origin, geological evolution, and potential for future human exploration. By analysing the data collected by the lander and rover, scientists will be able to gain valuable insights into the moon's geological processes and its potential as a resource-rich celestial body. Understanding the distribution and abundance of minerals and water on the moon can have profound implications for future human space exploration and even the establishment of lunar colonies. Furthermore, Chandrayaan-3 aims to study the moon's geology and its seismic activity. By deploying a seismometer, scientists can detect and analyse moonquakes, providing valuable information about the moon's internal structure and its geological processes. This knowledge can help us better understand the moon's formation and evolution, shedding light on the early history of our solar system.

The mission's objectives can be summarized into three primary goals. Firstly, Chandrayaan-3 aim to demonstrate safe and soft landing on the lunar surface which it has successfully accomplished, becoming the fourth nation ever to do so. This crucial achievement showcases India's capability to execute precise and controlled landings, laying the foundation for future missions involving manned landings or resource utilization on the moon.

Secondly, the mission seeks to showcase the mobility and in-situ exploration capabilities of the rover on the lunar surface. By roving across the landing site, the rover will enable extensive scientific analysis and mapping, providing valuable data on the moon's topography, surface features, and potential resources. This will pave the way for future missions that involve surface mobility and resource utilization.

Lastly, Chandrayaan-3 carries a suite of scientific payloads to conduct in-situ experiments and gather data on various lunar phenomena. These experiments will provide valuable insights into the moon's composition, geology, and environment. Advanced technologies have been incorporated into the lander module, including laser and RF-based altimeters for precise altitude measurements, laser Doppler velocimeters for velocity measurements, propulsion systems, landing leg mechanisms and inertial measurement systems for accurate positioning and orientation. The propulsion system, consisting of throttleable liquid engines and attitude thrusters, ensures precise control during descent. Navigation, guidance, and control systems are responsible for designing the powered descent trajectory, while hazard detection and avoidance cameras and processing algorithms help identify and avoid potential obstacles during landing. These technologies enable safe landing, precise positioning, and mobility on the lunar surface.

In an interview to a mainline newspaper, S. Somnath, Chairman, ISRO stated that 'the aim of the mission is to study all geo-physical characteristics of the lunar surface, study the so far unexplored south pole, and conduct thermal characteristics on the surface (in the first 10 cms.) of the moon.'

Preparation and the process:

The timeline for Chandrayaan 3 is carefully planned to optimize its mission. From launch to reaching the moon's surface, it involves several weeks of precision and teamwork.

Before embarking on its lunar journey, Chandrayaan 3 underwent meticulous testing and simulations to ensure its readiness and reliability. The spacecraft was subjected to rigorous environmental tests, simulating the harsh conditions of space and the lunar environment. These tests verified the functionality of its instruments and systems, ensuring that Chandrayaan 3 can withstand the challenges it will encounter during its mission.

To validate the performance of these advanced technologies in conditions similar to those on the Moon, various special tests have been conducted. An integrated cold test involved evaluating the performance of integrated sensors and navigation systems using a helicopter as a test platform. The integrated hot test simulated closed-loop performance using sensors, actuators, and NGC systems with the help of a tower crane. Additionally, the performance of the Lander leg mechanism was tested on a lunar simulant test bed to simulate different touchdown conditions.

Launch of Chandrayaan 3:

With meticulous planning, precise calculations, and the expertise of scientists and engineers from around the world, Chandrayaan 3 embarked on an awe-inspiring and complex journey to the moon. It is following a carefully planned

trajectory, passing through various stages, from launch and orbiting the Earth to orbital insertion around the moon and finally landing on its surface. Each stage requires precise coordination, precise manoeuvres, and the cooperation of ground-based tracking stations to ensure the spacecraft's safe arrival at its destination.

Chandrayaan-3 needs the Launch Vehicle Mark-III (LVM3) rocket to reach space because it acts like a taxi for the spacecraft. Just as a taxi carries people, the LVM3 rocket carries the spacecraft into space. Rockets like the LVM3 have powerful engines that generate the energy needed to overcome Earth's gravity and lift heavy objects, including the spacecraft. Without a rocket, the spacecraft cannot make its journey to the Moon.

The LVM3 rocket is India's heaviest rocket, weighing 640 tonnes and standing at a height of 43.5 meters. It has a payload fairing, which acts as a shield for the cargo carried by the rocket. The fairing is crucial for protecting satellites, maintaining an optimal temperature, and shielding against acoustic vibrations. It plays a vital role in successful satellite deployments, considering launch costs and orbit injection precision.

The LVM3 rocket's fairing has a diameter of 5 meters. It can carry payloads weighing up to 8 tonnes to lower Earth orbits (LEO) around 200 kilometres above the Earth's surface. However, for geostationary transfer orbits (GTO) about 35,000 kilometres from Earth, it can carry a lesser payload of approximately 4 tonnes.

Despite its impressive weight, the LVM3 is a robust rocket compared to those used by other countries and space organizations for similar missions. For example, the European Space Agency's Ariane 5 rocket weighs 780 tonnes and can carry 20 tonnes to LEO and 10 tonnes to GTO.

The LVM3 has successfully completed missions, including launching Chandrayaan-2 in 2019 and a fleet of 36 One Web satellites in 2022. It is a three-stage rocket, consisting of two solid boosters (S200), a liquid-fuelled core stage (L110), and a cryogenic upper stage (C25). The boosters burn for about 134 seconds before separating, followed by the ignition of the core stage at around 113 seconds. The payload fairing is jettisoned at approximately 217 seconds. After 313 seconds, the core stage separates, allowing the cryogenic upper stage to ignite. Finally, around 974 seconds into the flight, the spacecraft is injected into a Geosynchronous Transfer Orbit (GTO) with dimensions of 180 x 36,000 kilometres.

The Chandrayaan-3 mission represents a significant leap in our understanding of the universe and embodies humanity's ambition to explore the unknown. It showcases the dedication of scientists, engineers, and space enthusiasts to unravel the mysteries beyond Earth's atmosphere. The recent mating of the Chandrayaan-3 spacecraft with the LVM3 rocket brings us closer to this exciting mission, continuing India's inspiring journey of space exploration and scientific progress.

Technical features and components

To achieve its ambitious goals, Chandrayaan-3 comprises several crucial components working in synchronised manner as a team. The mission components include an Orbiter or Propulsion module (PM), a Lander module (LM) named Vikram, and a Rover named Pragyan, all working together in tandem to develop and demonstrate new technologies required for future interplanetary missions. Each equipped with cutting-edge instruments and sensors to collect invaluable data about the moon's environment.

The orbiter or the Propulsion Module will carry the Lander and Rover configuration from the launch vehicle to a circular lunar orbit trajectory of 100 kilometres and serves as the communication link, allowing us to stay connected with the mission from Earth. It will orbit the moon, collecting valuable data and transmitting it back to scientists for analysis. Once the Lander is separated from the Propulsion module, the latter will continue to operate with its own scientific payload, known as Spectro-polarimetry of Habitable Planet Earth (SHAPE), which will study the spectral and polarimetric measurements of Earth from the lunar orbit, enabling further understanding of our home planet.

There are six steps involved from the launch from Sriharikota to landing on the Moon. The first step was the launch itself. The second step involved injecting it into an Earth parking orbit during the 'Earth Manoeuvre Phase. The third step involved a series of manoeuvres to raise the orbit of Chandrayaan 3 and place it in the lunar transfer trajectory. The fourth step began with the spacecraft entering the Moon's sphere of gravitational influence. Here the thrusters reduced its speed for lunar capture. In the fifth step the orbit of the spacecraft around the moon circularised to 100 kms. by 100 kms. involving a series of complex orbital manoeuvres aided by the thrusters on the propulsion module. The sixth and the last step was taken on the day of the landing when the lander separated from the orbiter and performed a series of manoeuvres.

The 1,724 kg. lander, Vikram, built

with precision and equipped with a suite of scientific instruments and technology demonstrators, gently touched down on the lunar surface on 23rd August 2023. Vikram includes some upgrades to the lander (of Chanrayaan 2)—a bigger fuel tank, solar panels on all four sides instead of just two, additional navigation instruments, updated software, additional strength tests and more. Its payloads include a seismometer to study moonquakes, a thermal probe to analyse the lunar surface's temperature, and instruments to measure the moon's elemental composition and map its mysterious surface. One of the most exciting payloads is a high-resolution camera that has captured stunning images of the moon, revealing its geological features in unprecedented detail. The safe landing and roving capabilities demonstrated by Chandrayaan-3 will contribute to the development of advanced technologies necessary for future human space exploration, offering invaluable insights for the scientific community and inspiring generations to reach for the stars.

The lander that touched down gently on the lunar surface was specifically programmed to do so. Built with precision, carrying a suite of scientific instruments and technology demonstrators as payload to study the moon's geology, composition, and atmosphere. Each payload serves a unique purpose in unravelling the Moon's mysteries. The Lander module of Chandrayaan-3 is equipped with several scientific payloads aimed at studying various aspects of the lunar surface. These include:

1. **Chandra's Surface Thermophysical Experiment (ChaSTE):** This payload is designed to measure the thermal conductivity and temperature of the lunar surface in the vicinity of the landing site. By analysing these properties, scientists can gain insights into the geological characteristics of the Moon.
2. **Instrument for Lunar Seismic Activity (ILSA):** ILSA will help measure the seismicity around the landing site, enabling scientists to study the structure of the lunar crust and mantle. Understanding the Moon's seismic activity is crucial for unravelling its geological evolution.
3. **Langmuir Probe (LP):** LP is a device that will estimate the plasma density and its variations near the lunar surface. By studying the near-surface plasma environment, researchers can gain valuable information about the Moon's ionosphere and its interaction with the solar wind.

An artist's impression of Chandrayaan 2's lander and rover on the Moon.Chandrayaan 3 hardware is expected to look similar. *Credit: ISRO*

4. **Passive Laser Retroreflector Array:** Accommodated from NASA, this array is used for lunar laser ranging studies. It provides precise measurements of the distance between Earth and the Moon, allowing scientists to study the dynamics of the Earth-Moon system.

The lander also carries a 26 kg. robotic rover Pragyan, to explore the lunar surface. After the Chandrayaan-3 lander softly touched down on the Moon, ramps were deployed to facilitate the rover's exit. A wire connection between the lander and rover was snapped once stability was achieved on the lunar surface. The rover's release marked the continuation of the mission's scientific objectives to study the Moon's mysteries.

Pragyan's rollout was facilitated by a two-segment ramp, and it was powered by a solar panel to generate its required energy. The rover's deployment was carefully considered, taking into account factors such as temperature levels, incline, and dust conditions. During most of the day, Pragyan recharged its batteries via solar panels.

After two days of necessary preparations, the Pragyan rover, measuring roughly 92cm in length and 75cm in width, and featuring six wheels embarked on a 14-day exploratory mission of the lunar surface. It was equipped with two key payloads: the 'Alpha Particle X-Ray Spectrometer' (APXS) and the 'Laser Induced Breakdown Spectroscope' (LIBS).

APXS, dedicated to deriving the elemental composition of the lunar surface and LIBS tasked to determine the elemental composition of chemical elements like magnesium and aluminium present in lunar soil and rocks around the landing site. Pragyan also featured two Navigation cameras, known as NAVCAM-Left and NAVCAM-Right, mounted on its front. These cameras enabled the rover

A model of the Chandrayaan 2 rover being tested at ISRO's simulatedlunar soil facility. *Credit: ISRO*
Chandrayaan-3's high-resolution camera will capture stunning images of the moon's surface,

to navigate the lunar terrain, ensuring path planning and obstacle avoidance during its movement.

The rover's mission life is limited to one lunar day (approximately 14 Earth days), due to the harsh conditions on the Moon. The extreme cold and darkness experienced during the lunar night poses a threat to the rover's electronics components and battery. The rover could potentially 'awaken' after the lunar night if its components survived, but this is unlikely.

Chandrayaan-3's rover, Pragyan, contributed to the exploration of the Moon's southern pole. The rover's missions include conducting experiments, collecting samples, and analysing the lunar environment, regolith or moon dust, soil (broken rock), and potential resources. The synergy between the lander and rover aim to unlock the Moon's secrets, enhancing our understanding of its geology, composition, and atmosphere.

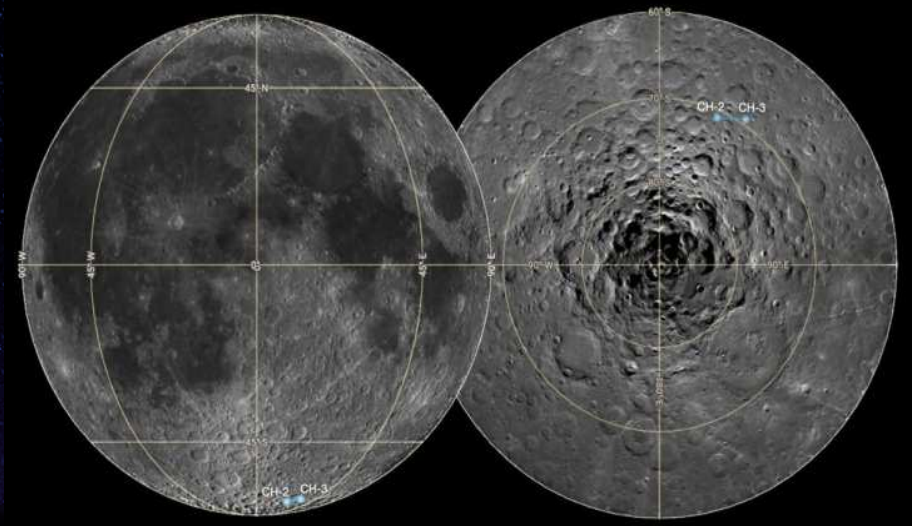
The analysis of this information will allow scientists to study the moon's topography in unprecedented detail, creating comprehensive maps of its terrain and identifying potential landing sites for future missions. By studying the presence and abundance of elements on the lunar surface, researchers can gain insights into the moon's formation and evolution, drawing comparisons to Earth's geology.

Exploring the Moon's Secrets: The Impact of Chandrayaan 3

The impact of Chandrayaan-3's mission to the Moon is expected to be profound and wide-reaching. The research conducted during this mission will provide valuable insights about the lunar environment, revolutionizing our understanding of our celestial neighbour and opening new doors to scientific discovery.

One of the key objectives of Chandrayaan-3 is to unravel the mysteries of the moon's atmosphere and the presence of volatile compounds. By studying these factors, scientists will gain a deeper understanding of how the moon interacts with the solar wind and its potential as a platform for astronomical observations and experiments. This knowledge will not only reshape our understanding of the moon but also pave the way for future space exploration endeavours.

In addition to the scientific breakthroughs, Chandrayaan-3 serves as an inspiration for future generations. The mission sparks curiosity and encourages young minds to explore the wonders of space and pursue careers in STEM fields. It showcases India's technological capabilities and its significant contribution to global space exploration efforts, fostering collaborations and partnerships that transcend borders in the pursuit of scientific knowledge.



The landing sites of Chandrayaan 2 and 3 are marked as CH-2 and CH-3respectively in these orthographic views of the Moon's nearside and southpole.
Credit: LROC Quickmap / Markings by Jatan Mehta

Chandrayaan-3 is on a momentous mission to the moon, aiming to accomplish ground-breaking achievements and significant milestones in lunar exploration. The rover's ability to traverse the lunar surface and collect samples mark a revolutionary feat in scientific exploration. These samples hold the key to unlocking the moon's elemental composition, revealing the presence of diverse minerals and the distribution of vital elements. By meticulously analysing these samples, scientists will deepen our understanding of the moon's formation and gain crucial insights into the early history of our entire solar system. This will yield an unprecedented wealth of data for scientists to delve into, unravelling new mysteries, making ground-breaking discoveries, and reshaping our knowledge of our closest celestial neighbour.

This remarkable mission brings together the expertise and resources of various international space agencies and institutions, fostering an environment of scientific cooperation and knowledge-sharing on a global scale. By uniting scientists from different nations, Chandrayaan-3 becomes a symbol of collective effort, leveraging expertise and nurturing collaborations.

In conclusion, Chandrayaan-3's mission to the Moon signifies a significant milestone in space exploration. It promises to unlock valuable insights about the lunar environment, reshape our understanding of the moon, and inspire future generations to pursue scientific endeavours. With its advanced technology, ambitious objectives, and international collaborations, Chandrayaan-3 is poised to make ground-breaking discoveries and propel us further into the realm of space exploration.

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