

ISSN-0971-8400



# YOJANA

**SPECIAL ISSUE**



OCTOBER 2021

A DEVELOPMENT MONTHLY

₹ 30



## Science & Technology

### LEAD ARTICLE

**Combating Covid-19**

Dr Shailja Vaidya Gupta

### SPECIAL ARTICLE

**Redefining Science Communication**

Dr Nakul Parashar

### FOCUS

**Energy Security : Nuclear Power**

M Balarama Murthy



# India in Space



**I**ndia is among a handful of countries with advanced capabilities in the Space sector. Far-reaching reforms in the Space sector are aimed at boosting private sector participation in the entire range of space activities. With these reforms, the sector will receive new energy and dynamism, to help the country leapfrog to the next stages of space activities. This will not only result in an accelerated growth of this sector, but will enable Indian industry to be an important player in global space economy. With this, there is an opportunity for large-scale employment in the technology sector and India becoming a global technology powerhouse.

Space sector can play a major catalytic role in the technological advancement and expansion of our industrial base. The proposed reforms will enhance the socio-economic usage of space assets and activities, including improved access to space assets, data, and facilities.

The newly created Indian National Space Promotion and Authorization Centre (IN-SPACe) will provide a level playing field for private companies to use Indian Space infrastructure. It will also hand-hold, promote, and guide the

private industries in space activities through encouraging policies and a friendly regulatory environment.

The Public Sector Enterprise 'New Space India Limited (NSIL)' will endeavour to re-orient space activities from a 'supply driven' model to a 'demand driven' model, thereby ensuring optimum utilisation of our space assets.

These reforms will allow ISRO to focus more on research and development activities, new technologies, exploration missions, and human spaceflight programme.

The space research activities were initiated in our country during the early 1960s, by Dr Vikram Sarabhai, the founding father of Indian space programme. To spearhead the space research activities, Indian National Committee for Space Research (INCOSPAR) was set up in 1962 under the Department of Atomic Energy. Subsequently, Indian Space Research Organisation (ISRO) was established in August 1969, in place of INCOSPAR. Throughout the years, ISRO has upheld its mission of bringing space to the service of the common man, to the service of the nation. In the process, it has become one of the six largest space

*Continued on Cover III...*



EDITOR  
SHUCHITA CHATURVEDI

PRODUCTION OFFICER  
D.K.C. HRUDHAINATH

COVER DESIGN  
GAJANAN PRALHADRAO DHOPE

OUR REPRESENTATIVES

Ahmedabad: Janhavi Patel, Bengaluru: BK Kiranmai,  
Bhubaneswar: Girish Chandra Dash, Chennai:  
Sanjay Ghosh, Guwahati: Hiramani Das, Hyderabad:  
Krishna Vandana P, Jalandhar: Gagandeep Kaur  
Devgan, Kolkata: Rama Mandal, Mumbai: Umesh  
Ujgare: Thiruvananthapuram: Roy Chacko.

Yojana (English): Room No. 647, Soochna Bhawan,  
CGO Complex, Lodhi Road, New Delhi-110 003.  
E-mail (Editorial): sec-yojanaeng-moib@gov.in

YOJANA, a development monthly published since 1957, is a theme-based journal providing in-depth analyses and views on socio-economic issues in the broader framework of government policies. Although published by the Ministry of Information and Broadcasting, YOJANA is not restricted to expressing the official point of view.

DISCLAIMER

- The views expressed in various articles are those of the authors and they do not necessarily reflect the views of the Government or the organization/s they work for.
- Maps/flags used in the articles are only indicative and they do not reflect the political map or legal representation of the flag of India/ any other country.
- The info graphics/figures are provided by the authors through their reliable sources and YOJANA claims no responsibility for the same.
- Images, graphics and illustrations, wherever used, are mostly sourced from government channels and are indicative in nature.
- YOJANA does not own responsibility regarding the contents of the advertisements. The readers are requested to verify the claims made in the advertisements regarding courses, career-guidance books or institutions.

SUBSCRIPTION/GRIEVANCES

Email: pdjucir@gmail.com

Phone: 011-24367453

(Monday-Friday, 9:30 am- 6:00 pm)

Postal Address: Abhishek Chaturvedi, Editor,  
Journals Unit, Publications Division, Room No.  
779, Soochna Bhawan, CGO Complex, Lodhi  
Road, New Delhi-110 003.

Please note that it will take at least eight weeks to start your subscription. Kindly raise your queries/grievances about non receipt of the journals only after this period.

SUBSCRIPTION-RELATED DETAILS : Page 69

Website: www.publicationsdivision.nic.in

@DPD\_india

@publicationsdivision

@dpd\_india

Let noble thoughts come to us from all sides  
Rig Veda

IN THIS ISSUE

LEAD ARTICLE

COMBATING COVID-19

Dr Shailja Vaidya Gupta .....8



INDIA'S RESPONSE TO COVID-19

Dr Alka Sharma, Dr Jyoti Mallick Logani,  
Dr Kamakshi Chaitri .....12

THE VACCINE QUEST

Gagandeep Kang .....16

FIT INDIA MOBILE APP ..... 19

SPECIAL ARTICLE

REDEFINING SCIENCE  
COMMUNICATION

Dr Nakul Parashar .....20



FOCUS

ENERGY SECURITY:  
NUCLEAR POWER

M Balarama Murthy .....24



THE HIMALAYAN FLOODS

Pradeep Srivastava ..... 28

GEOMAGNETISM: APPLICATIONS

Praveen B Gawali..... 32

NANOTECHNOLOGY IN TEXTILES

Dr Neha Yeshwanta Hebalkar..... 36

LIGHT HOUSE PROJECTS

Amrit Abhijat ..... 41

DRONE POLICY

Aarushi Aggarwal ..... 46

SCIENCE EDUCATION

Nimish Kapoor ..... 50

NUTRITION AND VACCINATION

Hemant Kumar Meena,  
Dr Rinky Thakur..... 54

LOCKDOWN DIARY

K Sindhu Alekya..... 61

EK BHARAT SHRESHTHA BHARAT .... 62

AWARDS FOR EXCELLENCE IN BOOK  
PRODUCTION, 2021 TO DPD ..... 70

REGULARS

DEVELOPMENT ROADMAP ..... Cover-II  
DO YOU KNOW ..... 63

AZADI KA AMRIT MAHOTSAV

MCQs ..... 65  
OUR BOOKS ..... 66

NOVEMBER ISSUE - PANCHAYATI RAJ



Number of pages: 72

Details of the Sales Outlets of the Publications Division on Page 11

YOJANA is published in Assamese, Bengali, English, Gujarati, Hindi, Kannada, Malayalam, Marathi, Odia, Punjabi, Tamil, Telugu and Urdu.



## Infinite Possibilities

The present pandemic situation has changed the way laymen look towards Science and its inventions. Science and technology have been the only hope humanity has had against the virus that is almost halting the world from time to time. Scientists, doctors, innovators, and tech experts are putting their heads together in taking the world out of the crisis. The value of Science has challenged the emphasis humanity had invested in money, power, success, and everything materialistic. With all eyes on vaccines, pandemic-combating strategies, and counting waves, Science and technology have consistently led from the front.

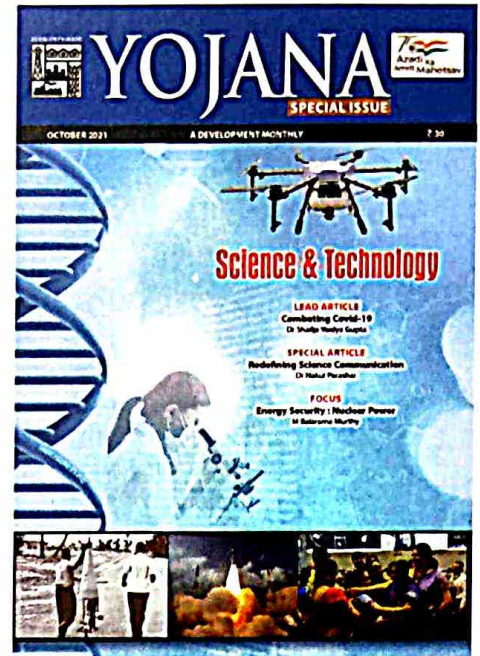
Even when the virus has changed the way the world functions, the technology has come forward to our rescue. Online classes for students have let the students catch up on their education, though it has had its own pitfalls. Offices devised work-from-home setups and that saved a lot many jobs which would have otherwise been lost, or workers would have risked their lives to attend the offices physically. Telemedicine helped tens and thousands of people. Digital transactions kept things moving at a faster pace and reduced the scope of the infection spreading through the physical transaction of currency. Limited travels along with opening up of markets and public places were made possible with affordable RT-PCR tests, PPE kits, sanitisers, and of course, the vaccines.

This issue of Yojana is dedicated to the yeoman service by the scientific community and the countless, often nameless people who are associated with bringing the multiverse of science into our lives through its fascinating applicability. While I write this piece on the computer, my writing desk has a bottle of sanitiser, a mobile handset, a pair of scissors, a pen, a random safety pin, and I wonder which of these inventions by a few curious minds can we do without. From the simplest of the machines to the most complex designs, everything around us has shaped us invariably.

Science is the forerunner of development. It is an inquisitive historian connecting us most precisely with our pasts, a wondrous fortune teller who warns us of climate change and its effects, and an innovative artist showing us glimpses of our future through the prototypes of the most recent inventions—with science, the possibilities become never-ending.

Introducing our younger generation to such a limitless universe of scientific knowledge, is a responsibility of all. Starting from the basic scientific temperament and rational thinking to making science a career choice, this should be a journey that needs to be open and accessible to everyone. The vision of New Education Policy 2020 reflects upon the non-segregation of science from other streams. It focuses on applied science, AI, robotics, and makes science fun and informative from an early age through the interactive labs. Funding of research and promoting innovation is also envisioned in the Policy.

This issue of Yojana brings to you some phenomenal stories from the world of science and technology. It tries to decode the functioning of various lesser-known fields of science including nanotechnology, geomagnetism, atomic energy, earth sciences, among many others. Science and technology are ever-evolving. There will be inventions, discoveries, and even unsuccessful experiments taking place in the labs worldwide while you are reading this. As they say, even the failures of these experiments teach immeasurably, so does the science itself. With every success or failure, science and technology introduce us to a newer world of infinite possibilities, giving a novel hope to humankind. □



for focused research and development of Corona vaccine and other science and technology issues on April 14 2020. A series of regular meetings with experts and vaccine companies to discuss and debate key aspects of vaccine development and other S&T matters were held. The VTF was monitored directly by the Prime Minister of India and his office, as were other empowered committees.

The Vaccine Task Force strategised the urgent and critical action plan for India's Scientific R&D response to Covid-19 pandemic, shouldered on six major pillars:

- Vaccine Development
- Personnel Protection Equipment (PPE) and Ventilators
- Testing, Tracking, and Diagnostics
- Therapeutics and drugs
- Surveillance: Seroprevalence and genome sequencing
- Regulation and regulatory support

### Vaccine Development

As early as in the second meeting of The VTF, held on 20 April, 2020, presentations by Bharat Biotech, Serum Institute of India Pvt Ltd, Zydus Cadila, Biological E, and Mynvax were arranged and the industry was assured that all support regulatory, technical, and financial would be fast-tracked and provided.

A cohesive and coherent coming together of government-academia-industry led to one of the most successful stories of Indian science, the development, and production of vaccines for Covid-19 in record time. The first week of January 2021 saw the Emergency Use Authorization (EUA) accorded to two Indian vaccines: Recombinant, replication-deficient chimpanzee adenovirus vector encoding the SARS-CoV-2 Spike glycoprotein, ChAdOx1 (Covishield) from the Serum Institute of India Private Limited, and the whole virion inactivated vaccine BBV152 (Covaxin) from Bharat Biotech International Limited. Covaxin was developed in collaboration with the

**COVID-19 Crisis**

Ministry of Ayush recommendations, based on Ayurvedic literature and scientific publications, for preventive health measures and boosting immunity with special reference to respiratory health.

**Measures for Enhancing Immunity**

- Drink warm water throughout the day.
- Daily practice of Yogasana, Pranayama and Meditation for at least 30 minutes.
- Spices like Haldi (Turmeric), Jeera (Cumin), Dhaniya (Coriander) and Lahsun (Garlic) recommended in cooking.

**Simple Ayurvedic Procedures**

- **Nasal Application**– Apply Sesame Oil/Coconut oil or Ghee in both the nostrils (Pratimarsh Nasya) in morning and evening.
- **Oil Pulling Therapy**– Take 1 table spoon Sesame or Coconut Oil in mouth. Do not drink, swish in the mouth for 2 to 3 minutes and spit it off followed by warm water rinse. This can be done once or twice a day.

**Ayurvedic Immunity Enhancing Tips**

- Take Chyawanprash 10gm (1tsf) in the morning. Diabetics should take sugar free Chyawanprash.
- Drink Herbal Tea/Decoction (Kadha) made from Tulsi (Basil), Dalchini (Cinnamon), Kalimirsch (Black Pepper), Shunthi (Dry Ginger) and Munakka (Paisiri) - once or twice a day. Add jaggery (Natural Sugar) and/or fresh Lemon Juice to your taste, if needed.
- Golden Milk- half tea spoon Haldi (Turmeric) powder in 150 ml Hot Milk - once or twice a day.

**Immunity Boosting Measures for Self-Care**

**Actions During Dry Cough/Sore Throat**

- Steam inhalation with fresh Pudina (Mint) leaves or Ajwain (Caraway Seeds) can be practiced once in a day.
- Lavang (Clove) powder mixed with Natural Sugar/Honey can be taken 2-3 times a day in case of cough or throat irritation.
- These measures generally treat normal dry cough and sore throat. However, it is best to consult doctors if these symptoms persist.

Indian Council of Medical Research (ICMR). These vaccines being available in record time, nine months from the declaration of the pandemic, is a testimony to the capacity of the Indian vaccine industry to respond rapidly, underlying India's reputation as a global player in vaccine development and manufacturing. This was reinforced with the third vaccine from India- the SARS-CoV-2 DNA vaccine candidate (ZyCoV-D), from Zydus Cadila being granted Emergency Use Authorization in

Preventive measures such as the mask advisory 'Face Covers for Curbing the Spread of SARS-CoV-2 Coronavirus: Manual on Homemade Protective Cover for Face and Mouth' issued on 30 March 2020, by the Government of India, were amongst the earliest in the world.

August 2021.




India also saw the emergence of smaller companies and startups developing Virus Like Particle (VLP) vaccine candidate and Mynvax/IISc Bangalore thermo-stable Receptor Binding Domain (RBD) of Spike protein of SARS-CoV-2 based vaccine candidate.

Today, about 50% of India has been vaccinated for the first dose, a total of 63.07 crore persons, 8.2% of the total world population, which is unparalleled and awe-inspiring, to say the least. The momentum of vaccination has picked up, crossing 1 crore (10 million) on 27 August 2021.

### Personnel Protection Equipment (PPE) and Ventilators

India also moved rapidly from an acute shortage of masks and PPEs to becoming an exporter of quality PPEs, much due to the efforts of the Defence Research and Development Organisation (DRDO), and the South India Textile Research Association (SITRA), Ministry of Textiles.

## Ayurvedic Immunity Promoting Measures

1.  Take Chyavanprash 10gm (1tsf) in the morning. Diabetics should take sugar free Chyavanprash.
2.  Drink herbal tea / decoction (Kadha) made from Tulsi (Basil), Dalchini (Cinnamon), Kalimirch (Black pepper), Shunthi (Dry Ginger) and Munakka (Raisin) - once or twice a day. Add jaggery (natural sugar) and / or fresh lemon juice to your taste, if needed.
3.  Golden Milk- Half tea spoon Haldi (turmeric) powder in 150 ml hot milk - once or twice a day.



“The Ventilator Project”—now a well-documented story of how a world-class ventilator was designed and built by a startup incubated at IIT Kanpur—is a validation of the coming of age of India’s startup ecosystem. Many other companies too have manufactured ventilators and other equipment. Notable is the role played by the AMTZ (the Andhra Pradesh Medtech Zone), Vishakhapatnam.

### Testing, Tracking, and Diagnostics

Testing, tracking, and diagnostics are the essential tools for Covid-19 management, containment, and availability of testing at will. The effective deployment of this strategy allows travel and livelihood to return to what is believed as normalcy. Scaling of testing requires both easy sample collection protocols and affordable test diagnostics. Diagnostic kit development saw various sectors, research institutions, validation, certification, and manufacturing industry working together for creating a milieu of these kits.

CSIR-IGIB (Council of Scientific and Industrial Research- Institute of Genomics and Integrative Biology), Delhi developed FELU-DA, FnCas9 Editor Linked Uniform Detection Assay and partnered with TATA Health to create the TATA MD CHECK, CRISPR Feluda Cas9 based integrated system for collection, testing, reporting, and tracing. The data is being managed in a centralised cloud from where it can directly be sent to ICMR database.

The single gene PCR diagnostic test developed by IIT Delhi has been approved and validated by ICMR. It is low cost, scalable, works with very basic models of the PCR machines, and is now available in the market as “Corosure”.

Dry Swab Collection-Direct RT-PCR Diagnostic protocol has been developed by CSIR’s Centre for Cellular and Molecular Biology (CCMB), Hyderabad. It has been approved and validated by ICMR and is being deployed for sero-surveillance.

### Therapeutics and Drugs

Four categories of drug development, namely, repurposing, new chemicals, phyto-pharmaceuticals, and drugs from traditional medicinal knowledge, those pioneered by the Ministry of Ayush, were prioritised. The Central Drugs Standard Control Organisation (CDSCO) approved five drugs in June 2020 to help treat patients with severe COVID-19; antivirals Remdesivir and Favipiravir; steroid dexamethasone; and immune-suppressant monoclonal antibodies-Tocilizumab and Itolizumab. Ayurvedic products were also made readily available.

Every country should prepare not only to tackle the present crisis, but for future crisis as well. India’s capacity in drug design needs support and long term investment, especially in view of the supply chain of Active Pharmaceutical Ingredients (APIs) being affected severely during lockdown, with a single node as the major procurement source. All drug candidates, including Ayurvedic ones, need robust clinical trials to provide scientific evidence for the efficacy that has been appreciated during the pandemic.

### Surveillance: Seroprevalence and Genome Sequencing

The VTF recognised the importance of serosurvey very early into the pandemic and recommended the drawing out of a national plan for serosurvey. Subsequently, serosurveys were conducted at Kolar, Karnataka, and Delhi region, providing evidence for the spread of the disease and possible solutions.

In September 2020, a phylogenetic cluster called the B.1.1.7 (now called the alpha variant) in the UK was detected, resulting in a large number of cases and the alarming second wave of the UK. This lineage quickly accumulated about 23 mutations across 5 genes, of which 17 are of relevance and are non-synonymous variants, and two are important variants, responsible for increased infectivity as well as increased

virulence. Increased transmission in the population can be prevented very early by surveillance on large scale. The UK had been sequencing the SARS-CoV-2 extensively and was able to detect the variant quickly. The need for a common platform for harmonised protocols for virus surveillance, genome sequencing, and characterisation was reiterated by the VTF, and following this, the Indian SARS-CoV-2 Genomic Consortium (INSACOG) was established. INSACOG conducts on a large-scale an epidemiological surveillance of circulating strains of SARS-CoV-2 in the country.

### Regulation and Regulatory Support

The most rapid response from the government was the Gazette Notification on 18 May, 2020, allowing the industry to stockpile vaccines after approval of Phase I of the clinical trials, as this was an enabling and trust-inducing notification by the government.

Fast track clearances were facilitated, with a recognition that regulatory processes needed an overhaul and evolution into a permanently efficient system. The onslaught of the pandemic also revealed the gaps in our preparedness. India was unprepared for participation in global trials due to a lack of identified clinical trial sites. Robust networks for clinical-trials research with harmonised CT protocols for

**Robust networks for clinical-trials research with harmonised CT protocols for both industry and academia are foundational to vaccine development. The pandemic saw underpowered clinical trials being carried out in India with few such trials aiming to look for definitive answers, these should be lessons learned and more pragmatic research cohorts designed in the future.**

both industry and academia are foundational to vaccine development. The pandemic saw underpowered clinical trials being carried out in India with few such trials aiming to look for definitive answers, these should be lessons learned and more pragmatic research cohorts designed in the future.

The VTF recommended that Government must support and partner with the industry in vaccine development Phase 3 clinical trials and set up testing and certification labs like Central Drugs Laboratory (CDL), Kasauli, in other parts of India. This has now been done.

It was also evident that to rapidly bring a product to market at a good scale, the procurement system needs to be favourable for indigenously developed products, as most Indian kits

have to deal with procurement specs which are largely inclined towards established standards.

Internationally easy-to-use tests are now emerging in the market, therefore, India should seize this opportunity, and apply for international certification and clearance for global markets.

There are many efforts not recounted here, suffice to say that while the pandemic saw desperately low times, it also saw Indian science and scientists rise to collaborate, and synergise with industry, and deliver on all accounts.

The success of Indian vaccine development during the Covid-19 pandemic will go down in history as a self-reliant India that came together with an unprecedented political will, governance, and partnership of academia and industry, to develop and deploy the vaccine, making it available to the Indian population in record time, with equity and equal access. The Indian science community has a lot to be proud of, viz vaccines, PPEs, ventilators, diagnostic kits, etc., however, much more needs to be accomplished. Our country has the attention of the governance and political leadership of the country, therefore, now is the time to show the world that Indian science has the potential to be a major participant in global science leadership. □

## Sales Outlets of Publications Division

New Delhi	Soochna Bhawan, CGO Complex, Lodhi Road	110003	011-24365609 011-24365610
Navi Mumbai	701, B Wing, 7th Floor, Kendriya Sadan, Belapur	400614	022-27570686
Kolkata	08, Esplanade East	700069	033-22486696
Chennai	'A' Wing, Rajaji Bhawan, Basant Nagar	600090	044-24917673
Thiruvananthapuram	Press Road, Near Government Press	695001	0471-2330650
Hyderabad	204, II Floor CGO Towers, Kavadiiguda, Secunderabad	500080	040-27535383
Bengaluru	I Floor, 'F' Wing, Kendriya Sadan, Koramangala	560034	080-25537244
Patna	Bihar State Co-operative Building, Ashoka Rajpath	800004	0612-2675823
Lucknow	Hall No 1, II Floor, Kendriya Bhawan, Sector-H, Aliganj	226024	0522-2325455
Ahmedabad	4-C, Neptune Tower, 4th Floor, Nehru Bridge Corner, Ashram Road	380009	079-26588669
Guwahati	Assam Khadi and Village Industries Board, Ground Floor, MRD Road, Chandmari	781003	0361-2668237

# India's Response to Covid-19

*Dr Alka Sharma  
Dr Jyoti Mallick Logani  
Dr Kamakshi Chaitri*

The Department of Biotechnology initiated an integrated response to mitigate the unprecedented Covid-19 pandemic. From the development of indigenous vaccines, novel point-of-care diagnostics, and therapeutic formulations based on traditional knowledge, to the establishment of research resources and offering services, DBT, Autonomous Institutions (AIs) of DBT, and Biotechnology Industry Research Assistance Council (BIRAC), have been working relentlessly over the past one year to develop effective interventions for combating the pandemic. DBT-BIRAC Research Consortium was launched and over 100 projects are being supported. More than 50 startup solutions have developed innovative products for Covid-19.

**'M**ission COVID Suraksha- The Indian Covid-19 Vaccine Development Mission' was launched under the Atmanirbhar Bharat 3.0 package, for the development of safe, efficacious, and affordable vaccines for Covid-19. Five vaccine candidates are in advanced development including DNA Vaccine (ZyCoV-D), mRNA vaccine candidate (HGCO-19), Adjuvanted-protein subunit based vaccine candidate (Corbevax) by Biological E, Intranasal vaccine candidate (BBV 154), and VLP vaccine candidate. ZyCoV-D, the world's first Covid-19 DNA vaccine, developed by Zydus Cadila, supported under the Mission, received Emergency Use Authorization (EUA) by the National Regulatory Authority (NRA) on 20 August 2021.

Nationally, five vaccine candidates have been accorded Emergency Use Authorization in India. There is also a promising pipeline of four vaccine candidates in various stages of clinical development. On the other hand, DBT is also supporting the development of nearly 15 vaccine candidates by industry and public sector laboratories at a cost of about Rs 100 Crores.

In order to cater to the national vaccine demands, the production capacity of Covaxin is being scaled through financial support to Bharat Biotech Industries Ltd (BBIL) and three other Public Sector Undertakings (PSUs), to achieve a capacity of nearly 100 million doses per month from the current 10 million doses per month. The PSUs

include Indian Immunologicals, Hyderabad, Haffkine Biopharmaceuticals, Mumbai, and Bharat Immunologicals and Biologicals (BIBCOL), Bulandshahar. Furthermore, technology transfer for Covaxin production from BBIL to Gujarat COVID Vaccine Consortium (GCVC), comprising of Hester Biosciences, OmniBRx Biotechnologies Pvt Ltd, and Gujarat Biotechnology Research Centre (GBRC), is being facilitated.

### **Strengthening Vaccine Development Ecosystem**

Efforts to strengthen the vaccine development ecosystem have been undertaken under focused Missions of the Department. Fifty-four clinical trial sites, across India, consisting of a network of public and private hospitals, clinics, and reputed academic institutions are facilitating vaccine clinical trials. Each site has access to a cohort of about 50000 to 100000 healthy volunteers, who can be tracked for prolonged periods. These sites are equipped with harmonised systems for GCP compliance, electronic data capture on a central platform, robust disease registry for capturing patient data on clinical presentation, treatment, and outcome.

Under Mission COVID Suraksha, immunogenicity assay labs are being supported at IRSHA Pune; Syngene International Ltd, Bengaluru; THSTI, New Delhi. The immunoassay laboratory of THSTI has also been recognised globally by Coalition for Epidemic Preparedness Innovations (CEPI) as one of the seven laboratories, for

Dr Alka Sharma is Scientist 'H', Dr Jyoti Mallick Logani is Scientist 'F', and Dr Kamakshi Chaitri, Scientist 'C', Department of Biotechnology, Ministry of Science & Technology, GoI. Email: alka.dbt@nic.in. Twitter: @DBTIndia



centralised assessment of Covid-19 vaccines. Efforts are also underway at THSTI, for the development of validated immunoassays utilising the emerging variant strains of SARS-CoV-2.

Viral neutralisation tests by THSTI have been delivered to Zydus Cadila, Biological E, Intas Pharmaceuticals, Premas Biotech, Mynvax, and Virchow Biotech. The immunoassay lab at IRSHA Pune is providing immunogenicity assay testing for their RNA Vaccine candidates by Gennova Biopharmaceuticals.

Facilities for animal challenge studies and immunoassay laboratories are being supported to accelerate pre-clinical and clinical development of the vaccine candidates. Institute of Life Sciences (ILS), Bhubaneswar; in Stem, Bengaluru; and Indian Institute of Science (IISc), Bengaluru, are being supported under the Mission for generating animal models for SARS-CoV-2. K-18 hACE2 transgenic mice breeder pairs are available for redistribution at inStem.

Additionally, the animal challenge facility at DBT-THSTI is offering Hamster Challenge services to vaccine manufacturers, whereby Hamster Infection model based Vaccine and Antiviral Testing services were offered to Zydus Cadila, Mynvax, Biological E, Themis Medicare, and VINS Bioproducts Ltd.

### **Upgradation of DBT's Laboratories as Central Drug Laboratories (CDLs)**

Considering the need for enhanced batch testing of vaccines, two DBT Autonomous Institutes - National Institute of Animal Biotechnology (NIAB), Hyderabad and National Centre for Cell Science (NCCS), Pune, have been identified for upgradation as Central Drug Laboratories (CDLs), for vaccine testing on 28 June 2021,

---

**Efforts to strengthen the vaccine development ecosystem have been undertaken under focused Missions of the Department. Fifty-four clinical trial sites, across India, consisting of a network of public and private hospitals, clinics, and reputed academic institutions are facilitating vaccine clinical trials.**

---

those countries.

Two series of training programmes encompassing 'Good Clinical Practice; Ethical considerations in clinical research; Good Clinical Laboratory Practice; Novel vaccine development and immunisation policy in a pandemic', were held.

### **COVID Diagnostics and Testing**

DBT has identified 21 city/regional clusters to scale up Covid testing as a part of the Hub and Spoke model. Nine DBT AIs are approved as hubs for Covid-19 testing. More than 54 lakh samples were tested to date across the hubs.

The first infectious disease mobile laboratory (I-Lab) was developed and deployed for Covid testing in inaccessible areas. More than 22,500 samples were tested in I-lab. DBT supported 'AMTZ COMManD (COVID-19 MedTech Manufacturing Development) Consortium', an indigenous manufacturing facility set up at the Andhra MedTech Zone (AMTZ) has achieved a production capacity of around 10 lakh RT-PCR Covid-19 diagnostic tests/day and about 1 lakh VTMs/day. AMTZ has so far manufactured 575 lakh tests of RT-PCR, 3.5 lakh Covid-ELISA tests, 11 lakh Viral Transport Media kits, 3000 IR thermometers, 2000 Pulse oximeters, and 4950 ventilators.

More than 300 Indian manufacturers are registered under the National Biomedical Resource Indigenisation Consortium, constituted by DBT, for the manufacturing of nearly 15 major molecular biology components/ reagents. Both AMTZ COMManD Consortium and NBRIC are examples of Atmanirbharta.

### **COVID Genomics**

Pan-India, 1000 SARS-CoV-2 RNA genome sequencing consortium has successfully completed the initial goal of sequencing of 1000 SARS-CoV-2 genomes in a record time of few months. Subsequently, to monitor



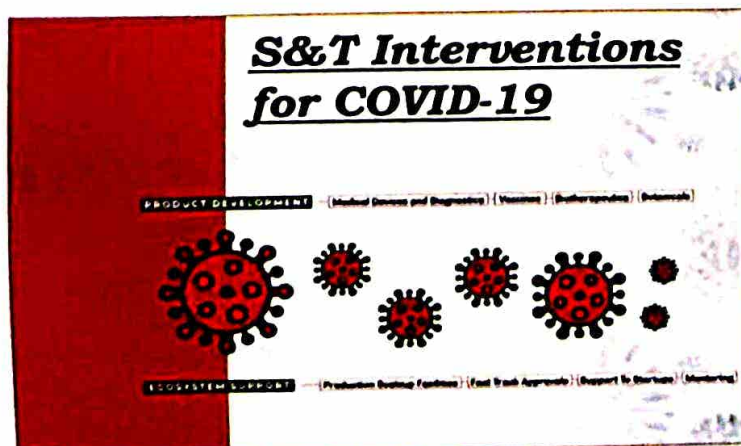
the emergence and community circulation of viral variants and variants of concern (VOC), the Indian SARS-CoV-2 Genomics Consortium (INSACOG) consisting of 28 Regional Genome Sequencing Laboratories (RGSs) was established with an aim to sequence SARS-CoV-2 from Covid-19 infections occurring in India. As of 30 August 2021, INSACOG partner institutions have sequenced 70,20 samples and the line list with Pangolin lineage information for 51651 sequences have been submitted to NCDC. To date, 46,404 viral genome sequences from India have been shared in the global repository of sequences called GISAID. Of these 46,404 viral genome sequences, 35,014 are shared with INSACOG Tag in GISAID.

INSACOG activities have been expanded to cover the various aspects for sentinel surveillance, targeted sampling (Surge, Vaccine-breakthrough, etc.), Hospital network samples sequencing for clinical correlation, and environmental surveillance (sewage samples, etc.)

### Therapeutics and Biorepositories

DBT-BIRAC supported anti-viral drug – Virafin (pegylated interferon alpha-2b) – developed by Zydus Cadila, has recently been accorded restricted emergency use approval, for treatment of moderate Covid-19.

Phase II clinical trials of AQCH, the first phytopharmaceutical drug approved for clinical trial by DCGI for Covid-19, developed by DBT-ICGEB and Sun Pharma are underway. Therapeutics from natural products in partnership with M/o AYUSH and monoclonal antibody-based therapeutics, are also being developed. DBT-BIRAC supported Eystem Research Pvt. Ltd has developed human iPSC-derived lung airway and alveolar epithelial cells for disease modelling and for testing potential therapeutics against Covid-19.



**The Partnerships for Advancing Clinical Trials (PACT) programme, a science diplomacy initiative of the Department of Biotechnology, in close partnership with the Ministry of External Affairs is aimed at advancing vaccine development activities in neighbouring countries and conducting training programmes to strengthen clinical trial capacity in those countries.**

Five Covid-19 biorepositories have been set up and so far more than 40,000 samples have been archived for use by biomedical researchers. Guidelines for sample sharing have been notified; the biorepositories have enabled validation of diagnostic kits, and the assessment of vaccine efficacy and immunogenicity.

### Regulatory Facilitation

The Department has proactively taken several steps to support researchers and industries involved in research on Covid-19 and issued Biosafety Regulations for Covid-19, in close coordination with CDSCO, for facilitating expedited clearances.

The following Biosafety Regulations for Covid-19 have been issued by the Review Committee on Genetic Manipulation (RCGM) and Drugs Controller General of India (DCGI):

1. Rapid Response Regulatory Framework to provide expedited regulatory approvals for all diagnostics drugs and vaccines.
2. Regulations and Guidelines for recombinant DNA Research & Biocontainment-Interim Guidelines of laboratory biosafety to handle Covid-19 specimens for R&D purpose.
3. A Rapid Response Regulatory Framework for Covid-19 vaccine development. The Department of Biotechnology has also worked with the NITI Aayog to provide guidelines for sharing of Bio-specimen and data for research on Covid-19.

### DBT-BIRAC Support to Startups

The DBT Public Sector BIRAC, over the last 9 years, has built a very strong and vibrant Biotech Innovation and Startup ecosystem consisting of over 4500 startups, 60 Bio incubators, and very well-established Academia industry partnerships. 50 BioNEST incubators spread across the country have nurtured 100+ Startup solutions for Covid-19. More than 300+ virtual events have been conducted since March 2020 by BioNEST incubators, and around 25,000 participants have been benefitted on the issues of business mentoring, fundraising, industry connect, legal advice, and how to sustain in the Covid and post-Covid times. Further, five indigenously developed solutions for Covid-19 by DBT-BIRAC supported startups, have been launched. A number of other solutions are being deployed ranging from a Remote Patient Monitoring ICU Bed device to a Vaccine Carrier device for delivery of Vaccines to remote areas as a part of the cold chain logistics. □

# The Vaccine Quest

*Gagandeep Kang*

**The year 2020 was revolutionary for vaccine science. Never before in the 222 years of the history of vaccines, have they been developed against an infectious agent so fast or on so many platforms. With the convergence of biomedical, engineering, and computing sciences, we have the opportunity to discover and design new antigens for vaccines. Planning for the future emergence of viruses can be done through analysis of genetic sequences of coronaviruses infecting animals and humans, and modelling the evolutionary emergence of new strains.**

**T**he first Adenovirus-vectored vaccine for Ebola was approved by regulatory only in the past years, and there are already three approved Adenovirus-vectored vaccines for SARS-CoV-2. The mRNA vaccines employed a technology for the development of science for over a decade, and have demonstrated powerful immune responses and excellent protection. The technology of inserting spike protein in moth cells used by Novavax allows high volume production of a protein vaccine that has demonstrated protection equivalent to mRNA vaccines in clinical trials. In India, data from the world's first DNA vaccine has recently become available.

Vaccines are our way out of the pandemic, but their success is still under threat because of the potential for the emergence of variants that could escape the immune response generated by the vaccines that are based on viruses, or viral protein derived from older or ancestral versions of SARS-CoV-2. In addition to working on designing new vaccines based on variants that we know (for example, Pfizer-BioNTech and Moderna have both already designed and tested vaccines based on the beta variant), some scientists have begun to develop a universal coronavirus vaccine, which will be able to protect not only against SARS-CoV-2 and its variants but also against other dangerous coronaviruses that may emerge in the future. It is important to remember that SARS, MERS, and SARS-CoV-2 have all emerged in the past 20 years, so the potential threat of new coronaviruses crossing over from animals to humans is very probable.

Coronaviruses belong to four families or genera namely, alpha, beta, gamma, and delta. SARS-CoV-2 is a Betacoronavirus, and in fact, all seven coronaviruses that infect humans belong to either the alpha or the beta genera. The genetic diversity among coronaviruses is large, so a vaccine that protects against all viruses in all families is considered extremely difficult. There is an ongoing research focusing on betacoronaviruses and more specifically, sarbecoviruses, a subgroup that contains SARS-Cov-1 and SARS-CoV-2, which are closer to each other, and then thinking about broadening to include other dangerous coronaviruses like MERS, and further considering all coronaviruses that infect humans.

There have been advances in science and technology that enable this stepwise approach. With the convergence of biomedical, engineering, and computing sciences, we have the opportunity to discover and design new antigens for vaccines. With high performance supercomputing, machine learning, and structural modelling of proteins, we



The author is a Professor, The Wellcome Trust Research Laboratory Division of Gastrointestinal Sciences, Christian Medical College, Vellore. Email: [gkang@cmcvellore.ac.in](mailto:gkang@cmcvellore.ac.in)

can now rapidly identify shared antigenic targets across multiple coronaviruses. Planning for the future emergence of viruses can be done through analysis of genetic sequences of coronaviruses infecting animals and humans, and modelling the evolutionary emergence of new strains. Predictions may not be perfect but they allow for a range of new viruses, for which preparedness is needed. A number of approaches have already begun to investigate the possibility of protection by vaccination that goes beyond SARS-CoV-2.

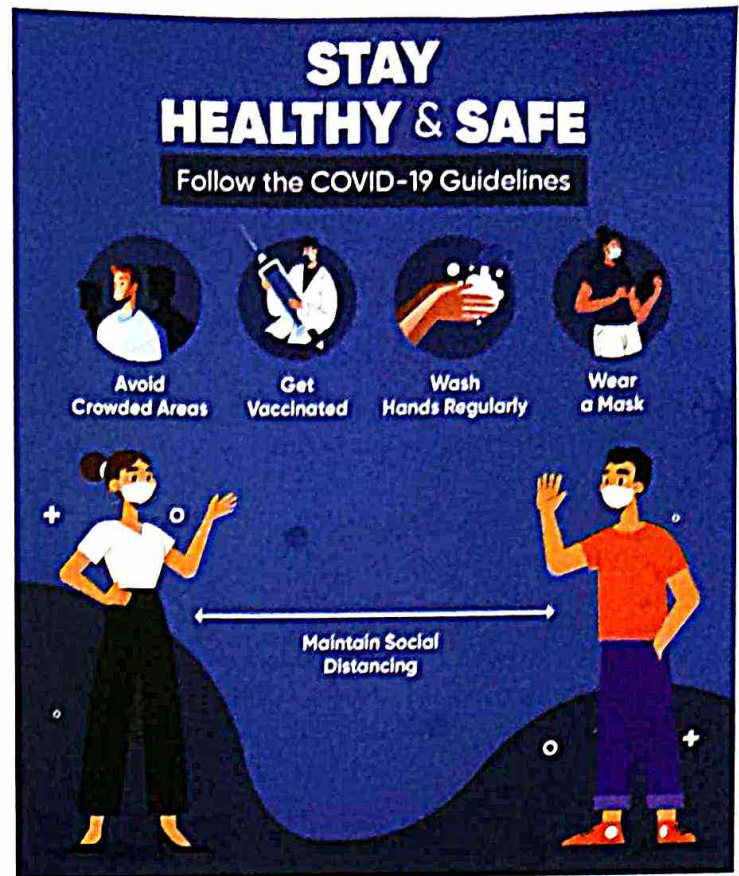
The Walter Reed Institute in the US has already made a vaccine that generated immune responses against both SARS-CoV-1 and SARS-CoV-2 in animal studies, and protected against challenges with SARS-CoV-2. This spike ferritin nanoparticle vaccine has now gone into human studies, but this and other recent studies are focused on trying to measure cross-reactive immune recognition, or the immune responses against different viruses, to figure out how far it is to protect against multiple viruses with a single vaccine.

Another nanoparticle-based approach used multiple copies of the receptor-binding domain of the spike protein which binds to the human receptor, and found that immune responses that were generated by cross-reacting against SARS-CoV-1, SARS-CoV-2, and sarbecoviruses found in bats. These and the other approaches are likely to be taken forward rapidly, but all have a similar goal, to induce the broadest and longest-lasting immune response, and for this the response has to be determined in a better way.

A broad immune response against a wide array of viruses can happen in two ways. The first is the antibody response, where the antibodies that can recognise many kinds of proteins are produced and can block the entry of viruses into human host cells. The second is the cellular response where T-cells may limit infection by destroying infected cells. Antibodies are generally quite specific so inducing a wider antibody response requires having many antigens in the vaccine. T-cells recognise parts of the virus that are broken down within the cell.

An interesting finding that induction of broadly neutralising antibodies could block many kinds of viruses, was a very significant for HIV researchers who had been looking at developing HIV vaccines. These broadly neutralising antibodies are produced by a small number of infected people, but reverse-engineering the antigen that can consistently induce antibodies with broad specificities can and has been done for HIV, and has been started for SARS-CoV-2. Researchers have identified that reactive antibodies

**There is an ongoing research focusing on betacoronaviruses and more specifically, sarbecoviruses, a subgroup that contains SARS-CoV-1 and SARS-CoV-2, which are closer to each other, and then thinking about broadening to include other dangerous coronaviruses like MERS, and then further considering all coronaviruses that infect humans.**



target the subunit 2 part of the spike protein. Further work will be required to characterise both the parts of the virus that induce this response, as well as approaches to ensure that these antibodies will neutralise many kinds of coronaviruses.

T-cell-based approaches are likely to be essentially made for the wide specificity of vaccines. Researchers are using mRNA approaches to present different parts of the spike protein since there is already evidence that the spike-based mRNA vaccines induce a T-cell response. Another approach is looking at combining the spike protein with other viral proteins, such as the nucleocapsid, which is less variable than the spike protein in order to induce broad T-cell responses. In other efforts, nanoparticles studded with either the receptor-binding domain or the spike proteins from different coronaviruses have been produced to induce a wide range of specific antibody responses. These mosaic vaccines will need to be evaluated in animal models before they can be moved to human testing. The testing will be complicated because the animals will need to be challenged with a range of viruses to assess protection, and these studies are difficult when protection with even one virus is being evaluated.

The parallel efforts reflect both the urgent need and huge advances in vaccine science. A key lesson from the

pandemic has been that multiple approaches are necessary. Creating a universal (or even a more broadly protective) vaccine is not going to be easy. Influenza is a disease where the diversity of viruses have challenged vaccines and vaccinology, yet decades of efforts have not yet resulted in an efficacious vaccine. The success of mRNA technology for SARS-CoV-2 has re-invigorated the field, and more efforts are being initiated to develop universal influenza vaccines applicable to all that has been learned with SARS-CoV-2.

• However, chances of success are likely to be higher with SARS-CoV-2 because of the lower variability of the infection. While both influenza and coronaviruses mutate, the mutation rate in SARS-CoV-2 is slower because coronaviruses have a proof-reading enzyme that cleans up any errors when the virus replicates.

In addition to looking at whether the vaccines will protect against disease, there continues to be a need to understand and test whether the new vaccines are safe. A phenomenon known as antibody-dependent enhancement of disease has been recorded for other viral infections, where a poor response to vaccination actually put vaccinated people at risk of severe disease. While this has not yet shown up as a concern with existing SARS-CoV-2 vaccines, it is possible that this may still occur later after vaccination-induced antibodies wane or be a new issue for universal coronavirus vaccines.

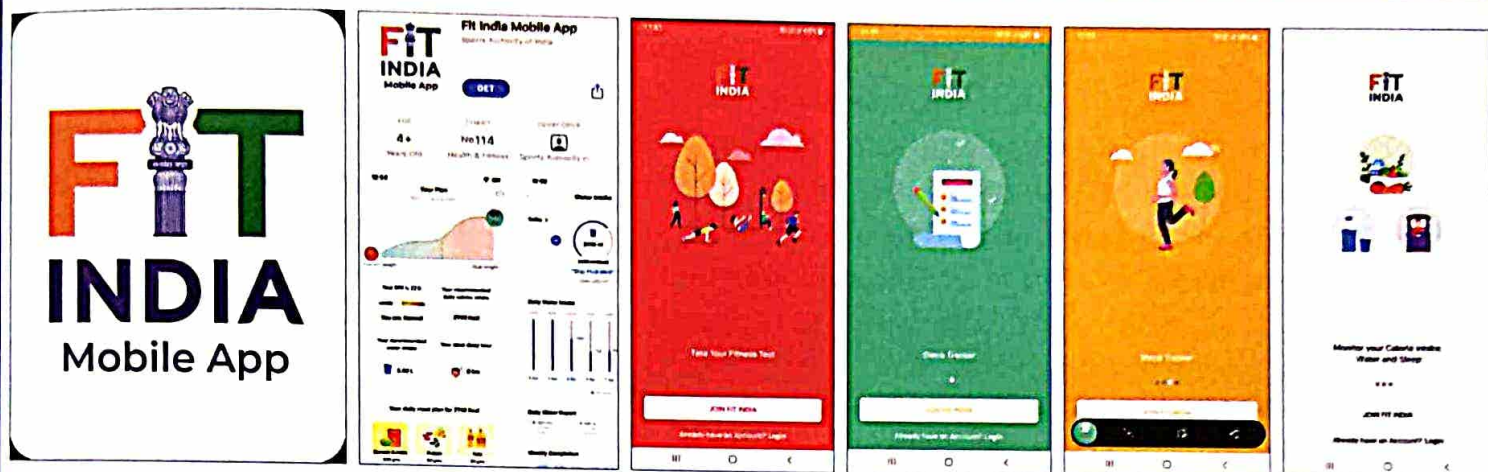
---

We need more research and we need it now if we are to have vaccines for future pandemics and epidemics. We know that emergence of viral infections and their introduction into human populations is more a question of when and where the next outbreak will occur, rather than a remote possibility. Much effort is happening globally for surveillance and for vaccine development and much research is happening in India, but we have not begun any ambitious programmes for vaccine research that link together multiple researchers with different areas of expertise and industry and government in order to enable the vaccine science. Preparedness for the future requires investment in infrastructure, people, and resources and cannot be built overnight. India has outstanding science institutions with capable scientists, but particularly in biology, most research focuses on the understanding of processes and mechanisms rather than on the development of technology for interventions. There is also limited linkage to academic medical centres which are essential for the evaluation of vaccines. The strategy and networking that is necessary for future vaccine science need to be formally established.

Vaccines are a priority for global health and we have seen their value in the current pandemic. In India, we need to be able to move faster for the next time so that we have vaccines quickly and can scale them up rapidly. This will not happen without investment, so we should begin planning and implementation now, or it may be too late. □

# The Fit India Mobile App

Through this App, citizens can assess their fitness parameters through a series of simple tests and further get ways for the improvement of fitness on regular basis. Additionally, Fit India Mobile App is having features like setting daily activity and fitness goals, activity tracker, water intake, calorie intake and sleep tracker, etc.



**T**he Fit India Movement was launched in 2019 with the vision of making India a fit and healthy nation. The key message is that fitness is easy, fun and free, and can be practised anywhere. One year later, on the occasion of the first Anniversary of Fit India movement, the Prime Minister launched ‘The age-appropriate fitness protocols for three age groups (1) 5-18 years (2) 18-65 years, and (3) 65+ years’ developed by an expert committee and endorsed by World Health Organization (WHO). Now, the Fit India App is launched for this purpose. It is free and available in English and Hindi on both the Android and the iOS platforms and has been developed keeping in mind that it works even on basic smartphones.

The unique features of the Fit India App are to empower each individual to check his/her fitness score based on a set of age specific fitness tests, and get specific recommendations on how to improve their fitness level through physical activities including yoga protocols. Animated videos have been provided to make individuals understand about the procedure for conducting the fitness tests themselves. These features are based on the age-appropriate fitness protocols.

The “Fitness Protocol” feature allows the user from different age groups to do various exercises which help

them in being able to keep up with basic fitness levels. The protocol covers exercises that are universally followed and duly ratified by health experts.

Everyone has a different food, activity and hydration need based on their age, gender, current lifestyle and body composition. The “My Plan” feature of Fit India Mobile App lets users define their current lifestyle–time spent on physical activity, water intake, sleep hours, current weight and targeted weight- to get a customised food plan, lifestyle changes for them to achieve his/her goals. The Fit India App recommends Indian food plan, number of glasses of water, and number of hours of sleep.

The “Activity Tracker” feature of the application helps users keep track of their daily-activity levels. The real-time Step Tracker helps individuals track their daily steps and encourages them to set higher goals for themselves. They can set hourly reminders and track their progress of fitness scores and daily activity over a period of time, share their fitness and activity data with others to motivate more people to take up fitness and lifestyle changes.

The App also provides opportunities for individuals, schools, groups, and organisations to participate in various Fit India Events, Certification Programs, etc. People can share their fitness success stories using this platform. □

**Download**

For Android - <https://play.google.com/store/apps/details?id=com.sai.fitIndia>  
 For iOS - <https://apps.apple.com/us/app/fit-india-mobile-app/id1581063890>

# Redefining Science Communication

*Dr Nakul Parashar*

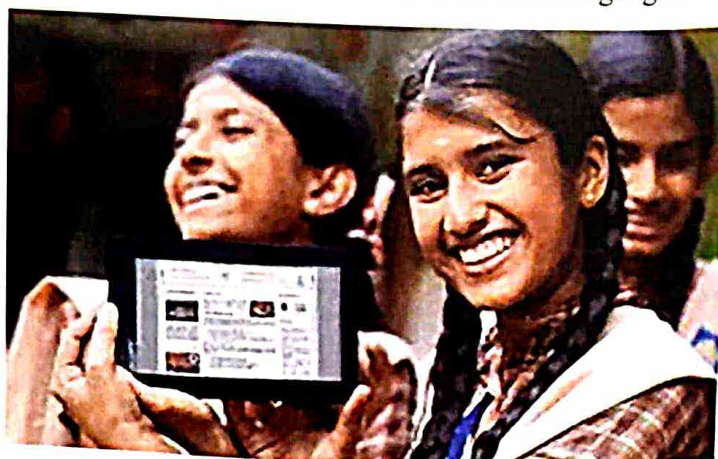
**India's science popularisation agenda is achieved through several two-way stakeholder-specific approaches. It serves as a robust knowledge-led tool to fulfill three mutually reinforcing public policy objectives. The first is to create and foster a well-informed citizenry. This is with special emphasis on developments in science and technology and the continual evolution of science and related knowledge systems. The second is about building capacities to communicate. This is through formal and non-formal teach and learn systems. The third objective is engagement that follows knowledge enrichment. This is a non-linear attribute of science communication; determined by the interplay of regulations, ease of access to alternatives, capacities to use them, and the milieu of equity and justice to exert rights.**

**C**ovid-19 has affected one and all directly or indirectly all over the world. Standard life patterns have been severely hit, and new normal is being talked about. Amidst all this, one crucial thing that has emerged is that the entire humanity has been looking anxiously towards the scientific community. They are waiting for the vaccines and booster vaccines to arrive that can effectively eradicate this virus. Getting information about the Covid-19 and its antidote has become the most critical talking point today. For the world, science & technology-related information was considered dry and drab for quite some time in the past. This event has brought back the necessity to keep ourselves duly abreast with the latest of how, why, what, and when of science & technology. For the scientists too, on the other hand, it has become equally important to keep the society timely aware of the developments they make in their fields of research. This is what we call Scientific Social Responsibility (SSR). Thus, this is critical for any society and country to move further. Its citizens need to be duly aware of the scientific & technological developments and possess the much-needed scientific temperament.

Adhering to the constitutional mandate of nurturing and inculcating a scientific temperament and promoting rational outlook, Vigyan Prasar (VP), with SCoPE (Science Communication, Popularisation, and Extension) as its mandate, has been active on every possible

communications' platform from print to electronic to digital to social media. This creative, cross-disciplinary, and effective platform enables dialogue and knowledge transfer. It has thus, helped put Indian science on the global science map. Vigyan Prasar started its operations in 1989. It has been since then serving the nation to meet its SCoPE needs.

The SCoPE has also found a reflection in the Science & Technology Innovation Policy 2020 draft, a landmark policy initiative by the Government of India. The draft emphasises science communication in Indian languages with local and hyper-local contexts for last-mile connectivity. Vigyan Prasar, for the past two years, has been popularising science in various Indian languages.



The author is Director, Vigyan Prasar. Email: [nakul.parashar@vigyanprasar.gov.in](mailto:nakul.parashar@vigyanprasar.gov.in), Twitter: [@VigyanPrasar](https://twitter.com/VigyanPrasar)



### Foray into Electronic Media

Vigyan Prasar, since its inception, has been utilising visual rhetoric, the most effective mode, to make scientific awareness and rational knowledge accessible to all. VP launched two critical initiatives on 15 January 2020: (i) DD-Science—a one-hour daily dedicated slot (5 pm to 6 pm) from Monday to Saturday on Doordarshan National channel; and (ii) India Science – an Internet-based 24×7 science TV channel. Leveraging on the far-reaching effect of social media, Vigyan Prasar’s programmes can be accessed through multiple platforms. It has been producing and telecasting this weekly programme to highlight the exemplary work of Indian scientists, institutions, and laboratories.

### Popularising Science in Indian Languages

Vigyan Bhasha is VP’s systematic approach to expanding science communication through Indian languages. The programme includes monthly newsletters, popular science books, translations, social media initiatives, films, state-level meets of science communicators, and training workshops and exhibitions. Bigyan Katha in Bangla (2020), Tajassus in Urdu (2019), Ariviyal Palagai in Tamil (2019), Kutuhali in Kannada (2019), and Sandhan in Assamese, Vigyanavani in Telegu (2021), and Vigyan Ratnakar in Maithili (2021), monthly newsletters and publications are helping the message of science reach the community and benefit society at large.

### Science in Print and Publishing

VP brings out publications in English and Hindi, as well as in other Indian languages. Its 300-strong title list of books, run the gamut of themes and issues, renowned science authors,

communicators, and illustrators strengthen and expand their reach. Dream 2047 is VP’s bilingual flagship monthly magazine, which has been in circulation since 1998. It publishes popular science articles, features, and S&T news by eminent science writers and contributors engaged in writing and popularising science.

### Facilitating the News World

The news services, Indian Science News and Feature Service, and India Science Wire (ISW), highlight the success and progress in science and technology in India through its daily news distribution to about 500 media outlets. Facilitating scientists to write popular science stories and articles that the masses can easily understand and in turn, can get consumed by the media is the need of the hour. Vigyan Prasar has been continuously organising training workshops for scientists, and masterclasses for short film making at all possible levels so that print-electronic and social media can use it easily and help spread the word of science & technology in the country.

### Science Film Festivals

Films have been one of the most important tools of science communication, which is being explored and promoted by Vigyan Prasar for the past two decades. Various events, outreach activities, workshops, and film festivals are organised to highlight the importance of film-making for science communication and to enhance the capacities of both professionals and amateurs.

VP’s flagship events – International Science VP Film Festival of India (ISFFI) and National Science Film Festival of India (NSFFI) – attract talented young filmmakers and science enthusiasts. Eminent filmmakers including

---

**Adhering to the constitutional mandate of nurturing and inculcating a scientific temperament and promoting rational outlook, Vigyan Prasar with SCoPE (Science Communication, Popularisation, and Extension) as its mandate, has been active on every possible communications’ platform.**

---





# VIPNET

(Vigyan Prasar NETwork of Science Clubs)



Shyam Benegal, Amol Palekar, Amitabh Bachchan, Shekhar Kapur, and many more have been associated as mentors or jury chairs with ISFFI and NSFFI.

## SCoPE through Radio

Since 2008, promoting science and technology through the radio has been one of the flagship programmes of Vigyan Prasar. Ever since 2018, it has produced programmes in 19 languages and broadcast from more than 117 stations of All India Radio (AIR). Vigyan Prasar has also utilised the reach and power of community radio.

## SCoPE through Network Clubs

One of VP's niche activities is inculcating science communication/popularisation through a network of science clubs (VIPNET) in schools. The club provides skill up-gradation training, awareness camps, and hands-on science workshops throughout the country. Various state education departments, tribal departments, and chains of schools are now partners in this initiative. A monthly newsletter named 'VIPNET Curiosity' keeps the club members updated.

## SCoPE in Research

The project Augmenting Writing Skills for Articulating Research (AWSAR), encourages PhD and post-doctoral scholars in science and technology streams to write popular science articles during their scholarship/fellowship programme, which are later published as a book.

## SCoPE for Students

Vigyan Prasar is a partner in India's most extensive talent search examination, VVM (Vidyarthi Vigyan Manthan) for the New India initiative using only digital devices initiated



by Vijnana Bharati (VIBHA). VVM is focused on school-going children from class VI to XI across the country. National Council of Educational Research and Training (NCERT) of the Ministry of Education, is also part of this initiative. The primary objective of the programme is to educate the students about India's legacy of Science & technology.

## Engage with Science

Engage with Science is an interactive platform aimed at school teachers and students to make science teaching and learning a lot of fun by deploying gamification tools and an incentive-driven competitive process.

## Amateur Radio Stations

Vigyan Prasar provides technical support and fulfills the informational needs of students and amateurs engaged in communication using amateur or ham radio. As the ham radio systems are resilient and can be used sustainably even in adverse circumstances, Vigyan Prasar's ham radio station assists other ham radio stations operating from the disaster-affected areas. For example, during the Uttarakhand disaster, the VIGYAN PRASAR ham radio station had provided significant support to the region.

Vigyan Prasar is engaged in the popularisation of astronomy at the national level through various means.

It has been organising various programmes through EDUSAT for maths popularisation, workshops, Ramanujan Yatra 2020, and Pi Day every year. Since 2013, VP has been focused on communicating science in the tribal areas of the country. Trainings, workshops, activity camps, and awareness programmes are being organised using film and radio as the medium of communication and other outreach activities. □

---

**Engage with Science is an interactive platform aimed at school teachers and students to make science teaching and learning a lot of fun by deploying gamification tools and an incentive-driven competitive process.**

---

# Energy Security: Nuclear Power

*M Balarama Murthy*

**Energy is the engine for economic growth and when the country moves ahead on the path of development, it is necessary to utilise every energy resource available in the country. Energy is vital for human development and its demand is rising parallel the human population, urbanisation, and modernisation. Currently, the world is still dependent on fossil fuels to supply a huge amount of consumed energy across the world. Economies are dependent on energy, which is why energy security is such an important issue.**

**E**nergy security means consistent availability of sufficient energy in various forms at affordable prices. These conditions must prevail over a longer period of time if energy is to contribute to sustainable development. India is one of the world's largest energy consumers and currently relies on importing fuels to a significant extent. The major fuel in India's energy mix is coal 55%, a major portion of which is produced domestically. Nuclear energy makes up about 3%, and renewable energy sources about 20%. There is a huge gap between energy demand and energy supply in India, due to its rapidly growing economy. Nevertheless, India plans to maintain economic growth of 8% annually, which implies that electricity demand will grow proportionately. Therefore, more and more reliable power supplies are required, since nearly one-third of India's population is still not connected to any of the country's five electricity grids.

Energy shortages in India will continue during the upcoming years. Even then, India as an emerging country will have to find a middle ground between economic development and environmental sustainability, which requires it to change its energy mix. Instead of the currently dominating coal, cleaner and sustainable sources of energy should play a major role. Nuclear energy is considered by many as being the only source of energy suitable to support continuous industrialisation and urbanisation. It currently provides only 3% of India's total electricity but is likely to gain importance and can reduce India's dependence on fossil fuels.

## **Nuclear Power in India**

India embarked on its commercial nuclear power production in 1969 with the commissioning of two boiling

water reactors (BWR) of 210 MWe capacities each. Its nuclear power programme was conceived to be a closed fuel cycle, to be achieved in three sequential stages. These stages feed into each other in such a way that the spent fuel generated from one stage of the cycle is reprocessed and used in the next stage of the cycle to produce power. This kind of closed fuel cycle was designed to breed fuel and to minimise the generation of nuclear waste.

The three-stage nuclear power production programme in India had been conceived with the ultimate objective of utilising the country's vast reserves of thorium-232. It is important to note that India has the world's third-largest reserves of thorium. Thorium, however, cannot be used as a fuel in its natural state. It needs to be converted into its usable "fissile" form after a series of reactions. To aid this and to eventually produce nuclear power from its thorium reserves, Dr Homi J Bhabha, who is regarded as the father of the Indian nuclear power programme, envisioned the roadmap of the three-stage nuclear programme.

In the first stage (see Figure 1), Pressurised Heavy Water Reactors (PHWRs) will be used to produce energy from natural uranium. PHWRs do not just produce energy, they also produce fissile plutonium (Pu)-239. The second stage involves using the indigenous Fast Breeder Reactor technology fueled by Pu-239 to produce energy and more of Pu-239. By the end of the second stage of the cycle, the reactor would have produced more fissile material than it would have consumed, thus earning the name "Breeder." The final stage of the cycle would involve the use of Pu-239 recovered from the second stage, in combination with thorium-232, to produce energy and U-233 — another fissile material — using Thermal Breeders. This production

The author is the Station Director at Madras Atomic Power Station, Kalpakkam. Email: [sdmaps@npcil.co.in](mailto:sdmaps@npcil.co.in)

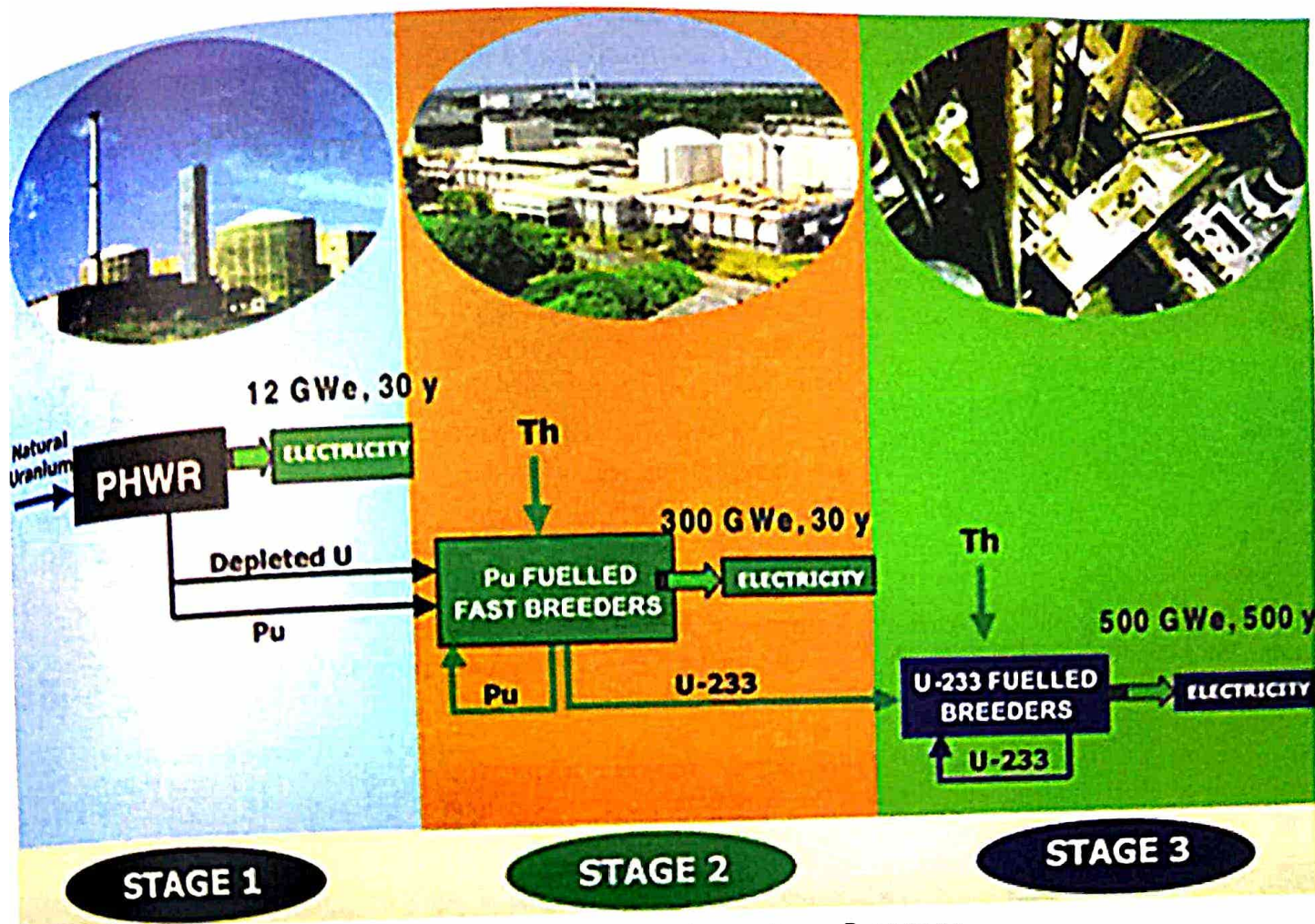


Figure 1: Indigenous three-stage Nuclear Power Programme

of U-233 from thorium-232 would complete the cycle. U-233 would then be used as fuel for the remaining part of the fuel cycle.

India is planning to significantly increase the present share of electricity derived from nuclear power from the present level of 3 per cent in the next two to three decades. Significant investments will also be required to secure fuel for the existing nuclear reactors, almost all of which are based on the Pressurised Heavy Water Reactor (PHWR) technology. Over the last two decades, India has gained expertise in fast reactors and the thorium fuel cycle and strives to become a world leader in nuclear power technology.

#### Nuclear Reactors in India

Nuclear Power Corporation of India Limited (NPCIL) is the public sector enterprise, under the Department of Atomic Energy (DAE), entrusted with the task of nuclear power generation in the country. Currently, there are 22 operational nuclear reactors in India with a total installed capacity of 6780 MWe. While the country's first two reactors at Tarapur, Maharashtra belong to the imported

BWR technology, India embarked on building PHWR plants with the setting up of the first two 220 MWe capacity reactors at Rajasthan Atomic Power Station (RAPS) at Rawatbhata in collaboration with Canada.

The next two PHWRs of 220 MWe capacity, each at Madras Atomic Power Station (MAPS) at Kalpakkam, Tamil Nadu marked the first completely indigenous nuclear power plant by the Department of Atomic Energy, and these reactors were commissioned during 1983-85. It is a significant milestone in the history of the Indian nuclear

programme and was a proud moment for Indian scientists and engineers. DAE/NPCIL further made substantial changes in the reactor designs and standardised 220 MWe PHWR units were built subsequently at Narora in UP (NAPS-1&2), Kakrapar in Gujarat (KAPS-1&2), Kaiga in Karnataka (KGS-1 to 4), and Rawatbhata in Rajasthan (RAPS-3 to 6).

By the 1990s, Indian nuclear scientists and engineers were ready to scale up from 220 MWe. Accordingly, two reactors of 540 MWe were commissioned at Tarapur in 2005 and 2006.

---

India is planning to significantly increase the present share of electricity derived from nuclear power from the present level of 3 per cent in the next two to three decades. Significant investments will also be required to secure fuel for the existing nuclear reactors, almost all of which are based on the Pressurised Heavy Water Reactor (PHWR) technology.

---

In parallel, India pursued collaboration with Russia and built two 1000 MWe capacity Pressurised Water Reactors of Russian design at Kudankulam in Tamil Nadu which became operational in 2014.

There are presently 22 reactors with a total capacity of 6780 MW in operation as shown in Figure 2.

Based on the successful operation of the 220 MWe PHWRs, NPCIL decided to avail advantage from economies of scale and volume by upgrading to 700 MWe capacity reactors and standardising this design for 'fleet construction'.

Kakrapar Unit-3, the first reactor in the 700 MWe PHWR series, has been commissioned in July 2020 and is currently undergoing tests before it enters commercial operation. In addition, 10 nuclear power reactors with a total of 8000 MW capacity are under construction. This includes a 500 MWe Prototype Fast Breeder Reactor (PFBR) of the second stage of

Questions are often raised about why India should continue to invest in nuclear power when even after 50 years of its entry, it contributes only 2-3 per cent to national electricity generation.

Should the focus not be on modern, renewable sources like solar and wind energy, which in the past five years have taken the share of renewables to more than 20%? What is the rationale for retaining nuclear power in India's energy mix?

the nuclear power programme and the plant is being constructed by Bharatiya Nabhikiya Vidyut Nigam Limited (BHAVINI). Additionally, the Government has accorded administrative approval and financial sanction of 10 indigenous PHWRs of 700 MW capacity each, to be set up in fleet mode.

On progressive completion of the projects under construction and accorded sanction, India's nuclear power capacity is expected to reach 22480 MW by the year 2031. More nuclear power plants are also planned for the future.

### Relevance of Nuclear Power

Questions are often raised about why India should continue to invest in nuclear power when even after 50 years of its entry, it contributes only 2-3 per cent to national electricity generation. Should the focus not be on modern, renewable sources like solar and wind energy, which in the past five years have taken the share of renewables to

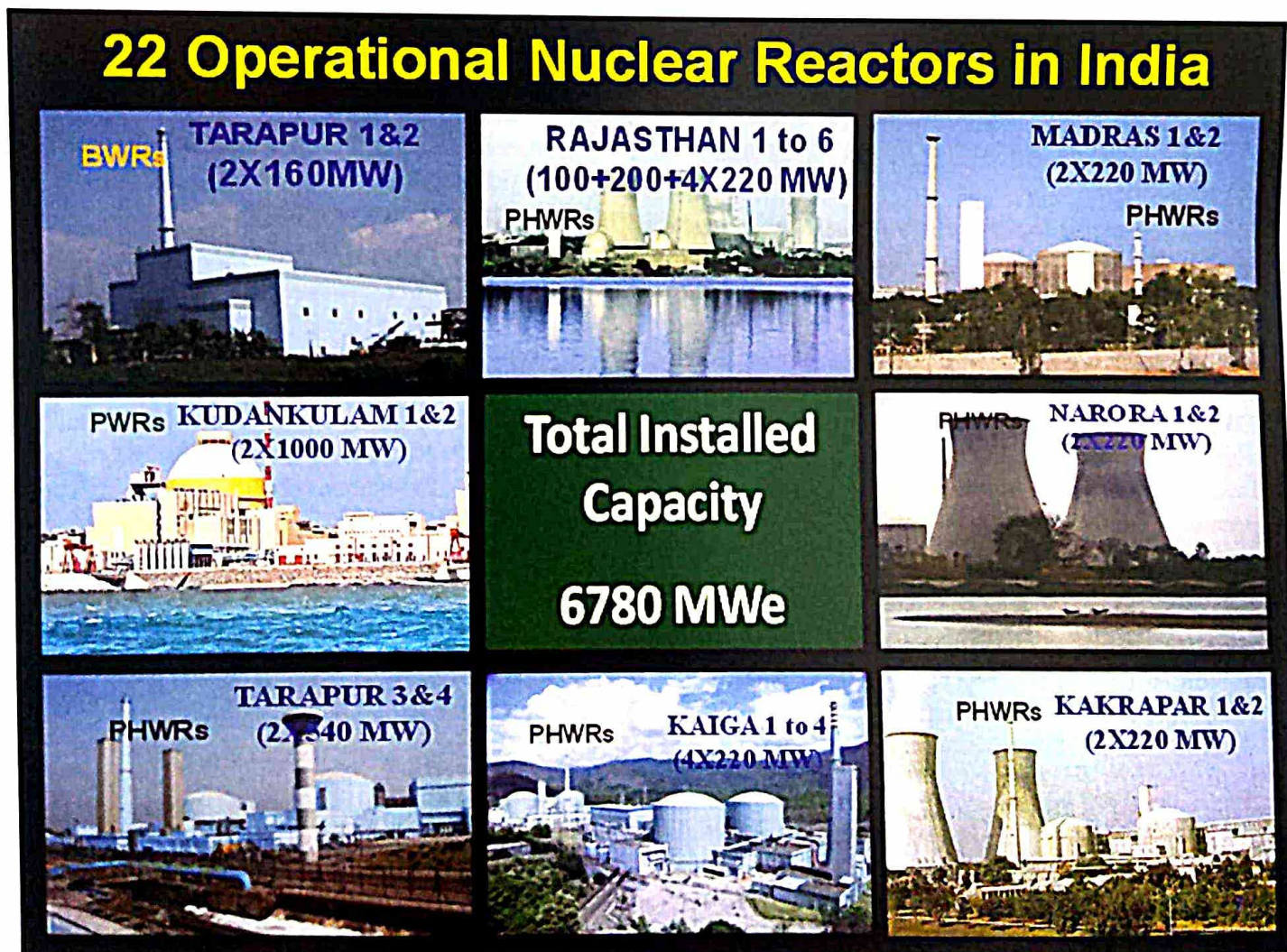


Figure 2

State	Location	Project	Capacity (MW)
Projects under Construction			
Gujarat	Kakrapar	KAPP-3 (*) & 4	2 X 700
Rajasthan	Rawatbhata	RAPP-7&8	2 X 700
Tamil Nadu	Kudankulam	KKNPP-3 to 6	2 X 1000
	Kalpakkam	PFBR	1 X 500
Haryana	Gorakhpur	GHAVP-1&2	2 X 700
Projects accorded Administrative Approval & Financial Sanction			
Karnataka	Kaiga	Kaiga-5&6	2 X 700
Haryana	Gorakhpur	GHAVP- 3&4	2 X 700
Madhya Pradesh	Chutka	Chutka-1&2	2 X 700
Rajasthan	Mahi	Mahi Banswara-1 to 4	4 X 700
	Banswara		
Projects accorded 'In-Principle' Approval			
Maharashtra	Jaitapur	Jaitapur- 1 to 6	6 X 1650
Andhra Pradesh	Kovvada	Kovvada- 1 to 6	6 X 1208
Gujarat	Chhaya Mithi Viridi	Chhaya Mithi Viridi-1 to 6	6 X 1000
West Bengal	Haripur	Haripur- 1 to 6	6 X 1000
Madhya Pradesh	Bhimpur	Bhimpur- 1 to 4	4 X 700
(*) - connected to the grid on January 10, 2021 and currently undergoing test runs.			

more than 20%? What is the rationale for retaining nuclear power in India's energy mix?

A major consideration is about availability of sources. Currently, India draws nearly 63 per cent of its total energy generation from thermal sources. Of this, nearly 55 per cent is met from coal and the rest from gas, with a minuscule amount from oil-fired plants. The worrisome part of this configuration is that India imports a significant part of its fossil fuels. For a large and rapidly developing country, bulk fuel imports raise economic and strategic vulnerabilities.

Another important factor is electricity generation's low carbon footprint. The large-scale use of coal has severe consequences for global warming and climate change, which are critical issues besides air pollution that the planet faces today. India's per capita carbon emissions stand at 1-1.2 tons, compared to 20 tons per capita of the US. If a growing Indian economy continues to rely on coal, carbon emissions are bound to rise. This will impact national expenditure on domestic environmental and health measures, as also India's global obligations. Nuclear energy, in this context, offers a meaningful alternative.

Renewable energy is environmental-friendly and a natural choice for India. However, its limitations should also be understood. Firstly, solar and wind energy generation is land-intensive. Secondly, while

nuclear plants have become completely indigenous, solar plants carry a dependence on imported technology and materials such as photovoltaic cells, battery, and storage equipment. Another solar and wind power generation-related handicap is in energy storage, which makes them unsuitable as a baseload source of electricity. Despite these challenges, renewables still merit a place in India's energy basket.

### Conclusion

India is a developing nation and its economy is dominated by the manufacturing and service sectors which are energy-intensive. That India's power generation capacity has increased a hundred-fold since independence, and it is today the third-largest producer of electricity in the world, are applaudable developments. Yet, at 1181 kWh in 2018-19, the per capita electricity consumption is low. This compares poorly with Canada's 17179 kWh, 13338 kWh in the US, and about 3000 kWh even in China. India needs to scale up electricity production to assure a reasonable quality of life for citizens. Such requirements make the choice for India, not between nuclear and renewable, but to include all available sources. Given the country's demographic growth, the aspirations of a young population, lack of indigenous fuel resources, and mounting climate change, we need a long-term vision and commitment to safeguard electricity for the upcoming generation that must be provided with all the resources. □



## DISASTER MANAGEMENT

# The Himalayan Floods

*Pradeep Srivastava*

**Rivers originating in the Himalayas are the lifeline of one-fifth of the global population. Large floods that are becoming more frequent in this region, due to rising population and urbanisation, are increasingly disastrous. This article provides a brief account of the latest tools of flood monitoring and flood mapping that can help planners in designing the strategies towards flood mitigation and disaster risk reduction.**

**T**he Himalayas extend for about 2400 km from west to east with width varying between 200-400 km. The two syntaxes of this mountain are drained by the rivers Indus (west) and the Brahmaputra (east). The Ganga river system largely drains the central part of the Himalayas. Over the last few decades, urbanisation has led to a dramatic increase in the population living in this mountain belt. During the past fifty years (1961-2011), the number of people living in the Himalayan region has grown from 19.9 to 52.8 million, and if the population keeps growing at the same rate, it is expected to touch the mark of 260 million by 2061 (Apollo, 2017). During the same period, a significant surface warming trend of Himalaya is predicted<sup>1</sup> where it is suggested that regions above 2000 m asl (above sea level) will witness a higher rate of surface warming.<sup>2</sup> This temperature rise will increase the available atmospheric energy and total precipitation, which in combination with mountain fragility and the growing urban centers is a perfect condition for disasters. The 2010 floods of Leh, 2013 Kedarnath floods, and 2021 Rishiganga floods are a few examples of volatility that extreme rainfall, the geology of the Himalayas, and urbanisation jointly lead to. The reports of inter-governmental panel on climate change (IPCC-2019) indicate an overall increase in the frequency of high-intensity rainfall events in the Himalayas and this

requires a careful understanding of extreme hydrological events as they interact through the variable orography and geology of the Himalayas. The available data of flood monitoring hardly extends to one hundred years which is not enough for flood mapping and reconstruction of longer flood records in different climatic settings of the Himalayas is required.

### **The Himalayas**

The Himalayan mountain belt, tectonically, is divisible into from north and south, the Indus Suture Zone (ISZ) of Ladakh, the Tethyan Himalaya, the Higher Himalayan Crystalline zone, the Lesser Himalaya, and the Siwalik of outer Himalaya. The ISZ lies in the rain shadow zone of the Indian Summer Monsoon (ISM), above an elevation of almost 3000 m asl where the scanty rainfall (~100 mm/year) occurs mostly under the influence of westerlies. The rivers Indus and Zanskar which flow through the region, therefore get most of their discharge from westerlies, partly from ISM, and snow and glacial melt. However, the floods in these rivers are normally induced by the interplay of ISM and upper atmospheric interactions. The area is devoid of vegetation and due to extreme temperatures, physical weathering of rocks occurs that forms a thick debris mantle on hill slopes. This debris mantle during excessive snow

The author is with the Department of Earth Sciences, Indian Institute of Technology, Roorkee. Email: [pradeep@es.iitr.ac.in](mailto:pradeep@es.iitr.ac.in)



melting and rainstorm events, fail and block small and large streams that breach subsequently to create floods. The Tethyan belt also behaves in a similar manner even though it lies at the northern fringe of ISM and receives a slightly higher amount of rainfall as compared to ISZ. The Higher Himalayan Crystalline zone lies above an elevation of ~1800 m asl and receives full spectrum of ISM rainfall. This zone is characterised by steep hill slopes and deep gorges with high gradient drainage systems. The Lesser Himalaya and outer Siwalik Himalaya are gentler and also receive a high amount of ISM rainfall. The orography and geology of the Himalayas is such that, from south to north, the first physiographic transition occurs above the Siwalik Himalayas and the second occurs at the base of the Higher Himalayan Crystalline zone, where there exists a regional fault called the Main Central Thrust (MCT). The two physiographic transitions form barriers to upcoming ISM rainfall front and receive focused precipitation. Therefore, the southern front largely has two belts of high rainfall (1500-2500 mm/year) that coincide with the two physiographic transitions. The MCT fault zone which is characterised by highly deformed and pulverised rocks where the hill slopes are of steeper (>40 degrees) gradient, in combination with focused rainfall, is most vulnerable to mass wasting and landslides. The orography and pattern of rainfall distribution decide the damage pattern and hotspots of erosion in the event of large floods. Another important thing to remember is that the headwaters of the rivers like Indus, the Ganga, and the rivers draining the central Himalayan ranges lie in rain deficient arid zones where extreme rainfall events can potentially create glacial/moraine-dammed lake outbursts, and massive snowmelt, leading to a flood. However, the headwater of the Brahmaputra, due to different orography and elevation receives ~1000 mm/a of ISM rainfall with downstream catchment >3000 mm/a. These contrasting characteristics between the two systems create floods that have discharges of different magnitude. The Brahmaputra is known to have experienced floods of megaflood category (discharge  $10^7$  Cumecs), where the Ganga and Indus historically have experienced large floods (discharge  $\sim 10^4$

Cumecs). Therefore, flood magnitude in the Himalayas is controlled by geology, orography, and rainfall distribution.

### **Causes of Floods in the Himalayas**

In general, the large floods in the Himalayas are caused by (i) intense rainfall events, (ii) Landslide dammed lake outbursts (LLOFs), (iii) Glacial dammed Lake outbursts (GLOFs), and (iv) Cloud bursts. Often, during warmer and strengthened monsoon years, the southern front of the Himalayas receives longer spells of precipitation that cause large floods that may last for almost full peak in the monsoon season. Such floods may have broader hydrographs ranging from weeks to months. Such rainfall phases that occur due to stationary monsoon troughs may also cause series of landslides in steeper gradient reaches of the mountain, where the area around the MCT zone is most vulnerable. During such years, the ISM front also penetrates deeper into what generally remains under the rain shadow zone i.e. ISZ in Ladakh, and produces flooding there as well. During these rainfall events, breaches of glacial and landslide dammed lakes also occur that compound the flood magnitude and induce multi-peaked flood hydrographs. Glacial Lake Outburst Floods (GLOFs) are generated by the breach of water bodies that are formed due to damming of streams by surging or advancing glaciers, or by impounding hill-slope runoff and snowmelt between the two moraine ridges (called moraine-dammed lake). Shyok

**The orography and pattern of rainfall distribution decide the damage pattern and hot spots of erosion in the event of large floods. Another important thing to remember is that the headwaters of the rivers like Indus, the Ganga, and the rivers draining the central Himalayan ranges lie in rain deficient arid zones where extreme rainfall events can potentially create glacial/moraine-dammed lake outbursts, and massive snowmelt leading to a flood.**

river in the Himalayan-Karakoram region frequently witnesses such glacial damming and the two events of GLOFs in this river which occurred in the years 1779 and 1932, are well documented.<sup>3</sup> The 2013 Kedarnath incident in the Garhwal Himalayas, besides widespread rainfall, was compounded by a breach of a moraine-dammed lake in the Chaurabari glacial region.<sup>4</sup> Landslide lake outburst floods (LLOFs) are analogous, with the dams being formed by landslides. Landslide activity that generally occurs during monsoon or an earthquake may potentially dam small channels for a longer duration, eg. landslide dammed lake (Gohana Tal) of Birahi Ganga, survived for 76 years (1893-1970). These dams may breach



and cause floods in the downstream regions as breach of Gohna Tal of Birahi Ganga in 1970 devastated the town of Srinagar (Garhwal), and significantly damaged the Ganga canal downstream in Haridwar. Likewise, the Sutlej river valley (Himachal Himalayas) also witnessed massive devastation due to LLOFs in the years 2000 and 2005.<sup>5</sup> In Ladakh Himalaya, a detailed account of 161 landslide events damming rivers in the Indus River Basin are described.<sup>6</sup> Summarily, the floods in the Himalayas are common and are caused by a combination of natural surface processes and rainfall distribution. However, the magnitude of flood is a function of overall geology, orography, catchment-wide distribution of lakes, landslide zone, and rainfall.

### Flood Mapping

Mapping of floods has four elements: (i) vertical rise in river level, (ii) rate of rising of flood, (iii) flow velocity, and (iv) lateral inundation of flood plains. The first point requires precise measurements of flood levels in rivers and streams which is normally done at river gauging stations. These gauging stations can now be equipped with state-of-the-art Internet of Things (IoT) and radars to quickly transmit the data to remote locations and flood management centres. Radars can help in tracking the locations of intense rainfalls and the temporal evolution of the storm. The rate of rise in flood is a function of how the drainage network efficiently delivers surface runoff to the channel. This will factor-in parameters like infiltration, drainage

density, gradient, and vegetation cover, etc., and will also decide the lag between the peak of rainfall event and of the hydrograph. The assessment of this time lag is key to activate alert systems and evacuation. The cause of flood is also important in this context like regional high-intensity rainfall will allow the gradual rise of flood level whereas the events like GLOFs and LLOFs will induce a faster rate of rise in flood levels. Therefore, flood level/rate measurement has to be inclusive of data at various levels.

In most cases, the flood level observation is not chronicled beyond hundred years which may not be enough to understand the long-term variability of floods and the forcing factors behind large events. We know whether the occurrences in 1970, 2013, 2021 of the Garhwal Himalaya are isolated events or they are riding over a long-term climatic cycle. This requires an understanding of geological archives. The Slack Water Deposits (SWDs) that are composed of centimetre to metre scale couplets of sand and silt represent an individual flood event. The stacks of these

---

**Mapping of floods has four elements: (i) vertical rise in river level, (ii) rate of rising of flood, (iii) flow velocity, and (iv) lateral inundation of flood plains. The rate of rise in flood is a function of how the drainage network efficiently delivers surface runoff to the channel.**

---

deposits containing records of several such events are common and found at tributary junctions, wider segments of channels, on top of the terraces, caves, and behind rocky embayments along the rivers. These are the locations where sudden slackening in flood velocities take place. The height of these deposits are above river levels, informing on the elevations so as to which flood levels rose and can be precisely measured using Differential Global Positioning



Systems (DGPS). These deposits can be dated using Optically Stimulated Luminescence (OSL) and <sup>14</sup>C AMS dating techniques on charcoal specs. SWDs are explored in the Indus, the Sutlej, the Ganga, and the Brahmaputra rivers, where the history of floods going back past ~15 ka is reconstructed.<sup>7</sup> Chronologically, constrained wood debris lying at higher levels along with the river course and debris flow deposits can be other archives that can be used to reconstruct extreme hydrological events.

The lateral extent of flood inundation can be mapped using satellite images and LiDAR (Light Detection and Ranging) data. The precision and resolution of this data at finer scales can help prepare maps of meaningful use. The flood velocities are generally measured using current meters, acoustic Doppler current profilers, tracers, and floaters. The most precise would be Doppler current profiler as it can measure flow velocity at different depths and can average out the turbulence. Besides above, one parameter largely ignored is flood sediment load. It is important as it imparts buoyancy to floodwaters which in the event of a large flood, is detrimental to the stability of infrastructures such as dams, bridges, and culverts. Sediment load of floodwaters can be measured by sediment monitoring gauges or sensors equipped with Laser In-Situ Scattering and Transmissometry or by physically sampling during the time of the flood. Satellite data can also help in getting generalised ideas on sediment load.

### Reducing Flood Vulnerability in the Himalayas

The floods are natural processes and are inevitable, though the damage done by these events can be minimised if attempted using scientifically sound databases and models. Proper understanding of the orography of the Himalayas and how past flood events have interacted with it and what were the damage patterns can help in preparing the damage predictive models of the Himalayas. This model can help in deciding the focus, magnitude, and type of infrastructural development to be done in the Himalayas. The foremost towards this is monitoring at various levels like installing a dense network of flood gauging systems and Radar in various drainage basins in the Himalayas, channelling all the real-time data to flood management centers using IoT. Longer time series of data archival using large monitoring networks,



historical, and geological archives ought to be prepared. Landslide and glacial lake monitoring systems should be in place and be linked to flood management centres via IoT. The combination of data on flood levels, flood hydrographs, and lateral inundation can be used to manage the floods and minimise the destruction. The inundation maps prepared using satellite images/LiDAR combined with maps of social infrastructure, if analysed on GIS platforms and Artificial Intelligence (AI) using long time series of datasets, can provide predictive models of flood events and damage patterns. □

### References

1. Kulkarni A, Patwardhan S, Kumar K, Ashok K, Krishnan R (2013) Projected climate change in the Hindu Kush-Himalayan region by using the high-resolution regional climate model PRECIS. *Mt Res Dev* 33(2):142–151
2. Sabin T.P. et al. (2020) Climate Change Over the Himalayas. In: Krishnan R., Sanjay J., Gnanaseelan C., Mujumdar M., Kulkarni A., Chakraborty S. (eds) *Assessment of Climate Change over the Indian Region*. Springer, Singapore. [https://doi.org/10.1007/978-981-15-4327-2\\_11](https://doi.org/10.1007/978-981-15-4327-2_11)
3. Lacey, J.M., 1932. Shyok Glaciers and Indus Floods. *Nature* 130, 771–772 (1932). <https://doi.org/10.1038/130771d0>
4. Srivastava, P., Kumar, A., Chaudhary, S., Meena, N., Sundriyal, Y.P., Rawat, S., Rana, N., Perumal, R.J., Bisht, P., Sharma, D., Agnihotri, R., Bagri, D. S., Juyal, N., Wasson, R. J., and Zigler, A. D., 2017, Paleofloods records in Himalaya: Geomorphology, v. 284, p. 17–30, <https://doi.org/10.1016/j.geomorph.2016.12.011>
5. Ruiz-Villanueva, V., Allen, S., Arora, M., Goel, N.K. and Stoffel, M., 2017. Recent catastrophic landslide lake outburst floods in the Himalayan mountain range. *Progress in Physical Geography*, 41(1), pp.3-28.
6. Hewitt, K (2006) Rock Avalanche Dams on the Transhimalayan Upper Indus Streams: a survey and assessment of hazard-related characteristics. *Italian Journal of Engineering Geology and Environment* 1: 61–65.
7. Chahal, P., Kumar, A., Sharma, P.C., Sundriyal, Y.P., and Srivastava, P., 2020, A preliminary assessment of the geological evidence of the mega floods in the upper Zaskar catchment, NW Himalaya: *Journal of the Palaeontological Society of India*, v. 65, no. 1, p. 64–72.

### Endnotes

1. Apollo, M., 2017. The population of Himalayan regions—by the numbers: Past, present and future. W: R. Efe, M. Öztürk (red.). *Contemporary Studies in Environment and Tourism*. Cambridge: Scholars Publishing, pp.145-160.
2. Juyal, N., 2010, Cloud burst-triggered debris flows around Leh: *Current Science*, v. 99, no. 9, p. 1166–1167.
3. Sharma, S., Shukla, A.D., Bartarya, S.K., Marh, B.S., and Juyal, N., 2017, The Holocene floods and their affinity to climatic variability in the western Himalaya, India: *Geomorphology*, v. 290, p. 317–334, <https://doi.org/10.1016/j.geomorph.2017.04.030>
4. Srivastava, P., Tripathi, J.K., Islam, R., and Jaiswal, M.K., 2008, Fashion and phases of late Pleistocene aggradation and incision in the Alaknanda River Valley, western Himalaya, India: *Quaternary Research*, v. 70, p. 68–80, <https://doi.org/10.1016/j.yqres.2008.03.009>.
5. Wasson, R.J., Sundriyal, Y.P., Chaudhary, S., Jaiswal, M.K., Morthekai, P., Sati, S.P., and Juyal, N., 2013, A 1000- year history of large floods in the Upper Ganga catchment, central Himalaya, India: *Quaternary Science Reviews*, v. 77, p. 156–166, <https://doi.org/10.1016/j.quascirev.2013.07.022>.

# Geomagnetism: Applications

*Praveen B Gawali*

**Geomagnetism has many societal applications and this science impacts all of humanity in one form or another. The very survival of all the life forms on earth is interminably related to the existence of this geomagnetic field. Efforts are being made to use it for an early-warning system of natural disasters including earthquakes and tsunami. A significant contribution to research in the field of geomagnetism started in the nineteenth century.**

**T**he magnetic field, since it originates inside the earth and travels through its different constituents and materials, turns into a handy tool to peer inside and examine it. Some of the material attracts electromagnetic waves towards it and some resist. The delineation of electromagnetically conductive and resistive bodies can help earmark sources of natural hazards or natural resources.

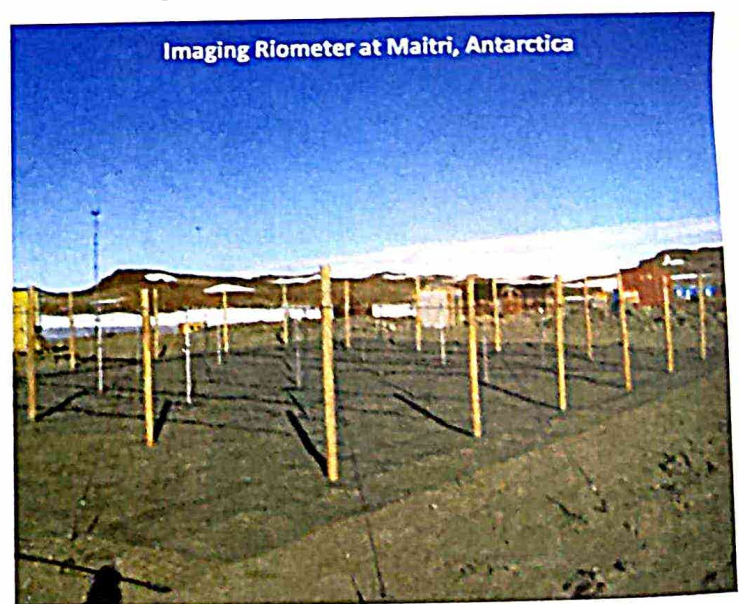
The antiquity of the Indian Institute of Geomagnetism (IIG) goes back to almost two centuries and it is a force to reckon within the field of geomagnetism and allied research areas. It has earned a great reputation of being one of the best in the world, with consistency in innovating new and advanced research. It is a global leader in magnetic and electromagnetic data collection. This data is eagerly sought by pioneers from around the world for their geomagnetic research. Geomagnetism is a global phenomenon and hence it cannot be understood in isolation or locally.

The research areas that are covered by IIG encompass a wide spectrum- on one hand, it explores the interior of the earth, and on the other, its vast boundaries reach the sun to understand its dynamics. If it explores different layers of the earth, it also investigates a gamut of atmospheric strata. If it uses seismic waves to unravel the earth's properties, it also harnesses radio waves to ensure seamless communication. Out of the sun, earth, or the dark space between these two entities, none have been left unexplored by IIG.

A set of magnetic instruments, way back in 1841, were to be installed at Aden (Yemen). However, because of some unforeseen circumstances, those instruments had to be installed at the Colaba Meteorological Observatory (MO). A separate enclosure was constructed and the magnetic observations were started.

But Colaba MO had to be shifted to Alibag in 1904 because the growing urbanisation was hampering magnetic readings, especially when the electric tram started its operation. It is practically possible to shift a magnetic observatory from one location to another and still retain the constancy of variations. This constancy was established by simultaneous measurements at Colaba and Alibag for almost two years from 1904 to 1906. The recordings have continued at Alibag since then and formed a continuous Colaba-Alibag magnetic observatories' data series. This data is a treasure trove that contains within it a range of dynamic phenomena that has been unravelled and continues to do so.

IIG was given a separate and independent mandate in 1971. India had started its exploration into space research. It needed specialised personnel to study geomagnetic



*Figure 1*

phenomena. There was also a growing expectation of fully comprehending the diaphanous domain of the earth. This is done by generating data at its MOs (Alibag, Nagpur, Visakhapatnam, Gulmarg, Rajkot, Silchar, Jaipur, Puducherry, Port Blair, Antarctica), carrying out periodic surveys, collating data (from satellites, probes, ground-based instruments), which is accumulated and assimilated by the scientists at the headquarters (Navi Mumbai campus), Regional Centers (Tirunelveli, Prayagraj, and Shillong), and quite often at the MOs as well.

The magnetic minerals embedded in crustal rocks are harnessed to map Curie temperature symptomatic of the crust-mantle magnetic transition zone. They are also used to understand the regional deformities and structural framework of the continental and oceanic realm. The mineralised zones and geotectonic fault categorisation become easier with remotely sensed magnetic data. The composite magnetic anomaly map developed at IIG is in a league of its own. The experts in the field can mine a wealth of information regarding the regional geology (natural resources) and tectonic framework of India (faults, lineaments, weak planes). Magnetic minerals play a very important role in understanding climate changes and environmental fluctuations. These minerals are quite stable in the unchanging physico-chemical domain but are quite sensitive to the changes in those circumstances. They alter themselves to maintain equilibrium with the surrounding. Laboratory investigations reveal the degree and phase change in magnetic mineralogy, which can then be associated with a climatic or environmental process.

The solar magnetism impacts celestial entities which include earth as well. The energetic particles emanating from the sun influence earth's magnetosphere, ionosphere, mesosphere, and thermosphere. Solar flares, coronal mass ejections, high-speed solar wind, and solar energetic particles are the manifestation of dynamic flux. The earth is also magnetic and the genesis of this field is theorised, modelled, and simulated to be at the core-mantle boundary. The field lines traverse through different earth layers to protectively blanket our planet. This is the shield that stops and deflects harmful radiation. Life and electrical communication, are thus maintained and sustained. The interaction of these charged particles with the atmospheric constituents creates aurorae at the polar regions (See Figure 2). These 'curtains of light' are especially more active and prominent when a magnetic storm hits the earth.



Figure 2: Magnetic Aurora

Solar wind emanates and flows continuously throughout the space in all directions. The earth experiences it, however, the recordings of its interaction and creation of electromagnetic currents in the atmosphere are carried out at the MOs. The complex interplay of heat and energy at the surface of the sun and its atmosphere creates a temperature dichotomy. The waves and particles that originate at the solar domain travel outwards at incredible speeds. To tackle this diaphanous domain, an eclectic approach is pursued to unravel complex forces that include gravity waves, infrared rays, ultraviolet radiation, and other perturbations, along with high-altitude winds that blow ions (charged atoms) across the earth's magnetic field by creating a dynamo. All these forces cause collisions between neutral and charged particles, enabling them to exchange charge, to transfer energy and momentum amongst them. The end time and the duration of the solar cycle are also attempted over here. It is now dawning on the experts that solar energy fluctuations can have an impact on the temperature dynamics of the earth.

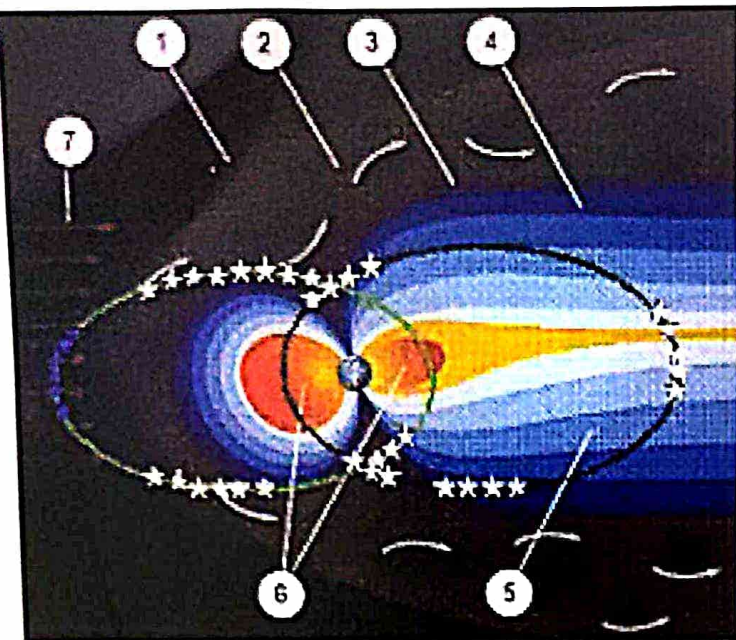
---

**Magnetic minerals play a very important role in understanding climate changes and environmental fluctuations. These minerals are quite stable in the unchanging physico-chemical domain but are quite sensitive to the changes in those circumstances. They alter themselves to maintain equilibrium with the surrounding. Laboratory investigations reveal the degree and phase change in magnetic mineralogy, which can then be associated with a climatic or environmental process.**

---

The atmospheric tides are global-scale variations in wind, temperature, and pressure, tied to solar input. They occur throughout the atmosphere on a regular basis and are seen once or twice daily (diurnally and semi-diurnally), with smaller tides at more frequent intervals. The tides move westward with the sun, driven by solar radiation, its absorption, and re-emission at various heights. These processes are active even when the sun is 'inactive' or quiet. But there is a crescendo of events when there is a solar 'storm'. The cataclysmic burst of charged particles and radiation completely rearranges global thermospheric circulation in a matter of hours.

The ionosphere and magnetosphere are a closely-coupled system



that channels energy and momentum from the solar wind to the upper atmosphere. A number of coupled current systems flow in these regions of highly conducting plasmas. These currents are responsible for most of the temporal changes in the geomagnetic field that occur on timescales of seconds to days, including magnetic pulsations. Studies of the ionosphere and magnetosphere seek to obtain a quantitative understanding of the flow of energy and momentum through the solar wind, magnetosphere, and ionosphere systems. This study in turn supports the physics of magnetic reconnection at the magnetopause, the response of the magnetosphere to changes in solar wind pressure, the processes responsible for viscous-like interactions. Investigations towards this direction elucidate the physical mechanisms responsible for generating pulsations and controlling their cross-field transport in the magnetosphere.

Plasma encountered in the earth's as well as other planetary magnetospheres, are generally far from their thermodynamic equilibrium states, and hence contain some amount of free energy. These free energy sources can generate several kinds of plasma modes in the magnetospheric boundary layers, such as magnetopause boundary layer, plasma-sheet boundary layer, polar cap boundary layer, etc.

Magnetic minerals also tell us about continental migration. Before the era of GPS, paleomagnetism was the only reliable and accurate technique to understand the direction and quantum of the plate movement. The concept of polar wandering and magnetic reversal baffled the geoscientists. The realisation of the presence of magnetic

banding in the oceans ultimately led to the formulation of the concept of plate tectonics and seafloor spreading. It revolutionised the way scientists thought about investigating natural resources. The plate boundaries and faulting zones were found to be the ideal candidates for mineralisation. Palaeomagnetism tied all the diverse and distant plates with the grand continent, Pangaea and its later subsidiaries like Gondwanaland and Laurasia. The dynamo that generates the magnetic field of the earth and how it operates is now fairly known and clear. The reversals that are generated are recorded in the rocks- and sediment-containing magnetic minerals. These polarity reversals and the 'normal' polarity of the earth are used as a relative timescale to magnetically date the rocks and sediments. The other geophysical techniques like gravity, electricity, seismicity, and GPS have shed light on many unknown aspects of the crust and mantle.

In a bid to be ahead of the evolution curve, IIG strives hard to be the best in the business by thinking within and out of the box for optimum utilisation of its available knowledge base. The long-series data that IIG has at its disposal is of immense significance. It has data related to solar processes, earth processes, the magnetosphere, and the atmosphere containing ionosphere. It became a foregone conclusion that combining data from these diverse, yet connected realms will highlight new insights and novel perspectives that were not thought of earlier or considered possible. The multi-disciplinary studies have brought out the interdependence of certain processes within the crust and ionospheric domain. The earthquake generated waves while traversing the subsurface or surface perturb the atmosphere. This perturbation sends shock waves into the atmosphere through the ionosphere. These waves straddling the surface and the atmosphere can be used to understand the dynamics of seismicity.

**The solar magnetism impacts celestial entities which include earth as well. The energetic particles emanating from the sun influence earth's magnetosphere, ionosphere, mesosphere, and thermosphere.**

**The interaction of these charged particles with the atmospheric constituents creates aurorae at the polar regions. These 'curtains of light' are especially more active and prominent when a magnetic storm hits the earth.**

The year 2021 marks the golden jubilee of the foundation of IIG. In 1971, it was set on a path to glory and given an independent mandate to pursue geomagnetic research. Nature Index Ranking has placed IIG amongst the top 10 research institutes of India, pursuing fundamental research in Earth sciences.

To sum up, geomagnetism or earth magnetism is an ever-changing entity, because of which it has to be monitored and recorded continuously. It is vital research in the field of scientific technology, allowing us to get more familiar with our planet and the solar system. □

# Nanotechnology in Textiles

Dr Neha Yeshwanta Hebalkar

Nanotechnology is being applied in various fields due to its ability to change physical, chemical, electronic, optical, thermal, magnetic, and biological properties of the matter because of its ultra-small size of less than 100 nm (1 nm = 1 part of 10 lakh equal parts of 1 mm). In the 3-D structure of the matter, when the dimensions are reduced to nano-size one by one, the formed nanostructures are called thin-film, nanowire, and quantum dot respectively. Thus, by engineering size and shape in nano dimensions, the properties of the matter can be manipulated to achieve the required functionality which is otherwise not possible with bulk materials. Such an amazing technology has proven its potential in all the fields, and the textile industry is not an exception.

**T**he textile industry caters to various segments in consumer products such as clothing, home furnishings, bathing accessories, automobiles, military, biomedical, electronic, and technical fabrics. Advanced textiles are desired to be smart and interactive. Smart Interactive Textiles (SITs) can sense electrical, thermal, chemical, magnetic, or other stimuli from the environment, and adapt or respond to them,

using functionalities integrated into the textile structure. The various applications of nanotechnology in textiles are illustrated in Figure 1.

Let's discuss some desirables about new generation clothing. Although the primary function of clothing is protection and aesthetics, our changing lifestyle, pollution, environmental conditions, and unexpected challenges such as the Covid-19 pandemic has led us to new requirements

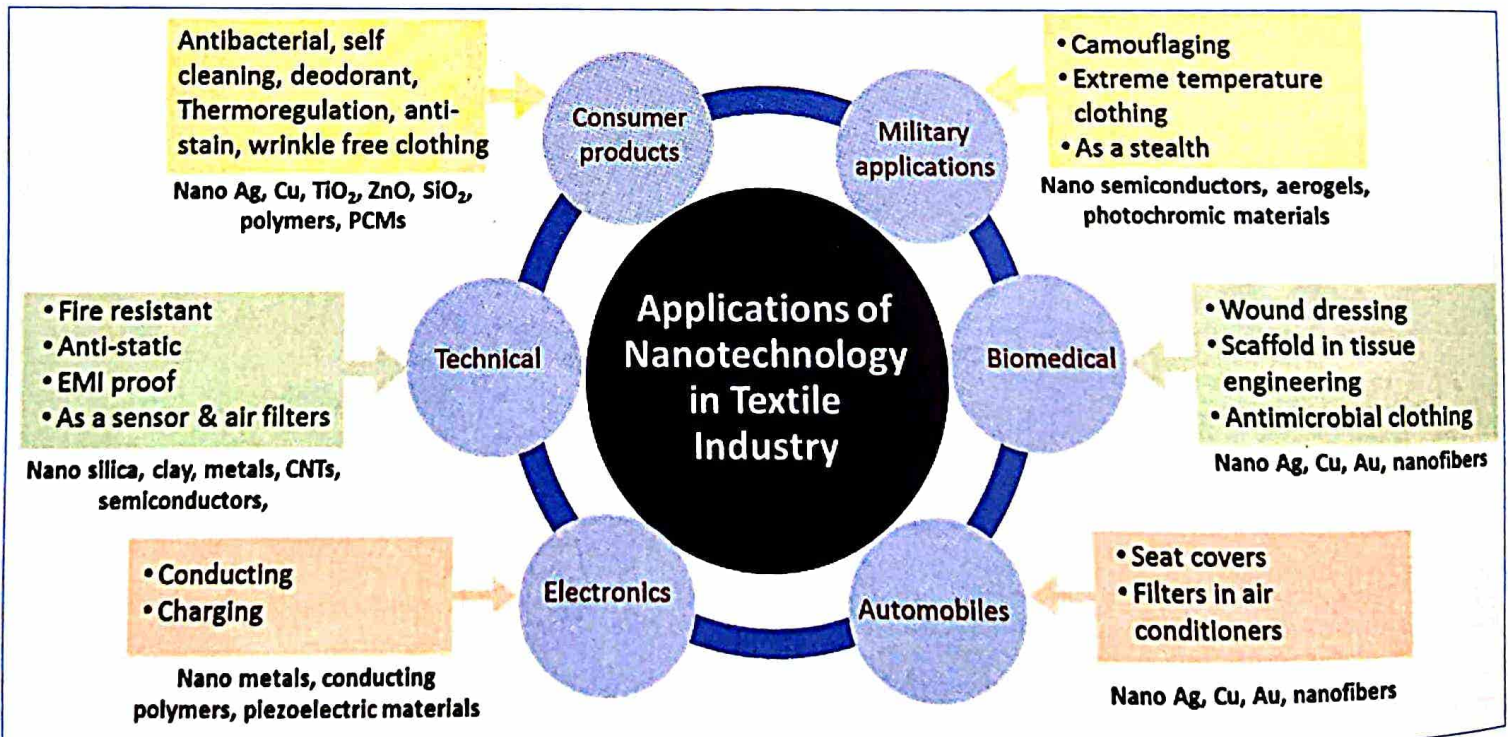


Figure 1: Applications of nanotechnology in various segments and nanomaterials used in the textile industry

The author is Scientist 'F', Centre for Nanomaterials, International Advanced Research Centre for Powder Metallurgy & New Materials, an autonomous R&D, Centre of Department of Science and Technology, Govt. of India. Email: neha@arci.res.in, Twitter: @arci\_res\_in

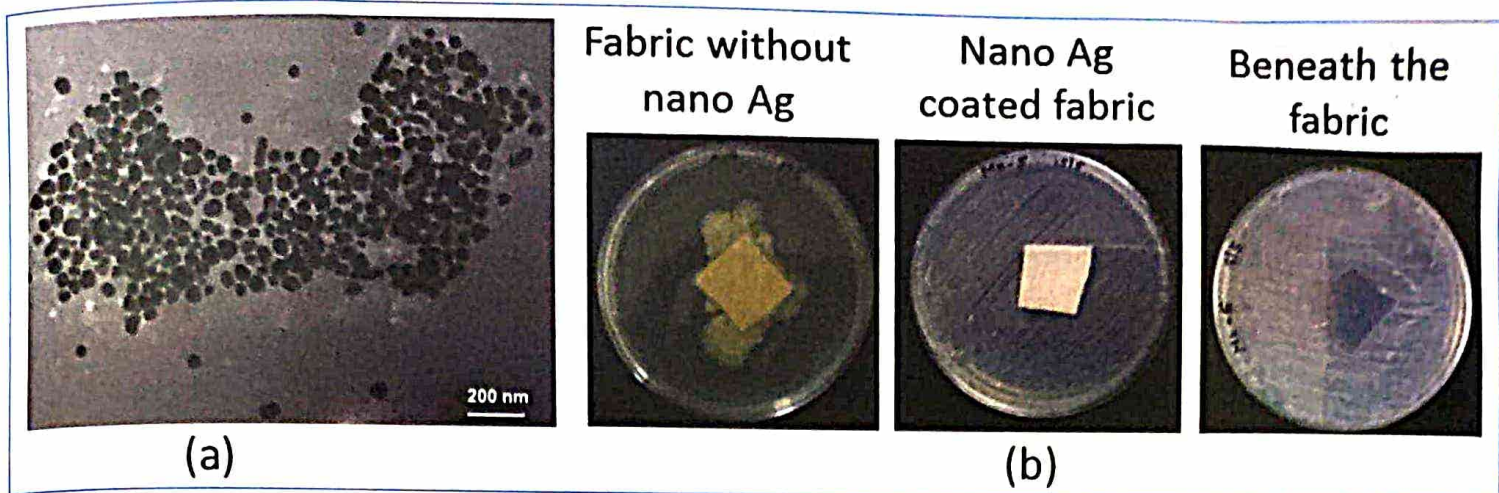


Figure 2: (a) 30-50 nm Ag particles seen under Transmission Electron Microscope, (b) antibacterial activity: Fabric without nano-Ag show bacterial growth on and around the fabric, when coated with a nano Ag, there is no bacterial growth on and below the fabric

in the apparel industry, for instance, added comfort, thermoregulation, hygiene, protection from UV light, fire, pathogens, electromagnetic field, etc. Due to long working hours and polluted air, the clothes we wear become a host for bacteria to grow in the sweat absorbed by the fabric, giving out a bad odour. The freshness in the apparel we wear can be retained for longer hours if the bacterial growth is restricted. Nanotechnology has played a very important role in achieving this target.

International Advanced Research Centre for Powder Metallurgy & New Materials (ARCI) has developed a nanosilver-based suspension that can be applied on the fabric surface to get antibacterial activity. Nanosilver uses the same scientific principle as the one that lies in our tradition to drink water stored in copper and silver vessels, where the ions of these metals, released in water, kill micro-organisms and make it safe for drinking. In the silver nanoparticles,  $\text{Ag}^+$  ions released from the surface interact with the bacterial cell membrane, proteins in the cell, and DNA which leads to cell death.<sup>1</sup> The advantage of the ultra-fine size of silver particles is that a very small amount of silver can be spread over the large surface area of the fabric. Tailored surface chemistry of nanosilver particles makes a strong chemical bond with fabric to give durability in functionality<sup>2,3</sup>. Figure 2 shows an image of silver nanoparticles seen under Transmission Electron Microscope and experimentally shown antibacterial activity. The antimicrobial textiles are most essential in the medical sector, especially in the present deadly pandemic conditions, for example, in curtains, bed covers, face masks, aprons used in the hospitals and diagnostic centres. It can also serve for the best hygiene in sportswear, baby products, sanitary napkins, wound healing dressings, and so on.

The antimicrobial textiles are most essential in the medical sector, especially in the present deadly pandemic conditions, for example, in curtains, bed covers, face masks, aprons used in the hospitals and diagnostic centres. It can also serve for the best hygiene in sportswear, baby products, sanitary napkins, wound healing dressings, and so on.

napkins, wound healing dressings, and so on.

Other compounds such as zinc, copper, and their oxides coupled with metal nanoparticles can also be used as antibacterial agents. Recently, ARCI has demonstrated coating of copper-oxide nanoparticles doped with a trace amount of silver in the active layer in the face mask to give protection against the SARS-CoV-2 virus. This indigenous technology is the need of the hour and is being accelerated for its commercialisation.

Titanium dioxide ( $\text{TiO}_2$ ) is another strong antimicrobial material that conducts the phenomenon known as “Photocatalysis”. In simple words, the active Titanium dioxide, a semiconductor material: 1) absorbs ultraviolet rays in sunlight equivalent to its energy bandgap in presence of little moisture in the air, 2) creates highly reactive radicals, which degrade most of the organic pollutants, including germs, in its contact, and 3) keeps the surface and surroundings clean. This phenomenon is

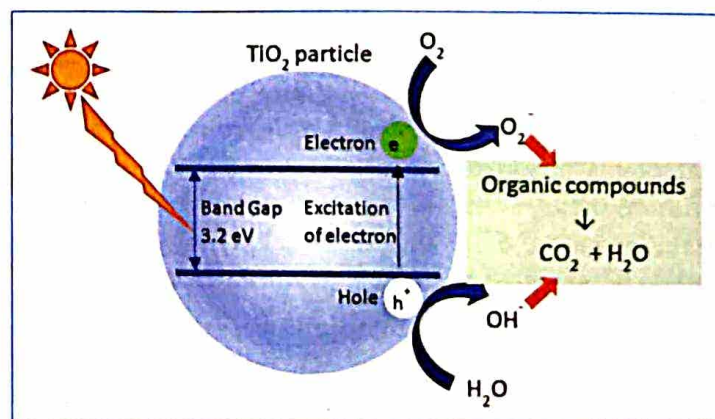


Figure 3: Schematic representation of photocatalysis in  $\text{TiO}_2$  nanoparticle

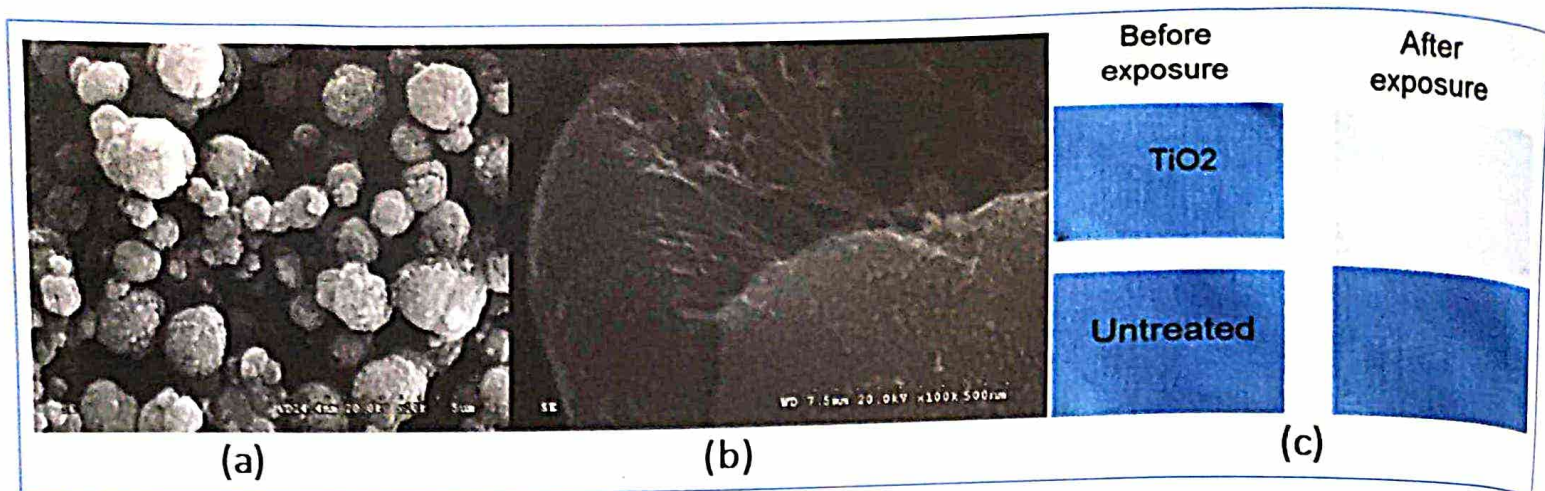


Figure 4: (a) Scanning Electron Microscope image Titania microspheres, (b) radially arranged titania nanorods in a microsphere, (c) 'self-cleaning' of titania microspheres incorporated in cotton fabric with methylene blue dye used as a model pollutant and exposed to sunlight for 8 hours. The untreated fabric does not change the colour much, however, the fabric with TiO<sub>2</sub> degrades methylene blue and decolorises the fabric.

schematically explained in Figure 3. The energy bandgap in titania can be tailored by customising the nanoparticle size and crystal structure<sup>4</sup>. The highest efficiency of photocatalysis is achieved by engineering the bandgap and by surface functionalisation of metal nanoparticles. Thus, any surface coated with TiO<sub>2</sub>, gets self-cleaned, when exposed to the sunlight.

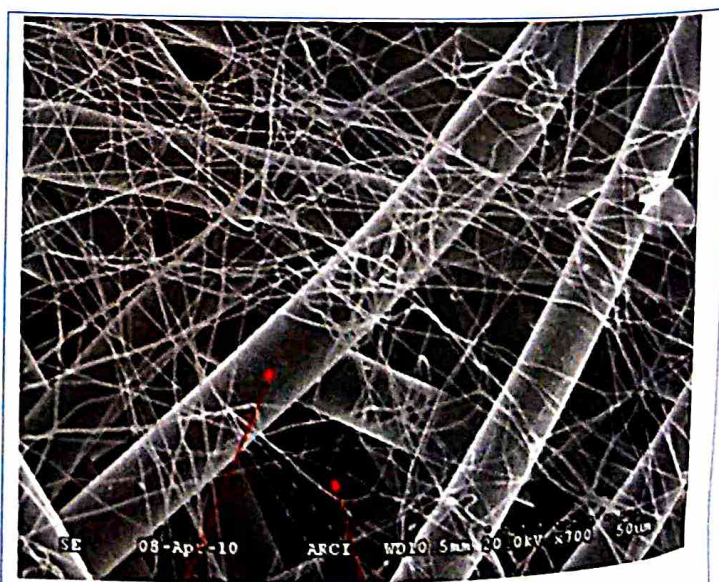
A novel titanium dioxide microsphere developed at ARCI has proved its high efficiency in the 'self-cleaning' property. It can clean the organic pollutants just by giving sunlight exposure for few hours. Figure 4 gives the micrograph of titania microspheres and their self-cleaning activity on coated fabric. This technology saves detergent, water, and electricity simply, we just have to wear these clothes and breathe fresh air. The product has been successfully commercialised and 'self-cleaning' garments are launched in the market under the tag "Sun Wash". The same titania is also very effective against giving protection from harmful UV rays in sunlight. 'Wearable Sunscreen' tagged garments in the market are based on this property of titania microspheres.

These were desired to have clothing for indoor use where self-cleaning can be activated by visible light from LED lamps. Again, this can be achieved by manipulating the bandgap in titania by doping another element in trace quantity or by surface functionalising in such a way that titania absorbs visible light wavelengths (400-800 nm) and initiates the photocatalytic activity. In a further development, the titania particles were coupled with carbon dots to give rise to the visible light active titania.

A thin coating of nanofibers on the fabric used in air filters for air conditioners and automobiles' exhaust, stops ultra-fine particles thereby increasing the efficiency of the filters. Electro-spinning technique has been used to produce these air filters.

There are several other needs for everyday clothing such as thermoregulation, where fabric responds to changes in the body temperature and maintains comfort by either heating or cooling. The Phase Change Material (PCM) is incorporated into the fabric to fulfill this function. The PCM stores and releases heat by self-undergoing a change in its phase. The polymeric microcapsules filled with perfumes/deodorants/insect repellents can be integrated with fabric for slow release. Stain and wrinkle resistance are also the most desired functionalities.

The synthetic fibers develop a static charge. The anti-static property can be imparted on them by coating



Base medium fiber Nanofibers  
Nanofibers covers the micron size pores of base medium and traps the fine particles.

Figure 5: Nanofibre-coated air filter fabric is seen under Scanning Electron Microscope

hydrophilic nano-sized oxide particles like titanium dioxide, zinc oxide, Antimony Tin Oxide (ATO), silica, or bonding electrically conducting nanoparticles which can effectively dissipate the static charge which is accumulated on the fabric.

There is another class of textiles called technical textiles, which are used in special applications. For example, fireproof and flame retardant fabric is required in the suit used by firefighters. The high-temperature stable materials are combined with thermally insulating and fireproof materials such as nanoporous silica aerogel for this application. On the contrary, the personnel working at subzero temperatures need protection against low temperatures in their clothing, tents, food storage, etc. The same silica aerogel can serve this purpose because of its thermal insulation property for cold temperatures too. The silica aerogels are ultra-low density nanoporous materials, best known for their thermal insulation performance in the temperature ranging from cryo to 800° C. Figure 6 depicts silica aerogel's thermal insulation and fire resistance performance.

The fabric can be used as a sensor or charger by functionalising with Piezoelectric nanocrystals which can convert mechanical load into electrical energy. This electrical signal can be used to sense a heartbeat or to charge a small battery. Other examples of technical textiles include functions like electromagnetic field shielding, electrical conducting, anti-static, camouflaging, stealth, water repellency, and so on. The nanomaterials used in these applications are mainly carbon nanotubes, nanoparticles of metals, metal oxides, clay, semiconductors, polymers, etc.

The nanomaterials can be applied to the fabric at various levels, at the fiber or yarn stage, during the spinning or weaving process, or directly on the fabric. Most conveniently, the ready fabric is treated by a conventional padding process, where active nanomaterials are mixed in the textile finish chemical, where it gets soaked with this liquid, and then goes through hot rollers where excess liquid is squeezed out. Heat and pressure are applied to the fabric to fix the nanomaterial on its surface. Both synthetic and natural fibers can be functionalised with nanomaterials.

Nanotechnology has great potential in the textile industry. Functional and smart textiles can play an important role in the economy of the nation. However, there are limitations in applications due to the scientific

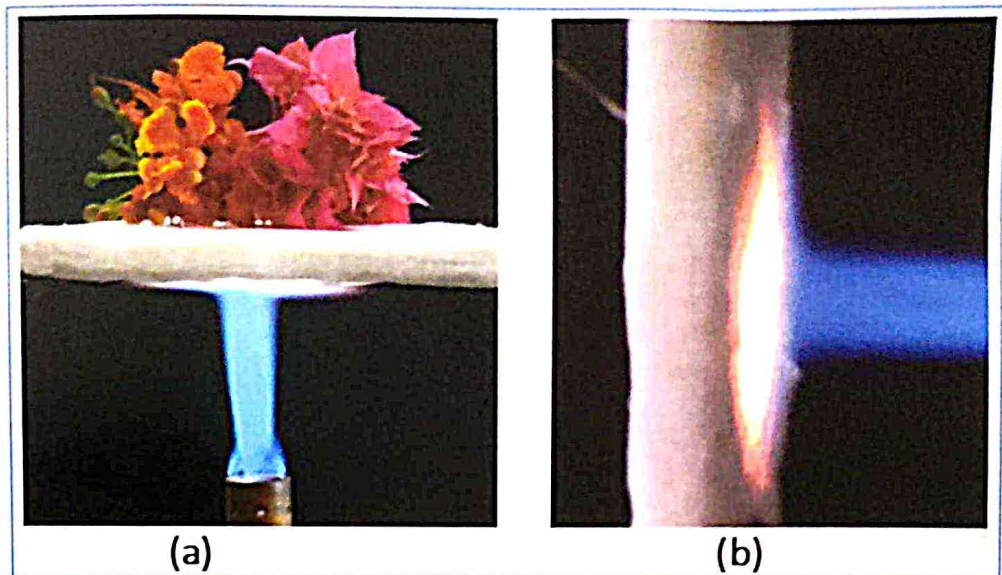


Figure 6: Silica aerogel sheet showing (a) efficient thermal insulation, and (b) fire resistance property

complexity and the cost adhered to it. A proper study is necessary to find any toxic effects of handling or wearing the nanomaterials to eliminate any health risks due to short or long-time exposure. For example, nanosilver application on textiles was studied for leaching of silver in water while washing the fabric, and it achieved its concentration within safe limits. Before launching the technology commercially, it was confirmed that the technology is environment-friendly. □

#### References

1. The Antibacterial Mechanism of Silver Nanoparticles and Its Application in Dentistry, Iris Xiaoxue Yin, Jing Zhang, Irene Shuping Zhao, May Lei Mei, Quanli Li, Chun Hung Chu, *International Journal of Nanomedicine*, 2020, 15, 2555–2562
2. Synthesis and surface chemistry of nanosilver particles Revathi Janardhanan, Murugan Karuppaiah, Neha Hebalkar, Tata Narsinga Rao, *Polyhedron*, 2009, 28, 2522–2530
3. Silica– silver core-shell particles for antibacterial textile application, K. Nischala, Tata. N. Rao and Neha Hebalkar, *Colloids and Interfaces – B: Biointerfaces*, 2011, 82, 203–208
4. Environmental Applications of Semiconductor Photocatalysis, Michael R. Hoffmann, Scot T. Martin, Wonyong Choi, and Detlef W. Bahnemann, *Chemical Review*, 1995, 95, 69-96

#### Further Reading

1. Modern Applications of Nanotechnology in Textiles, A.P.S. Sawhney and B. Condon, K.V. Singh, S.S. Pang, and G. Li, David Hui, *Textile Research Journal*, 2008, 78(8), 731–739.
2. Selected applications of nanotechnology in textiles, Wong YWH, Yuen CWM, Leung MYS, Ku SKA, Lam HLI *AUTEX Res. J.* 2006, 6(1), 1-8.
3. Application of nanotechnology in textile engineering: An overview, J. K. Patra and S. Gouda, *Journal of Engineering and Technology Research*, 2013, 5(5), 104-111.
4. Applications of nanotechnology for high-performance textiles, *Journal of textile and apparel technology and management*, Lei Qian, Juan P. Hinestroza, 2004, 4(1), 1-7.



# Light House Projects

*Amrit Abhijat*

On 1 January 2021, the Prime Minister laid the foundation of six Light House Projects (LHPs). India charted into a decisive shift in the manner of construction that is perceived and implemented in the country. This also marked the beginning of a journey to prepare the country to adopt the innovative technologies in government programmes as a part of the course curriculum, and in bringing about greater awareness in the sectors and the populations. These are called Light Houses as these projects have a demonstrative effect wherein people from all sectors such as faculty and students of engineering/planning/architecture institutes, builders/developers, innovators, policymakers will be able to see and get exposed to site and learn the use of innovative technologies on the ground.

**L**et us look at the broader perspective in which the Light House Projects were conceived within the larger fold of GHTC-India under the “Housing for All” programme.

11.2 million houses under the Scheme, 11.2 million have been sanctioned; out of this over 8.4 million have been grounded for construction, and more than 5 million have been completed and delivered to the beneficiaries. This Scheme has propelled massive investment opportunities and provided the much-needed impetus to industrial production and employment.

As a part of the continuous efforts of the Government of India to fulfill the housing needs of the urban poor, Pradhan Mantri Awas Yojana-Urban (PMAY-U) was launched in June 2015 with an aim to provide all-weather pucca affordable houses to all eligible urban households by the year 2022. So far, against a validated demand of

Construction of houses at this scale offers an opportunity for inviting innovative and alternative technologies from across the globe which may trigger a

## Components



**Construction Technology India: Expo-cum-Conference**



**Identifying and Mainstreaming Proven Demonstrable Technologies for the construction of Light House Projects**



**Identifying Potential Future technologies for Incubation and Acceleration Support through ASHA-India (Affordable Sustainable Housing Accelerators)**

The author is the Joint Secretary & Mission Director of PMAY (Urban): Housing for All Mission in Ministry of Housing & Urban Affairs, Government of India. Email: [jshfa-mhua@gov.in](mailto:jshfa-mhua@gov.in)



major transition through the introduction of cutting-edge building materials, technologies, and processes. In order to comprehensively address the housing shortage in a time-bound manner, the conventional system of housing construction was felt to be inadequate, and hence there was an urgent need to explore new and emerging, disaster-resilient, environment-friendly, cost-effective, and speedy construction technologies.

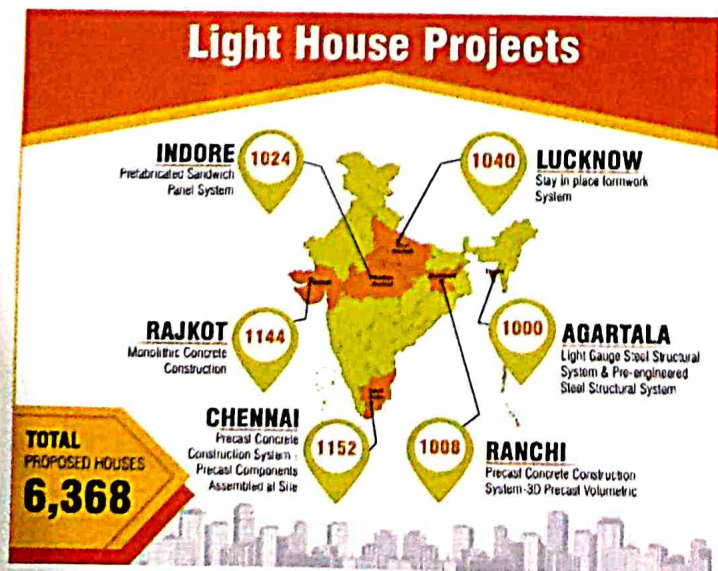
After much deliberation with the multi-stakeholders, Global Housing Technology Challenge-India (GHTC-India) was initiated in January 2019 with three components.

Further, through a rigorous technical evaluation and deliberation, 54 innovative technologies from across the world were shortlisted and grouped into six broad streams or categories as per their suitability for different geo-climatic regions of the country.

Out of these, six distinct technologies were taken up for the construction of innovative projects in six states across the country. Six sites i.e. Indore (Madhya Pradesh); Rajkot (Gujarat); Chennai (Tamil Nadu); Ranchi (Jharkhand); Agartala (Tripura), and Lucknow (Uttar Pradesh) were selected for construction of model housing projects through a national challenge process wherein all States/UTs participated and were selected through an evaluation process that showcased a sense of co-operative federalism. These LHPs comprise about 1,000 houses at each location along with allied infrastructure facilities which are required to be completed within 12 months.

These six LHPs were introduced for familiarisation, adaption, and adaptation of the innovative construction technologies, materials, and processes suited to Indian geo-climatic, and other conditions so that they may be replicated for construction in other development projects of public and private sectors. Special attention has been paid to the fact that these technologies are resource-efficient, sustainable, climate-resilient, cost-effective, and result in a faster pace of construction.

These are called Light Houses as these projects have a demonstrative effect wherein people from all sectors such as faculty and students of engineering/ planning/ architecture institutes, builders/developers, innovators, policymakers will be able to see and get exposed to site and learn the use of innovative technologies on the ground. The six innovative projects are similar to Light Houses which would give a direction to the construction industry in housing and institutional construction (universities, yards, infrastructure).





The technologies being used in LHPs are new to the country with limited use in the construction sector. Therefore, learning, evaluation, documentation, adaptation, and mainstreaming of these technologies in different geo-climatic conditions and percolating the right technical know-how in the minds of stakeholders are of utmost importance.

These projects will serve as live laboratories for on-site and off-site learning, facilitating the transfer of technology to the field, and its further replication. It is intended that large-scale citizen participation and technical awareness may be created for on-site learning, deliberations, experimentation, and encouraging innovation, thereby mainstreaming these global technologies in the Indian context.

Taking this agenda forward, MoHUA has proposed a comprehensive strategy to collaborate with young minds, creators, students, faculties, entrepreneurs, States/UTs, and other stakeholders, for wide dissemination of knowledge and technical learning on the use of innovative technologies on the ground.

On the line of Satyagrahis and Swachhagrahis, a program of 'TECHNOGRAHIS' was launched in February 2021 for free enrolment of all stakeholders interested in learning different phases of use of innovative technologies in LHPs. Technograhis will be the change agents of innovative and sustainable technologies to Transform the Urban Landscape for the New Urban India. They will get first-hand information of the technologies being used and in turn, they can adapt and adopt them as per their requirements in the construction sector for a 'Make in India' approach. More than 15,000 Technograhis have already been enrolled so far, who are being engaged with regular updates from LHP sites through webcasting and other media.

The live labs have been expanded to reach out to many more through a free-of-cost e-Module certificate course on these innovative technologies that is open to all. This e-module includes audio-visual classes, on-site recording of construction, talks by domain experts/developers/project engineers, etc.

In a major policy push towards the use of innovative



and alternate technologies in the LHPs sector, MoHUA has introduced a Technology Innovation Grant (TIG) to offset this impact and absorb the issues related to economies of scale and other related factors. TIG is a financial grant provided to the States which is in addition to the existing funding under PMAY(U).

The technological adaption will get framed under the NAVARITIH, a short-term online certificate course intended to enhance the capability of the building professionals about the new and emerging building materials and technologies for housing and building construction. In addition, an online course on Vulnerability Atlas of India would be useful for urban managers, States & National Authorities dealing with disaster management and mitigation in the evaluation of the multi-hazard profile of the region and incorporating them in DPRs, i.e. Design basis and Tender documents.

India is witnessing a rapid change in the construction industry wherein new materials, technologies, and processes are being introduced on a regular basis. GHTC-India aspires to develop an eco-system to deliver on the technological challenges of the housing construction sector in a holistic manner. Apart from the LHPs, nearly 16 lakh houses are being constructed using innovative and alternative technologies by States/UTs under PMAY-U and other schemes.

Out of the 54 innovative technologies identified under GHTC-India, 39 of them have been evaluated and certified under the Performance Appraisal Certification Scheme (PACS) through Building Materials and Technology Promotion Council (BMTPC). Central Public Works Department (CPWD) has issued a Schedule of Rates (SOR) for 29 of these technologies. Innovative Technologies recognised in the Schedule of Rates will make it possible for widespread adaptation in public construction works.

The Ministry has also been coordinating with the Ministry of Education, Govt of India to adopt these

innovative technologies as a part of the course curriculum for Undergraduate/Post Graduate students of IITs/NITs/SPAs/CEPT, etc. The Ministry of Skill Development and Entrepreneurship is being associated to prepare training modules on new technologies for artisans/masons/electricians/plumbers/carpenters, etc. in ITIs/Skill Development Councils.

It is expected that the footprint of innovative technologies will increase in projects developed by private sectors, CPWD, NBCC, Defence, Railways, etc. These will go on to demonstrate firm resolve to address issues of climate change by reducing the carbon footprints, thermal comfort, C&D waste reduction, reduction of the construction period, etc. to which India is committed. This will also address the housing shortage in which technology has a significant role in reducing the construction time. It will also serve as a financial investment as these will not be a business as usual (originally these projects take about 24 to 36 months) but will get reduced to 12 months or so. These Light Houses will stand out for India's pursuit of innovation, excellence, adaptation, and self-reliance (Aatmanirbhar) in construction methods and provide better homes with people being at the core of each action.

Through LHPs, beneficiaries (house owners) will have access to improved living conditions and environment in futuristic, aspirational, modern, and dignified houses.

Adoption of these innovative technologies would contribute towards achieving the Sustainable Development Goals as laid out by the United Nations, the New Urban Agenda, and the Paris Climate Accord.

As the dynamics of the construction sector in India are evolving and innovating at a pace much faster than envisioned, it is imperative that use of modern and alternate technologies be used vastly to save on time, cost, ensuring quality and long-term efficiency.

*Views expressed are personal.*

□

Ministry of Information and Broadcasting  
Government of India

आजादी का  
**AMRIT MAHOTSAV**

www.publicationsdivision.nic.in | @publicationsdivision | /DPD\_India | /dpd\_India | /businesswng@gmail.com

# Drone Policy

*Aarushi Aggarwal*

Scientific thought and exploration hold an important position in Indian society and culture. Our long history is dotted with notable mathematicians and scientists whose contributions to their fields have been widely acknowledged. The various campuses of the Indian Institute of Technology (IIT), established soon after India's independence, have produced some of the finest scientific minds in the world. To encourage this scientific spirit, the Government of India has recently released a new and liberalised drone policy. This article looks at this new policy, the Drones Rules 2021, while also highlighting its past usage in India and prospects.

## Drones in India

Drones, officially known as Unmanned Aircraft Systems (UAS), have been in widespread use in the Indian military since the 1990s. While the first drones were imported into India from Israel for use in active combat, India's Defence Research and Development Organisation (DRDO) has since then developed numerous indigenous drones that have been successfully deployed by the three wings of the Indian Armed Forces. The evolving nature of warfare has prioritised training in and preparation for stealth missions. Drones are a key element of this transformation and are indispensable in reconnaissance, precision targeting, and intelligence gathering, among others.

To further encourage domestic innovation and indigenous development of drone systems, in June 2021, the Ministry of Defence announced a budgetary allocation of INR 498.8 crore (USD 67 million) over five years, for a scheme under Innovations for Defence Excellence (iDEX). iDEX is the executive arm of the Defence Innovation Organisation (DIO) and is responsible for creating an ecosystem that fosters indigenous innovation



and technological development in India's defence and aerospace sectors. It engages with MSMEs, startups, innovators, academics, and R&D institutions to evaluate technologies for scalability and aids the armed forces in technological adoption.

This scheme will provide financial support to 300 MSMEs, startups and innovators, and 20 partner incubators. It also promises to sustain the emergent robust synergy between India's innovators, the defence manufacturing industry, and the country's defence systems. On a larger scale, it is a testimony to the Make in India programme and the growing government support for indigenously developed technologies.

## Drones Rules, 2021<sup>1</sup>

Technological development over the last three decades, since drones were first used in India, has made them more affordable, accessible, and applicable across sectors. It is not uncommon for drones to be used in aerial photography, infrastructure assessment, agricultural inspection, disaster management and fire-fighting, police surveillance and now, even package delivery. A global e-commerce giant has announced that it is currently developing a future delivery system designed to safely get packages to customers in 30 minutes or less using autonomous aerial vehicles.<sup>2</sup> To prepare for this, India needs specific drone corridors for cargo deliveries.

In July 2021, the Government of India released a draft policy for drones that is “built on a premise of trust, self-certification and non-intrusive monitoring” and is “designed to usher in an era of super-normal growth while balancing safety and security considerations.” The policy recognises the immense applications of drones and allows enthusiasts and professionals to explore this within more liberal regulations. Until now, keeping in mind the security concerns, civilian use of drones was restricted and closely monitored. However, more widespread usage and enhanced counter-surveillance systems have eased some of the concerns regarding civilian usage. This has allowed greater civilian usage of drones, even for recreational purposes.

The new policy<sup>3</sup> qualifies drones into five classifications based on their maximum all-up weight, including the payload. Mini drones can be as light as less than 250 grams while large drones can weigh over 150 kilograms. To ease the civilian purchase and use of drones, the price for obtaining a remote pilot licence has been reduced significantly to INR 100 and de-linked from the size of the drone. Remote pilot licences will now also be valid for up to 10 years.

Furthermore, the government no longer mandates any licences for the operation of neither a mini (less than 250 grams) nor a pilot licence to operate nano (greater than 250 grams and less than or equal to 2 kilograms) drones. Requirements for security clearance before issuance of any registration or licence have also been removed. However, all drones must be qualified with a ‘certificate of airworthiness’ before they can be operated. The Ministry of Civil Aviation will also soon release its Digital Sky programme,<sup>3</sup> intended as a single window for required clearances, which have been reduced from 25 to five. The Ministry will also release an interactive airspace map on its website that will

---

**The new policy qualifies drones into five classifications based on their maximum all-up weight, including the payload.**

**Mini drones can be as light as less than 250 grams while large drones can weigh over 150 kilograms. Remote pilot licences will now also be valid for up to 10 years.**

---



show three zones — yellow (controlled airspace), green (no permission required), and red (flying not permitted) so that the drone users can know where they may operate their UASs. In a significant change, a previous no-fly radius of 45 kilometres around airports has now been reduced to 12 kilometres.

### Indian Drone Market

As the previous section states, drones have abundant uses across numerous sectors. With the easing of policies governing the non-military use of drones in India, the market for drones has received an important impetus. Reports suggest that India is already the fastest-growing drone market in the world. A January 2020 report by PwC also suggested that the market size of drones in India would be USD 885 million. It is expected to reach USD 1,810 million by FY 2026, growing at a compound annual growth rate (CAGR) of 12.6 per cent between 2020 and 2026. Meanwhile, the global market for drones will surpass USD 43 billion in 2024 from USD 14 billion in 2018 at a CAGR of 20.5 per cent.<sup>4</sup> To leverage this opportunity effectively, therefore, the liberalised policy has been welcomed by industry players and drone enthusiasts alike. It also comes at an opportune time as global businesses expand to include drones in business-efficiency enhancement, speed delivery, and expand operations.

India is currently the third-largest importer of military-grade drones with 6.8 per cent of total Unmanned Aerial Vehicle (UAV) imports according to the Stockholm International Peace Research Institutes (SIPRI).<sup>4</sup> To reduce dependence on imports, DRDO has launched several programmes to develop and deploy UAVs in India. At the same time, there are over 185 startups engaged in the development of drones for various purposes, including military usage, surveillance, deliveries, agricultural purposes, visual mapping, etc. The Drones Policy, 2021 will further enhance this emerging ecosystem and create a thriving market for drones’

research and development in India. Apart from public sector entities and startups, India's private sector companies are also involved in drone manufacturing.

### **India's Inherent Innovation Potential**

India's entire economic and social system is undergoing tremendous changes. As our economy expands to include geographic and cultural peripheries, new voices are emerging into the mainstream, and they are bringing ever new ideas to the forefront of national and international discussions. The deep penetration of the internet has, at the same time, allowed Indians to become well acquainted with emerging global ideas and adapt them to our local conditions and needs. They are now producing an amalgam of international ideas with Indian technology. The innovation potential in India is, therefore, inherent to its social fabric. The Government's recognition of this characteristic—as is evident in this policy change and numerous others—is an important boost to the Indian economic standing and business potential.

The easing of regulations surrounding the use of drones has also potentially opened the segment to international funding that can be instrumental in driving research and development, studying adaptability to Indian systems and innovation at large. The Government has already significantly liberalised India's FDI regime,

such that the country has emerged as one of the leading destinations for global foreign direct investments (FDI) despite the Covid-19 pandemic. Total FDI inflows into India grew by 13 per cent in 2020, even as global FDI declined by 42 per cent.<sup>5</sup> The increasing attractiveness of India as a destination for FDI is a testimony to its business and innovation potential that was widely displayed in the early days of the pandemic, when India's startups and private sectors developed ventilators and other Covid-19 pandemic related equipment in record time, and with negligible prior experience.

Now, with the targeted support to the drone industry, India can be sure to witness a transformation in its interaction with Unmanned Aircraft Systems. The skies are now wide open for all to explore. □

### **References**

1. <https://pib.gov.in/PressReleaseDetailm.aspx?PRID=1749154>
2. <https://www.amazon.com/Amazon-Prime-Air/b?ie=UTF8&node=8037720011>
3. [https://www.civilaviation.gov.in/sites/default/files/Draft\\_Drones\\_Rules\\_14\\_Jul\\_2021.pdf](https://www.civilaviation.gov.in/sites/default/files/Draft_Drones_Rules_14_Jul_2021.pdf)
4. <https://www.moneycontrol.com/news/business/eyes-in-the-sky-exploring-indias-evolving-drone-ecosystem-7160921.html>
5. <https://unctad.org/news/global-foreign-direct-investment-fell-42-2020-outlook-remains-weak>

# Science Education

*Nimish Kapoor*

The New Education Policy (NEP) 2020 is a big revolutionary step in the education system of India. NEP aims to implement new dimensions in school education like experiential and hands-on learning, arts-integrated and sports-integrated education, story-telling, and life-skills based pedagogy. Classroom transactions will shift towards competency-based learning and education. The mandated content will focus on key concepts, ideas, applications, and problem-solving. Teaching and learning will be conducted more interactively. Curriculum content will be reduced in each subject to its core essentials, making space for critical thinking and more holistic, inquiry-based, discovery-based, discussion-based, and analysis-based learning. Applications, online modules, and ICT-equipped libraries will play a major role in the times to come.

**F**or the last few decades, many schemes and programmes are being run by the Department of Science and Technology (DST), the Government of India and its institutions for school students, which give a clear glimpse and correlation with the structure and action points inbuilt in NEP. Today these programmes can play a major role in fulfilling the objectives of NEP. Dissemination of these programmes and schemes are required at the grassroots level to connect the children of the remotest parts of the country.

## **INSPIRE Programme and MANAK Scheme**

Innovation in Science Pursuit for Inspired Research (INSPIRE) programme is one of the flagship programmes of DST and implemented by National Innovation Foundation (NIF) to encourage students to pursue science as a career. The Scheme has been aligned with Action Plan-18 of the Startup India programme that stipulates the 'launching of innovation-focused programmes for students.'

INSPIRE aims to communicate to the youth population of the country the excitements of creative pursuit of science, attract talent to the study of science at an early stage, and build the required critical human resource pool for strengthening and expanding the Science & Technology system and R&D base. INSPIRE Scheme has included three programmes - (a) Scheme for Early

Attraction of Talents for Science (SEATS), (b) Scholarship for Higher Education (SHE), and (c) Assured Opportunity for Research Careers (AORC).

The INSPIRE Awards - MANAK (Million Minds Augmenting National Aspirations and Knowledge) Scheme, being executed by DST with NIF - India, aims to motivate students in the age group of 10-15 years and studying in classes 6 to 10. The objective of the Scheme is to target one million original ideas/innovations rooted in science and societal applications to foster a culture of creativity and innovative thinking among school children. Under this, schools can nominate the five best



The author is Scientist 'E' and Head of Publications Division in Vigyan Prasar. Email: [nkapoor@vigyanprasar.gov.in](mailto:nkapoor@vigyanprasar.gov.in), Twitter: @VigyanPrasar





original ideas/innovations of students by mid-October, every year.

This programme reaches Indian districts and schools across the country through regional workshops, audio-visual tools, and literature. An internal idea competition in schools is organised, and nominations of two to three best original ideas are submitted, in any Indian language, by the respective Principal through online E-MIAS (E-Management of INSPIRE Awards MANAK Scheme) portal.

NIF provides mentoring support to students for the development of prototypes, in coordination with reputed academic and technology institutions of the country. The selection of ideas/innovations is based on novelty, social applicability, environment friendliness, user-friendliness, and comparative advantage over the existing similar technologies. Finally, it showcases 1,000 best ideas/innovations at the National Level Exhibition & Project Competition (NLEPC) with the shortlisting of the top 60 innovations for national awards.

Incubation support is provided to selected innovations, which has helped in scaling up students' creativity. As a result, ideas like 'manual waste lifting and dumping cart' evinced market interest and the technology

was transferred to a firm, now a startup recognised by the Department for Promotion of Industry and Internal Trade (DPIIT).

### **'Vigyan Jyoti' and 'Engage with Science'**

The DST is scaling up its two initiatives—Vigyan Jyoti and Engage with Science. Both the programmes are mandated to create a level-playing field for the meritorious girls in high school to pursue Science, Technology, Engineering, and Mathematics (STEM) in their higher education. It also offers exposure to girl students from rural backgrounds to help plan their journey from school to a job of their choice in the field of science.

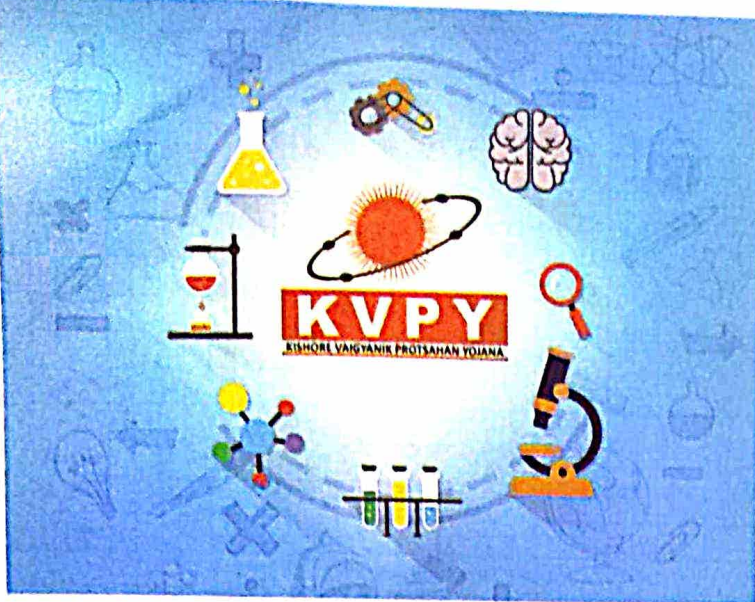
Vigyan Jyoti is a programme to promote STEM learning among girl students from grades 9 to 12 to pursue STEM in their higher education, especially from the top colleges in the areas where girls are hugely underrepresented. Vigyan Jyoti aims to tap 100 girl students in 550 districts from 2020-2025, the

students will be chosen based on their percentile. The initiative focuses on solving the multidimensional problems associated with the meagre representation of women in the Engineering and Technology streams in higher education, by building confidence and excitement towards these streams.

---

**The objective of the Scheme is to target one million original ideas/innovations rooted in science and societal applications to foster a culture of creativity and innovative thinking among school children.**

---



Scaling up of the interactive learning platform - Engage with Science is another initiative of DST to build interest and create a community of practice with students, teachers, and scientists connecting the high-school students to the higher education institutions. This programme is being coordinated by Vigyan Prasar. Engage With Science is an interactive programme available on top of the India Science Over-The-Top (OTT) platform.

Engage with Science has been planned to make learning relevant and foster scientific spirit amongst the country's youth. It would address the school students directly who need more knowledge outside the classroom and provide insights into an interactive way of learning. More details are available at [www.engagewithscience.in](http://www.engagewithscience.in).

### Vidyarthi Vigyan Manthan Programme

Vidyarthi Vigyan Manthan (VVM) is a national programme for popularising science among school students of standard VI to XI, conceptualised to identify the bright minds with a scientific aptitude among the student community. VVM is being organised by Vijnana Bharati in collaboration with Vigyan Prasar and the National Council of Educational Research and Training (NCERT).

With objectives to create an interest among students in science, VVM programme educates school children about India's contributions, from traditional to modern, to the world of science and technology, and provides hands-on training to students through workshops and other events. VVM also provides mentors for preparing students to carry forward their education in the field of science and conducts competitive tests to identify students who have a scientific bent of mind.

Students participating in VVM undergo multi-level testing procedures which include- objective type questions' answering, comprehensive writing, presentation and group

discussion, role-play, practical examination and other methods of science. VVM provides an opportunity to national winners (called Himalayans) and zonal winners, to participate in an extensive training cum internship 'Srijan' for few weeks in any one of the reputed national labs or premier research institutions. VVM is introducing Bhaskara Scholarship of Rs 2000 per month to the national winners for one year. VVM is a national level, App-based, science talent search examination that is conducted online. Students may get more information on VVM at [www.vvm.org.in](http://www.vvm.org.in).

### Kishore Vaigyanik Protsahan Yojana (KVPY)

Kishore Vaigyanik Protsahan Yojana (KVPY) is a flagship programme of the DST, implemented by the Indian Institute of Science (IISc), Bangalore to encourage students who are studying Basic Sciences to take up a research career in science. Fellowship and contingency grants are provided to the selected KVPY Fellows up to the pre PhD level or five years, whichever is earlier.

### National Children's Science Congress

National Children's Science Congress (NCSC), also referred to as Children's Science Congress (CSC) at the district and state levels, is a nationwide Science Communication programme of the National Council for Science and Technology Communication (NCSTC), DST, Government of India.

Children's Science Congress forum, available to children in the age group between 10-17 years, prompts children to think of some significant societal problems, ponder over its causes, and subsequently try and solve the same using the scientific process. This involves close and keen observation, raising pertinent questions, building models, predicting solutions on the basis of a model, trying out various possible alternatives, and arriving at





an optimum solution using experimentation, fieldwork, research, and innovative ideas. The Children's Science Congress encourages a sense of discovery. It emboldens the participants to question many aspects of our progress and development, and express their findings.

It is a group activity on a local specific problem using simple methods of science. More information is available on [www.ncsc-india.in](http://www.ncsc-india.in).

### Science Clubs

VIPNET, an acronym for VIGyan Prasar NETwork of Science Clubs, weaves all science clubs, societies, organisations which are already established, or are going to be established, and are willing to work for science communication, to strengthen the popular science movement in the country with far-reaching implications for the development of society.

An active and fully functional science club working in any part of the country can be a part of VIPNET by simply registering with VIPNET for affiliation. VIPNET clubs work as local activity centers of the network to disseminate information on S&T at grassroots level with the objectives to reach out to fellow citizens, especially in remote areas to popularise science, stimulate a spirit of curiosity, inquiry, innovation, and creativity to supplement conventional education and foster scientific temper.

---

**The programme is expected to connect 1,151 Kendriya Vidyalayas with 38 National Laboratories of CSIR targeting 100,000 students and nearly 1,000 teachers annually.**

---

To register, visit [www.vigyanprasar.gov.in/vipnet](http://www.vigyanprasar.gov.in/vipnet).

### JIGYASA Programme

The Council of Scientific and Industrial Research (CSIR) has launched a student-scientist connect programme JIGYASA, in collaboration with Kendriya Vidyalaya Sangathan (KVS), with the primary objectives of extending the classroom education and focusing on well-planned research laboratory-based learning. JIGYASA is planned to inculcate the culture of inquisitiveness, along with the scientific temper amongst the school students and their teachers. The programme is expected to connect 1,151 Kendriya Vidyalayas with 38 National Laboratories of CSIR targeting 100,000 students and nearly 1,000 teachers annually. For more information on JIGYASA, reach to [csirjigyasa.niscair.res.in](mailto:csirjigyasa.niscair.res.in).

Along with these innovative programmes, the Govt of India has launched Atal Innovation Mission (AIM) to create and promote a culture of innovation and entrepreneurship across the country to adopt a holistic approach, encompassing schools, universities, research institutions, industry, etc. With many student-centric programmes on S&T, the launch of NEP will develop a scientific attitude in children and pave the way for the creation of New India. □

# Nutrition and Vaccination

*Hemant Kumar Meena  
Dr Rinky Thakur*

**Nutrition is a critical part of health and development. Better nutrition is related to the improved infant, child and maternal health, stronger immune systems, safer pregnancy and childbirth, lower risk of diseases and longevity. Malnutrition, in every form, presents significant threats to human health.**

**T**oday, the world faces a double burden of malnutrition that includes both undernutrition and obesity, especially in low and middle-income countries. Women are at a greater risk of malnutrition due to the increased nutritional requirements associated with menstruation, pregnancy, and lactation. Also, they are more exposed to risk factors for malnutrition such as HIV/AIDS, food insecurity, and poverty. The nutritional status of women has major implications on the well-being and nutrition of all the family members. Each year, approximately 2.3 million deaths among 6-60 months-aged children in developing countries are associated with malnutrition, which is about 41% of the total deaths in this age group<sup>1</sup>. According to the Comprehensive National Nutrition Survey report (2016–2018), 35% of Indian children aged 0–4 years are stunted, 17% are wasted, and 33% were underweight<sup>2</sup>.

For the healthy development of women and children, the Government of India has various health and nutrition-related programmes and schemes.

## **Initiatives on Nutrition**

The Government implements Anganwadi Services Scheme, POSHAN Abhiyaan, Pradhan Mantri Matru Vandana Yojana, and Scheme for Adolescent Girls, under the Umbrella Integrated Child Development Services Scheme (ICDS), as targeted interventions for children upto the age of 6 years; pregnant women, lactating mothers, and adolescent girls throughout the country. For meeting the nutritional needs of school-going children, the National Programme of Mid-Day Meal in schools is implemented.

## *Anganwadi Service Scheme*

Anganwadi Service Scheme is one of the major flagship programmes launched in 1975 by the Government of India. It represents one of the world's largest and unique programmes for Early Childhood Development. It provides a package of six services, namely, supplementary nutrition, pre-school non-formal education, nutrition & health education, immunisation, health check-up, and referral services. The beneficiaries of the Scheme are children in the age group of 0-6 years, pregnant women, and lactating mothers. ICDS is the largest outreach programme operational through Anganwadi Centres (AWC) which serves as the first outpost for health, nutrition, and early learning services at the village level. The number of operational AWCs reported as of 15 August 2021 was 13.05 lakh.



Hemant Kumar Meena is Deputy Secretary, NITI Aayog and Dr Rinky Thakur is Research Officer, NITI Aayog. Email: [wcd-niti@gov.in](mailto:wcd-niti@gov.in)



- (i) The number of beneficiaries [children (6 months to 6 years), and pregnant women & lactating mothers] for the Supplementary Nutrition Programme reported as of 15 August 2021 was 10.70 crore.
- (ii) The Number of beneficiaries- children (3 to 6 years) for the Pre-School Education Programme reported as of 15 August 2021 was 3.39 crore.

**POSHAN Abhiyaan**

Launched in 2018, POSHAN Abhiyaan is the flagship programme which aimed at drawing the nation’s attention to the complex issue of malnutrition and strived to address it in a mission-mode. The Abhiyaan attempts to deliver a high impact package of interventions for first 1,000 days of life, along with strengthening the training and capacity building, multi-sectoral convergence, and bringing out behavioural change through Jan Andolan. Target is to bring down stunting of children aged under 6 years from 38.4% to 25%, by the year 2022.

The key features devised under POSHAN Abhiyaan are:

1. A high-impact package of interventions with a focus on (but not limited to) the first 1000 days of a child’s life.
2. Strengthening delivery of high impact package of interventions through-
  - Remodelling of nutrition-monitoring by leveraging technology and management through ICDS-CAS (now POSHAN Tracker);



- Improving capacities of frontline workers through the Incremental Learning Approach (ILA) mechanism;
  - Emphasising on convergent actions among the frontline workforce
3. A focus on cross-sectoral convergence to emphasise the multidimensional nature of malnutrition, mapping of various schemes contributing towards addressing malnutrition. Convergence committees at the state, district, and block levels will support decentralised and convergent planning and implementation, supported by flexi-pool and innovation funds to encourage contextualised solutions.
  4. Ramping up behaviour change communication and community mobilisation through Jan Andolan, a large-scale national nutrition behaviour change campaign that uses community-based events, mass media, and other approaches.

The Abhiyaan has set key pillars which are fundamental for achieving the desired targets. (Figure 1)

**Pradhan Mantri Matru Vandana Yojana (PMMVY)**

Launched on 31 December 2016, PMMVY is a maternity benefit programme which provides partial compensation for wage loss in terms of cash incentives of Rs 5000 for adequate rest, and improved health of the pregnant and lactating mothers. This Maternity Benefit Scheme was implemented in January 2017 as a Direct Benefit Transfer (DBT) with a cash incentive of Rs 5000

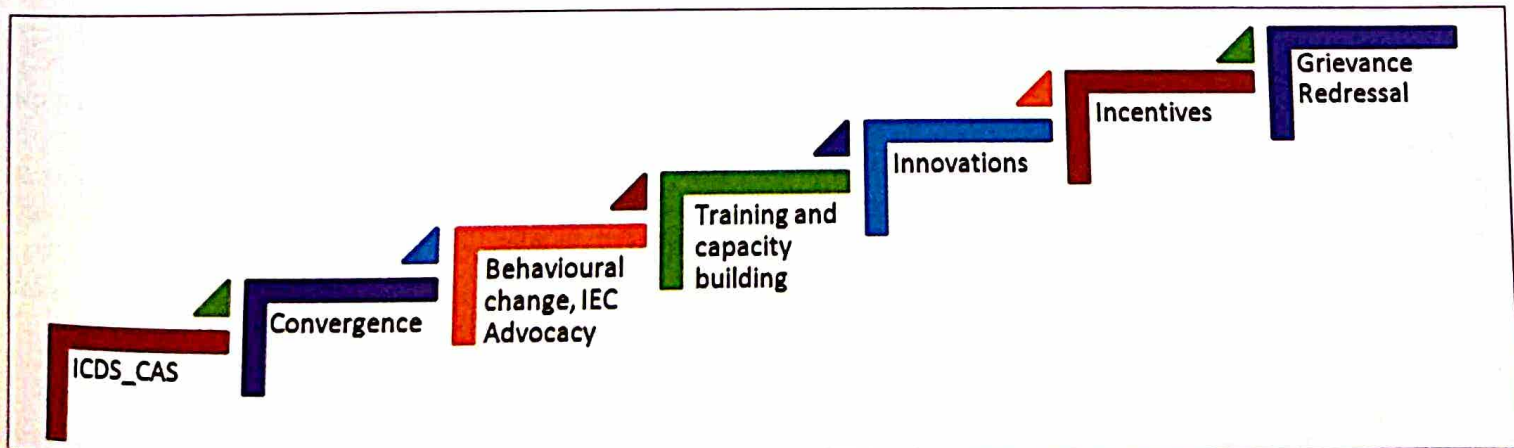


Figure 1: Pillars of POSHAN Abhiyaan

**First Installment**

**Early registration of pregnancy with frontline worker, within five months of pregnancy**

**INR 1,000**

**Second Installment**

**Receipt of at least one antenatal care (ANC) check-up in first six months of pregnancy**

**INR 2,000**

**Third Installment**

**Registration of child birth and Receipt of first cycle of immunisation (BCG, OPV, DPT, Hepatitis-B, or its equivalent/substitute)**

**INR 2,000**

**Total Value of Cash Transfer under PMMVY: INR 5,000**

Source: Evaluation of WCD schemes, DMEO Report, 2020

Figure 2: Installments against Conditionalties under PMMVY

to be provided to the pregnant women & lactating mothers for the first child given in three installments, subject to fulfilling specific conditions related to maternal and child health.

PMMVY is implemented using the platform of Anganwadi Services Scheme or the Social Welfare Department and Health system. All the eligible beneficiaries who have applied and fulfilled with the conditionality, receive payments through Direct Benefit Transfer (DBT) to their individual Bank/Post Office accounts that are specified by them in their application form(s) on approval by the competent authority.

The Scheme benefits provided in instalments are summarised in Figure 2.

PMMVY scheme presents a successful model of DBT scheme, ensuring that maternity benefits reach the beneficiary accounts directly. As on 30 April 2021, over

2.24 crore beneficiaries have been enrolled in the scheme.

### Scheme for Adolescent Girls

Fulfilling the multi-dimensional needs of out-of-school adolescent girls (11-14 years) with an aim to motivate them to join school system, the Government of India approved implementation of restructured Scheme for Adolescent Girls (SAG) to focus on out-of-school adolescent girls in the age group of 11-14 years in the year 2017-18. A package of following services is provided to adolescent girls:

- Nutrition supplies
- Iron and Folic Acid (IFA) supplementation
- Health check-up and Referral services
- Nutrition & Health Education (NHE)
- Mainstreaming out-of-school girls to join formal schooling
- Life Skill Education, Counselling, etc.

Each out of school adolescent girl in the age group of 11-14 years registered under the scheme is provided supplementary nutrition containing 600 calories, 18-20 grams of protein and, micronutrients for 300 days in a year. Nutrition is given in the form of Take Home Ration or Hot-Cooked-Meals, whichever is feasible.

All these schemes addressed in one or other aspects related to nutrition, have the potential to improve nutritional outcomes in the country. For alleviation of malnutrition, the Government has announced Mission POSHAN 2.0 to strengthen nutritional content, delivery, outreach, and outcomes with focus on developing practices that nurture health, wellness, and immunity against disease and malnutrition.

### National Programme of Mid-Day Meal in Schools

In order to improve the nutritional status of school going children, the National Programme of Mid-Day



Meal in Schools is implemented by the Ministry of Education, wherein one mid-day meal is provided to children as per the nutritional standards given in the Schedule-II of the National Food Security Act, 2013. Under the prevailing circumstances (Covid-19), as it is not possible to provide hot cooked meals, States/UTs have been advised to provide Food Security Allowance (FSA) comprising of food grains, pulses, oil, etc., (equivalent to cooking cost) to all eligible children until the time their schools are closed due to the aforesaid pandemic.

### *Anemia Mukh Bharat*

Under Anemia Mukh Bharat strategy, support is provided to the States and UTs for prevention and treatment of anemia in children (5-9 years) and adolescent girls and boys (10-19 years). The strategy involves provision of prophylactic iron folic acid supplementation, periodic deworming, testing and treatment of anemia using digital methods and point of care treatment through school platform along with addressing non-nutritional causes of anemia in endemic pockets with special focus on Malaria, Haemoglobinopathies, and Fluorosis.

### **Initiatives on Vaccination**

The Ministry of Health and Family Welfare, Government of India provides several vaccines to infants, children, and pregnant women through Universal Immunisation Programme (UIP). It is a vaccination programme launched by the Government of India in 1985.<sup>3</sup> It became a part of Child Survival and Safe Motherhood Programme in 1992, and is currently one of the key areas under National Rural Health Mission since 2005. The programme consists of vaccination for 12 diseases- tuberculosis, diphtheria, pertussis (whooping cough), tetanus, poliomyelitis, measles, hepatitis B,



**The Abhiyaan attempts to deliver a high impact package of interventions for first 1,000 days of life, along with strengthening the training and capacity building, multi-sectoral convergence, and bringing out behavioural change through Jan Andolan.**

diarrhoea, Japanese encephalitis, rubella, pneumonia (*haemophilus influenzae* type B), and Pneumococcal diseases (pneumococcal pneumonia and meningitis). Hepatitis B and Pneumococcal diseases were added to the UIP in 2007 and 2017 respectively.<sup>4</sup>

Universal Immunisation Programme is one of the largest public health programmes in the world. It targets around 2.9 crore pregnant women and 2.67 crore newborn annually. More than 1.2 crore immunisation sessions

are conducted every year. It is one of the most cost-effective public health interventions and largely responsible for reduction of the Vaccine-Preventable Diseases (VPD) and decrease in under-5 mortality rate. A child needs seven contacts till the age of five years to complete immunisation under UIP.

### *Mission Indradhanush*

The Ministry of Health and Family Welfare, Government of India launched Mission *Indradhanush* in December 2014 that seeks immunisation coverage for children and pregnant women in India from 65% in 2014 to at least 90% in the next five years through special catch-up drives. It will eventually close immunity gaps and strengthen immunisation coverage.<sup>5</sup> The Government has identified 201 high focus districts across the country that have nearly 50% of all unvaccinated or partially vaccinated children in the country. Bihar, Madhya Pradesh, Rajasthan, and Uttar Pradesh account for 82 of the 201 high focus districts and nearly 25% of the unvaccinated or partially vaccinated children of India.

- **Nature of Intervention** – The largest ever applications of the “periodic intensification of routine immunisation” strategy was launched by the Government.
- **Intensified Mission Indradhanush** – The Government launched Intensified Mission Indradhanush on 8 October 2017 to reach each and every child under two years of age and all those pregnant women who have been left uncovered under the routine immunisation programme. The target under IMI was to increase the full immunisation coverage to 90% by December 2018. However, only 16 districts in the country have achieved 90% coverage so far.
- **Intensified Mission Indradhanush 2.0** – IMI 2.0 is monitored at the highest level under a special initiative ‘Pro-Active Governance And Timely Implementation (PRAGATI)’ The Intensified Mission Indradhanush 2.0 will target the districts which have immunisation

coverage of 70% or below. This aims to achieve the Sustainable Development Goal of ending preventable child deaths by 2030.<sup>6</sup>

**Intensified Mission Indradhanush (IMI) 3.0** – Intensified Mission Indradhanush 3.0 aims to ensure accessibility to the unreached population with all available vaccines and accelerate the coverage of children and pregnant women in the identified districts and blocks. Focus of IMI 3.0 will be the children and pregnant women who have missed their vaccine doses during the Covid-19 pandemic.

#### **Birth Dose Vaccination Protocol**

Birth dose vaccination is an integral part of UIP. It is provided against the three VPDs of Hepatitis-B, Poliomyelitis and Childhood TB. Birth dose vaccination protocol for the same was developed and shared with the States/UTs for ensuring that no institutionally-delivered newborn gets left without the birth dose.

#### **Covid-19 Vaccination**

Covid-19 pandemic broke out in December 2019 and spread across the world. The Government of India took proactive steps to respond to the pandemic and initiated the preparedness of the health systems to respond to all aspects of Covid-19 management. The public health efforts of India were strongly supported by its research and development capacity in developing vaccines against Covid-19. The Covid-19 vaccination utilises the existing infrastructure of the Universal Immunisation Programme (UIP). A unique digital platform- Co-WIN supports the vaccination activity, helps the programme managers in registration and tracks every beneficiary for Covid-19 vaccination along with real-time information on the available stocks of vaccine, their storage temperature, actual vaccination process, generation of digital certificates, etc. A 24x7 National Call Centre was established to address queries from general public on Covid-19 and the vaccination process.

#### **Covid-19 and Delivery of Health Services**

In order to address the challenges arising out of Covid-19 and closure of schools, the MoHFW has issued guidance notes to all the States and UTs regarding “Enabling Delivery of Essential Health Services during the COVID-19 Outbreak” on 14 April 2020 and “Provision of Reproductive, Maternal, Newborn, Child, Adolescent Health plus Nutrition services during and post COVID-19 pandemic” on 24 May 2020, for continuation of service delivery amid pandemic. The States and UTs have been advised to ensure home

---

**The States and UTs have been advised to ensure home distribution of Iron Folic Acid supplementation to the target age groups i.e. Pre-school Children 6-59 months, Children 5-9 years, Adolescents 10-19 years, Pregnant and lactating women in the containment zones.**

---

distribution of Iron Folic Acid supplementation to the target age groups i.e. Pre-school Children 6-59 months, Children 5-9 years, Adolescents 10-19 years, Pregnant and lactating women in the containment zones. In non-containment zones, it has been advised to undertake distribution of IFA supplements through the Village Health Sanitation Nutrition Days (VHSNDs) to be held in a staggered manner while following all the personal protective

measures and social distancing norms by the front line workers (FLWs), i.e. ASHAs/ANMs/AWWs.

During the strict lockdown months, AWCs were closed across States. In November 2020, the M/o WCD issued guidelines to open AWCs and resume services outside containment zones by following Covid-19 safety protocols at the AWCs. VHSNDs were partly operational in a few States following staggered approach and in non-containment zones. Routine services were provided on-demand at health centres. In April 2020, the MoHFW issued guidance on the delivery of health and nutrition services through home visits by FLWs. Several States continued home visits and bundled essential services, such as distribution of food supplements and counselling of beneficiaries, with home visits. This step was taken by most States to ensure continuity of services.

In the challenging times of pandemic, the Government of India is working for plugging gaps in service delivery, and convergence between ICDS and health services to deliver the package of essential interventions. The focus is towards propagating Jan Andolan by conducting home visits, community-based events, mass media, and more on participation of families and communities. □

#### **Endnotes**

1. *Schroeder DG, Brown KH.* Nutritional status as a predictor of child survival: summarizing the association and quantifying its global impact; *Bull World Health Organ.* 1994; 72(4):569-79.
2. Comprehensive National Nutrition survey report 2016–2018. <https://nhm.gov.in/index1.php?lang=1&level=2&sublinkid=1332&lid=713> . Accessed 15th Oct 2019.
3. “Shri J P Nadda launches Pneumococcal Conjugate Vaccine (PCV) under Universal Immunization Programme (UIP)”. pib.nic.in. Retrieved 2017-05-30.
4. Patra, Nilanjan. “UNIVERSAL IMMUNIZATION PROGRAMME IN INDIA: THE DETERMINANTS OF CHILDHOOD IMMUNIZATION” Indian Statistical Institute, Calcutta. p. 1. Retrieved 1 February 2012.
5. *Global Immunization Data.* 2014; (July):82–5. [Last accessed on 2018 May 29]. Available from: [http://www.who.int/immunization/monitoring\\_surveillance/global\\_immunization\\_data.pdf](http://www.who.int/immunization/monitoring_surveillance/global_immunization_data.pdf)
6. Sharma, Neetu Chandra (31 October 2019).” Intensified Mission Indradhanush (IMI) 2.0 from December 2019”. *Livemint*.



# Lockdown Diary

*K Sindhu Alekya*

**T**he evening of 25 March 2020, was novel in its own way. On hearing about PM Modi's address to the Nation, my family of four gathered in the living room, glued to the TV set. A nationwide lockdown of 21 days was ordered, restricting the movement of 1.38 billion people in order to contain the spread of the coronavirus. My folks were thrilled by the unprecedented stay-at home vacation and hurriedly vetted out drafts of what their interlude would look like. My mother proposed a break from her morning hectic routine and declared a leisurely waking up schedule, my father listed down all the movies he would watch and retro songs he would listen to, my brother had a pile of combat games he needed to play and I, freshly out of school and yet to get into a college, put out a plan for recreations I had planned years in advance for when my 14 years of schooling would come to an end. We would watch the TV news daily, to keep a count of the virus infection numbers but little could we gauge the extent to which this unprecedented break could extend. We were all thankful for the unmonitored days ahead of us.

Out of institution, as we all were, we felt a sense of fearlessness where our time belonged to us and not to any organisation. We were to plan the usage of this time, our schools and offices didn't put us in any framework of functionality for these 21 days, and their sense of timing didn't decide our timetables but 'we' made our own schedules.

"Where the mind is without fear and the head is held high... Into that heaven of freedom, my father, led my country awake." Written by Nobel Laureate Rabindranath Tagore, these lines are from Tagore's own translation of "Chitto Jetha Bhayshunyo" (translates to-Where the Mind is Without Fear) into English in 1912, which also was a part of Gitanjali, the reverted collection of poems giving India its first Nobel Prize. It represents Tagore's vision of a new and awakened India. The father here, refers to the divine proclaiming that it was not the bondage of externally imposed imperial rule, but the walls of fear in our own hearts, that kept us subservient for so long. This idea of fearlessness was vindicated in our struggle for freedom, which did not stop on the midnight of 14-15 August 1947,

but on 26 November, 1949, inculcating each citizen with this idea of fearlessness and autonomy.

I am not here to despise any organisation. It is the cornerstone of productivity and efficacy. Time is a depleting entity. A good sense of time makes men honourable, a sense of personal integrity is obtained when we add values personal to us, in our time. One of the most valuable skills in our economy can become increasingly rare. I believe only a fearless mind with no apprehensions of surveillance and molycoddling can cultivate such rareness. The same idea of uninhibited cultivation of thought is presented in the book "Deep Work" by Cal Newport. He argues that professional activities performed in a distraction free environment push cognitive abilities to the maximum, which creates new values, improves skills and produces work which is hard for others to replicate.

Such a work environment was rendered by the lockdown where innovation was seen flourishing. In 2021, before the first half of the year even progressed, the country added 11 unicorns companies (privately owned technology - driven startups) to its tally. With the addition of these new unicorn companies, the country now has 48 of them. India's startup performance has never been so glorious. Whether these new startups survive the test of time and the wrath of the economy is yet to be seen. But there is a noticeable rise in the number of wise and talented people coming forward with their ideas. I refuse to believe that there are only limitations that this pandemic has brought to our normal functioning of lives. Rather, this might be an attempt to look at the few hours of our non-institutionalised time brought by the lockdown each day, from a fresh perspective. Simple things like fixing your sleep cycle and exercising routine, learning a new recipe, brainstorming new ideas for your own startup, can be achieved through this freedom of time utilisation offered by the pandemic. □

*(Note: The article is the winning-entry of the contest held in the month of August, 2021. Few other notable mentions received were of N Soumik, Biswambarnath Pande, Sai Sankar Sarangi, and Gaana Krishnendu.)*

The author is pursuing undergraduate degree in Journalism and Mass Communication. Email: [sindhualekya07@gmail.com](mailto:sindhualekya07@gmail.com)

# Ek Bharat Shreshtha Bharat

**E**k Bharat Shreshtha Bharat programme aims to enhance interaction and promote mutual understanding between people of different States/UTs through the concept of State/UT pairing. The States carry out activities to promote a sustained and structured cultural connection in the areas of language learning, culture, traditions & music, tourism & cuisine, sports and sharing of best practices, etc.

India is a unique nation, whose fabric has been woven by diverse linguistic, cultural and religious threads, held together into a composite national identity by a rich history of cultural evolution, coupled with a freedom struggle that was built around the tenets of non-violence and justice. The spirit of mutual understanding amidst a shared history has enabled a special unity in diversity, which stands out as a tall flame of nationhood that needs to be nourished and cherished into the future.

Time and technology have narrowed down distances in terms of connection and communication. In an era that facilitates mobility and outreach, it is important to establish cultural exchanges between people of different regions, as a means to further human bonding and a common approach to nation-building. Mutual understanding and trust are the foundations of India's



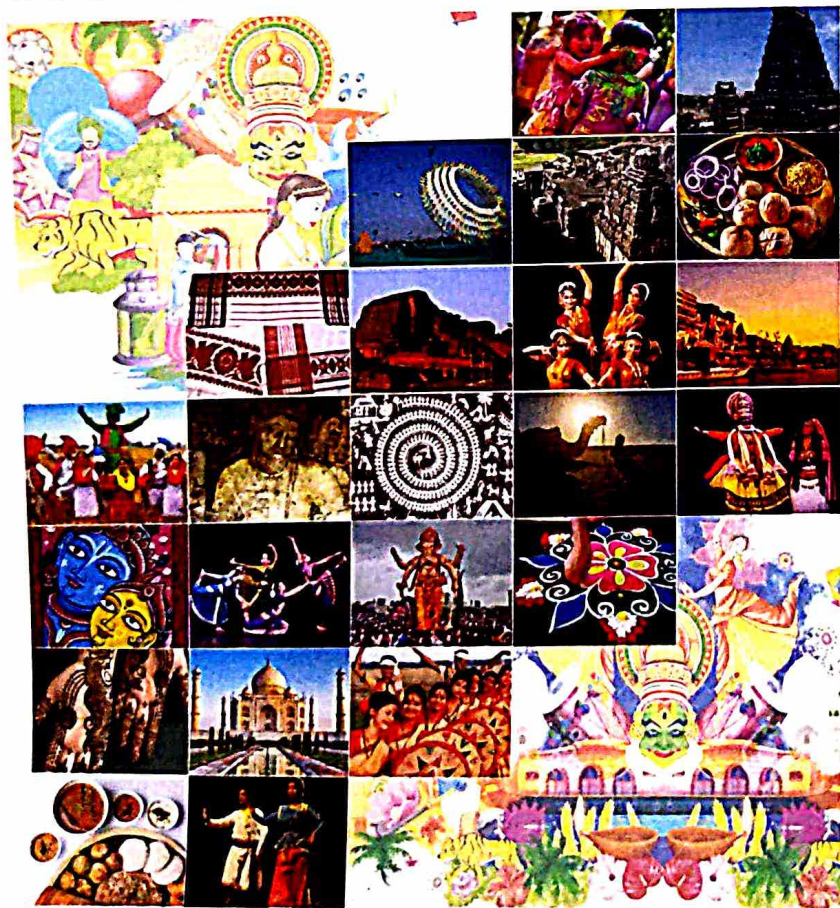
## एक भारत श्रेष्ठ भारत

strength and all citizens should feel culturally integrated in all corners of India. Students from the north-east, for example, should not feel like 'strangers in a strange land' when they arrive in Delhi, or a person from Uttarakhand should not feel like an outsider in Kerala.

The mission of Ek Bharat Shreshtha Bharat is:

- To **CELEBRATE** the Unity in Diversity of our nation and to maintain and strengthen the fabric of traditionally existing emotional bonds between the people of our country;
- To **PROMOTE** the spirit of national integration through a deep and structured engagement between all Indian States and Union Territories through a year-long planned engagement;
- To **SHOWCASE** the rich heritage and culture, customs and traditions of States for enabling people to understand and appreciate the diversity that is India, thus fostering a sense of common identity;
- **TO ESTABLISH** long-term engagements and,
- **TO CREATE** an environment which promotes learning between States by sharing best practices and experiences.

Cultural diversity is a joy that ought to be celebrated through mutual interaction & reciprocity between people of different States and UTs so that a common spirit of understanding resonates throughout the country. Various States and UTs are paired with another State/UT for a time period, during which they carry out a structured engagement with one another in the spheres of language, literature, cuisine, festivals, cultural events, tourism, etc. The paired States/UTs sign MoUs with each other, delineating a set of activities that they would carry out. An activity calendar for each pair is prepared through mutual consultation, paving the way for a systematic process of mutual engagement. Such interaction between different segments of the population of each pair of States /UTs at the cultural level, generates the vibrance of understanding and appreciation amongst the people and forges mutual bonding, thus securing an enriched value system of unity in the nation. □



# Artificial Intelligence



Artificial Intelligence technologies are on a pathway to become the most powerful agents of transformation in human history. AI will reshape the global economic and technological landscape, as well as every aspect of our daily lives.

## Healthcare

The scope of AI is increasing every day. It does what humans can do, but takes lesser time, and makes it more efficient at a lower cost. It has a modern technique via which it assists patients in the healthcare system live longer, without a doctor for the most part. There are various applications that benefit patients manage a healthy routine, and keep in check their behavioural patterns. Not only that, they help in detecting the early stages of diseases via monitoring various symptoms, and aiding emergency care.

Apart from this, Robotics is a branch that is now entering healthcare as robots are helping doctors in difficult and precision-required surgeries. They are supportive in rehabilitation centres as they guide individuals in their exercises and therapies. Recent growth can be observed in the research field due to AI, as implementing it in the right direction cuts costs and manpower in the field, along with saving time and lives. A few machine learning technologies have provided a knowledge base in building up algorithms that can act just like the human brain itself.

## Education

AI is a utility in the education sector in multiple ways.

It allows the teacher and student to invest lesser time while giving out more potential in their learning process. There are some applications that help prepare good combinations of question papers, with a student-centric approach, focusing on each student personally, hence also saving teacher's time and extra effort. AI is smart enough to generate a personalised content for each student, so that their learning gets quicker and easier. Skill mapping help students understand which areas they have to work harder in. Microlearning gives a better insight into a particular skill or area which needs brushing up. Furthermore, it is a 24x7 available and accessible platform, helping students get back to their studies with just a few clicks, any time of the day.

## Airlines Industry

AI helps in managing the revenue as it lays out the analytics required to understand how a product is sold to the targetted audience, providing them with budget-friendly products within specified time. AI helps with the customer-centric approach, as individuals face delays or other issues during their journey, which can be handled by the predictive data and analysis stored in their applications. It ensures a good flight experience and provides consistent technical support. Apart from this, various questions and decisions such as which route to take, estimated time duration, etc. also become easy with the help of AI and machine learning. Overall, there becomes a better possibility for good customer service due to the analyses provided by AI.

Compiled by Shruti Kirti. □

## Multiple Choice Questions

- Who said these lines for Mahatma Gandhi- "Generations to come will scarce believe that such a one as this ever in flesh and blood walked upon this earth."
  - Jawaharlal Nehru
  - Martin Luther King Jr
  - George Orwell
  - Albert Einstein
- What way of protest did Mahatma Gandhi adopt in South Africa to oppose racial discrimination?
  - Satyagraha
  - Armed Revolution
  - Do or Die
  - Quit India
- When was Mahatma Gandhi assassinated?
  - 15 August 1947
  - 26 January 1950
  - 30 January 1948
  - 2 October 1950
- Who conferred the title of the Father of Nation upon Mahatma Gandhi?
  - Sardar Patel
  - Lord Mountbatten
  - Queen Victoria
  - Netaji Subhas Chandra Bose
- In which year did Mahatma Gandhi first appear on Indian currency?
  - 1947
  - 1950
  - 1969
  - 1975
- Pravasi Bharatiya Divas (NRI Day) commemorates the return of Mahatma Gandhi to India from South Africa. On which day is it celebrated?
  - 30 January
  - 9 January
  - 31 January
  - 26 January
- As a sign of protest against the Jallianwala Bagh massacre, which award did Mahatma Gandhi return?
  - Kaisar-E-Hind
  - Knighthood
  - Hind Kesari
  - Rai Bahadur
- In which year did Mahatma Gandhi become the President of the Indian National Congress?
  - 1924
  - 1919
  - 1947
  - 1932
- In which city was Mahatma Gandhi assassinated?
  - Nagpur
  - Delhi
  - Ahmedabad
  - Kolkata
- In which year did Mahatma Gandhi return from South Africa?
  - 1930
  - 1929
  - 1910
  - 1915

Answers : 1. (d) 2. (a) 3. (a) 4. (d) 5. (c) 6. (b) 7. (a) 8. (a) 9. (a) 10. (d)

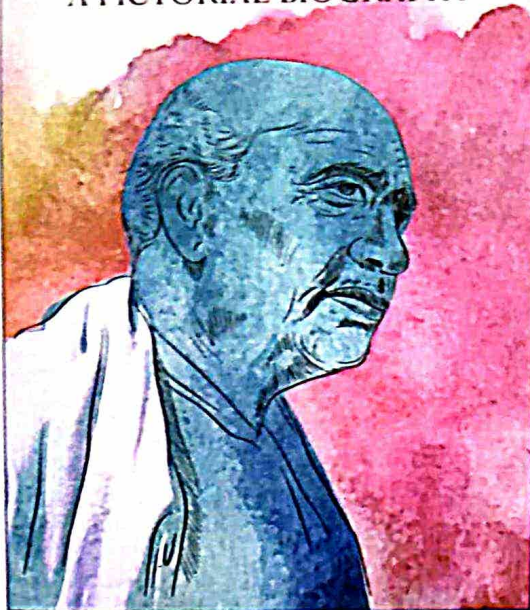
## OUR BOOKS

75  
Azadi Ka  
Amrit Mahotsav

As India commemorates 75 years of independence, this book celebrates Sardar Patel as an image of hope, devotion, and bravery. It also reminds the readers of how far the nation has journeyed in its struggle for freedom. Vallabhbhai Patel was not only a great leader of the masses, but also a far-seeing statesman, and an able administrator who handled with exemplary mastery and finessed the complex problems facing the new government. Born on 31 October 1875, his thirty-three years of work in the cause of the nation is full of many-splendored achievements. This book exhibits the pictorial representation of the revolutionary national leader Sardar Vallabhbhai Patel, who was 'not only the organiser of the fight for freedom but also the architect of the new State when the fight was over.'

As Gandhiji remarked, 'No disappointment, however great, can make him gloomy for long. And he will not let me be serious for two consecutive minutes.' Patel's work

### SARDAR PATEL A PICTORIAL BIOGRAPHY



Price: INR 180

ISBN No: 978-93-5409-107-0

in the early phase of parliamentary programme was of inestimable value in creating an all-India framework for the functioning of provincial ministries are thereby preparing the ground for the evolution in post-Independence India of a truly national, political outlook. As the first Deputy Prime Minister and Home Minister, he dealt with the incorporation of over 560 princely states in the Indian Union. He persuaded the rulers of the princely states to 'co-operate in the general interest' as the alternative is 'anarchy and chaos which will overwhelm great and small in a common ruin if we are unable to act together in the

minimum of common tasks.'

This book traces the different stages of Patel's life, through visual glimpses such as his early life, legal career, after the Bardoli Satyagraha, post-independence, and his journeys to weave the country together. □

*Compiled by Albeena Alvi, Shruti Kirti*



For more books on Azadi ka Amrit Mahotsav, visit: [www.publicationsdivision.nic.in](http://www.publicationsdivision.nic.in)

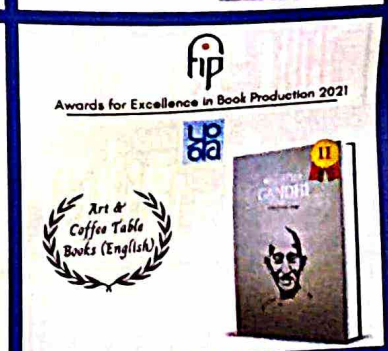
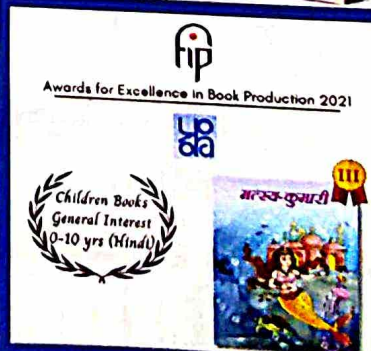
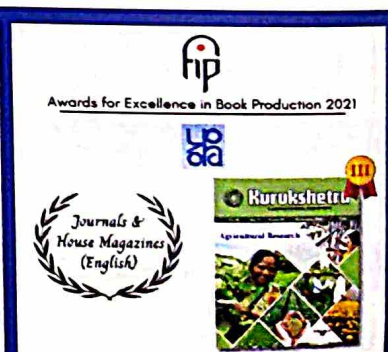
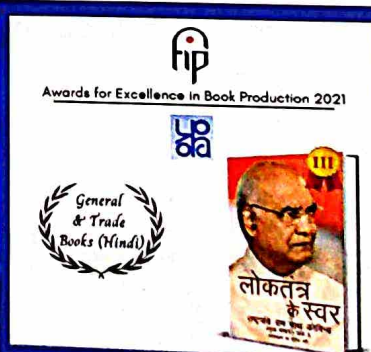
# Awards for Excellence in Book Production, 2021 to DPD



Various journals and books of the Publications Division, Ministry of Information and Broadcasting have been awarded for Excellence in Book Production, 2021 by the Federation of Indian Publishers, a representative body of the publishing industry. The categories of the awards include General and Trade books, Art and Coffee Table books, Children's literature, Reference books, and journals in multiple languages.

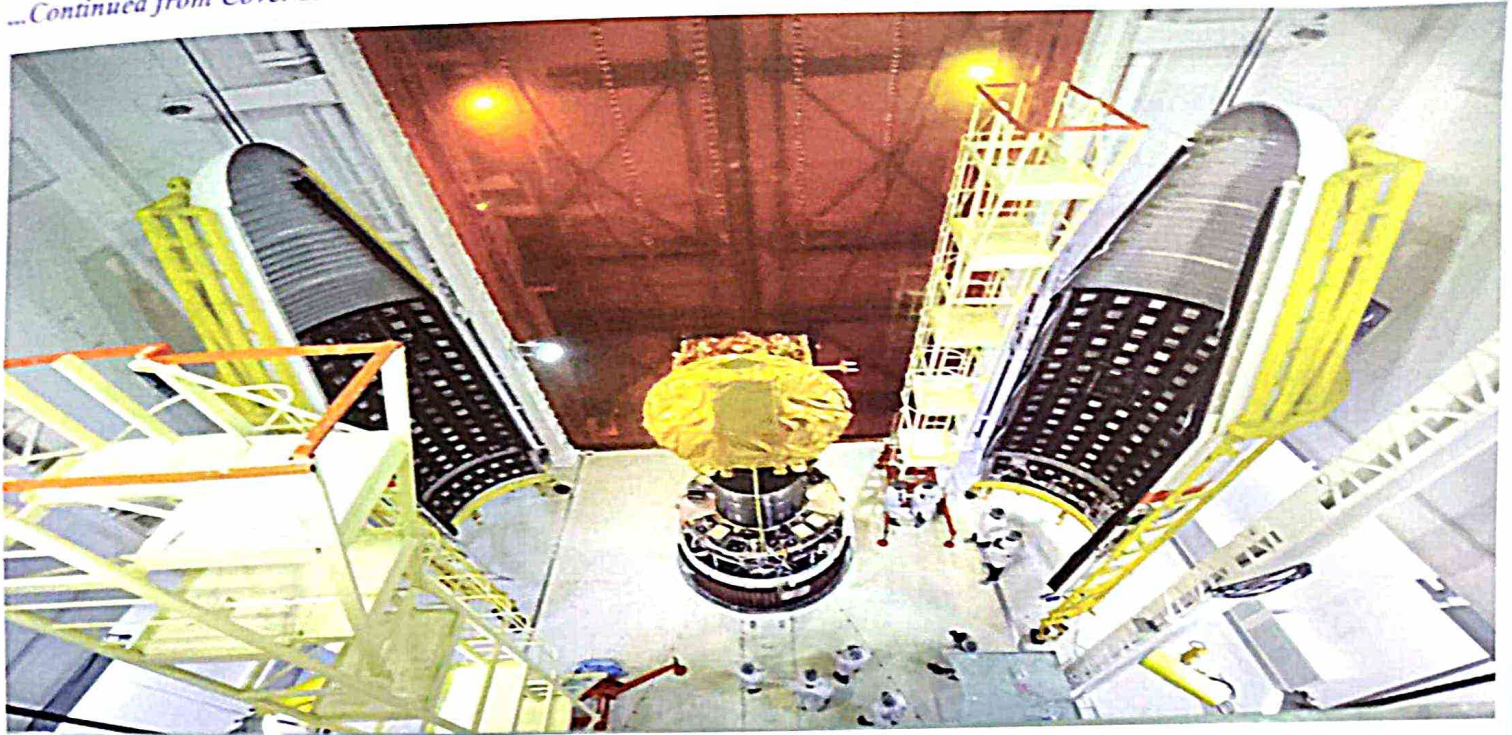
The Publications Division is a repository of books and journals highlighting subjects of national importance and India's rich cultural heritage. Established in 1941, the Division has emerged as a premier publishing house of the Government of India, enriching knowledge resource in distinctive streams by showcasing India's heritage with quality publications. It publishes books on land and people, history of the freedom movement, children's literature, art and culture, flora and fauna, Gandhian literature, biographies of the builders of modern India, speeches of Presidents and Prime Ministers, books on contemporary science, economy, history, and most recently, Azadi ka Amrit Mahotsav. Besides books, the Publications Division also publishes 18 monthly journals, that include Yojana in English, Hindi, and 11 other Indian languages, Kurukshetra (English and Hindi), Bal Bharti (Hindi), and Ajkal (Urdu and Hindi).

TITLE	CATEGORY	AWARD POSITION
Loktantra ke Swar-Rashtrapati Ram Nath Kovind	General and Trade Books (Hindi)	Second
Mahatma Gandhi: A Life Through Lenses	Art and Coffee Table Books (English)	Second
Courts of India- Past to Present	Art and Coffee Table Books (Regional Languages) (Bengali)	First
Matsya - Kumari	Children Books (General Interest) (0-10 Years) (Hindi)	Third
Women in Satyagraha	Children Books (General Interest) (Regional Languages) (Gujarati)	First
Economic Survey 2020-21 Volume-I	Reference Books (English)	Third
Kurukshetra Vol. 68 (September 2020)	Journals and House Magazines (English)	Third
Yojana (January 2021)	Journals and House Magazines (Regional Languages) (Punjabi)	First



On behalf of Publications Division, Additional DG, Shubha Gupta received the awards from Dr Rajkumar Ranjan Singh, MoS, Ministry of External Affairs and Education, GoI.

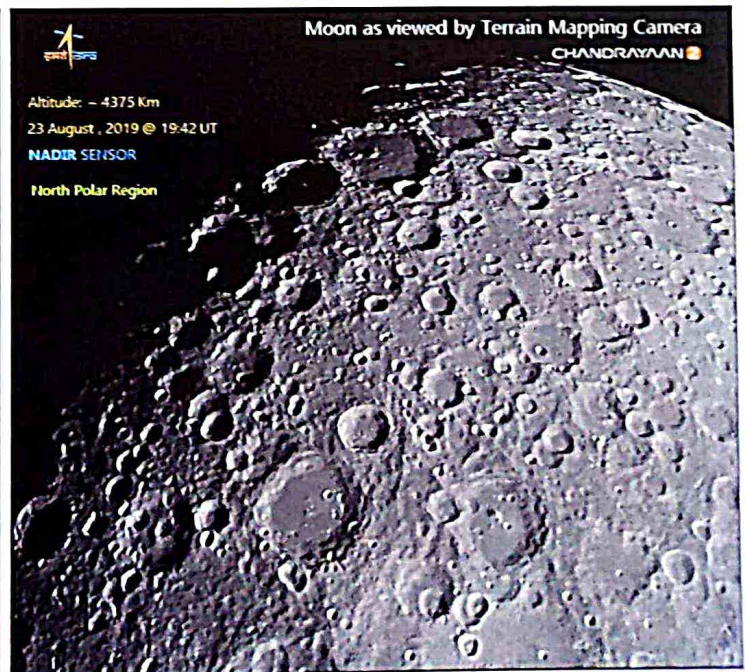
...Continued from Cover II



agencies in the world. India maintains one of the largest fleet of communication satellites (INSAT) and remote sensing (IRS) satellites, that cater to the ever-growing demand for fast and reliable communication and earth observation respectively.

Future readiness is the key to maintaining an edge in technology and ISRO endeavours to optimise and enhance its technologies as the needs and ambitions of the country evolve. Thus, the country is moving forward with the development of heavy-lift launchers, human spaceflight projects, reusable launch vehicles, semi-cryogenic engines, single and two-stage to orbit vehicles, development, and use of composite materials for space applications, etc.

The indigenously developed Chandrayaan-2 spacecraft, comprising of Orbiter, Lander, and Rover was successfully launched on-board indigenous GSLV MK III-M1 Mission on 22 July 2019. After accomplishing four earth bound maneuvers and Translunar Injection, the spacecraft was successfully inserted into the lunar orbit on 20 August 2019. A series of moon bound maneuvers were then carried out to achieve a lunar orbit of 119x127 km. The Lander 'Vikram' was separated, as planned, from the Orbiter on 2 September 2019. After two successful de-orbiting maneuvers, powered descent of the Lander was initiated on 7 September 2019 to achieve soft landing on the moon surface. □



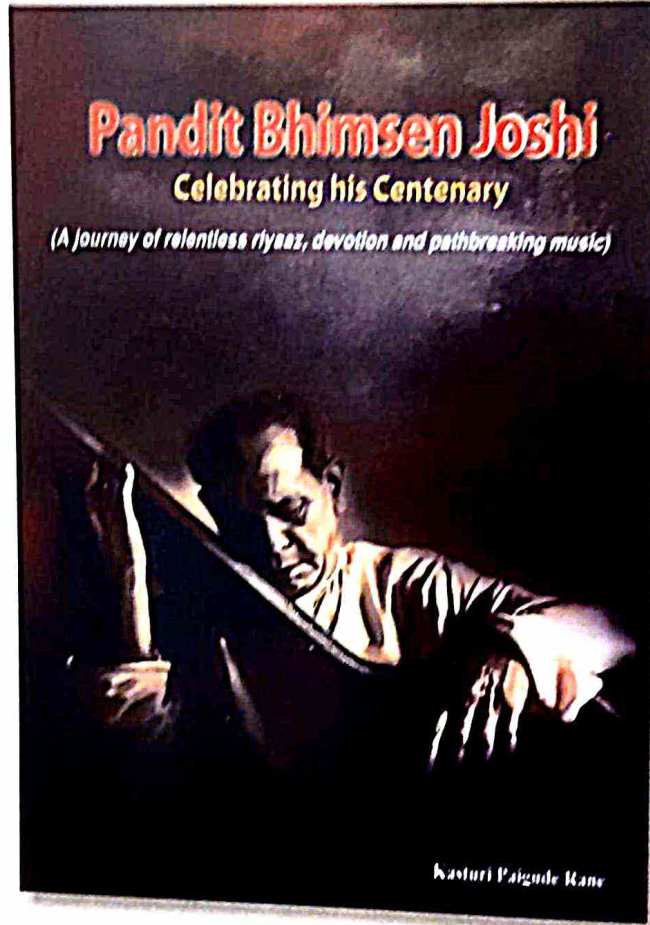


Regd. No. RNI 949/57

Licensed U(DN)-56/2021-23 to post without  
pre-payment at RMS, Delhi (Delhi Post  
Postal Regd.) DL(S)-95/3230/2021-23



Now available print & ebook editions



Price- Rs. 310/-

**Pandit Bhimsen Joshi**  
**Celebrating his Centenary**

For placing orders, please contact: Ph : 011-24365609,  
e-mail: [businesswng@gmail.com](mailto:businesswng@gmail.com)

**Book your copy today**  
**at your nearest book shop!**



**Publications Division**

Ministry of Information & Broadcasting, Government of India  
To buy online visit: [www.bharatkosh.gov.in](http://www.bharatkosh.gov.in)  
website: [www.publicationsdivision.nic.in](http://www.publicationsdivision.nic.in)