



Science & Technology Led Excellence for **Inclusive Development**

**Brief Account of
Four Years Achievements
2014-2018**

Ministry of Science and Technology
Ministry of Earth Sciences
Government of India



**Council of Scientific & Industrial
Research (CSIR)**

Ministry of Science and Technology
Anusandhan Bhawan
Rafi Marg
New Delhi-110 001
India

Department of Biotechnology (DBT)

Ministry of Science and Technology
Block 2, 7th Floor, CGO Complex
Lodhi Road
New Delhi-110 003
India

**Department of Science & Technology
(DST)**

Ministry of Science and Technology
Technology Bhavan
New Mehrauli Road
New Delhi-110 016
India

Ministry of Earth Sciences (MoES)

Prithvi Bhavan, IMD Campus
Lodhi Road
New Delhi-110 003
India

Science & Technology Led Excellence for Inclusive Development

**Brief Account of
Four Years Achievements
2014-2018**



सत्यमेव जयते

**Ministry of Science and Technology
Ministry of Earth Sciences
Government of India**

Science & Technology Led Excellence for Inclusive Development

BRIEF ACCOUNT OF FOUR YEARS ACHIEVEMENTS 2014-2018

June 2018

Designed & Printed at
CSIR-National Institute of Science Communication and Information Resources (CSIR-NISCAIR)
Vigyan Sanchar Bhawan, New Delhi

FOREWORD

Dr. Harsh Vardhan

Hon'ble Union Minister
For Science & Technology and
Earth Sciences

INDIA'S progress in the field of science and technology has been exponential during the last four years and the R&D work has addressed many of the problems the society is facing now. Science is now regarded as one of the most powerful instruments of growth and development. India is ranked sixth globally in the number of scientific publications and ninth in the number of patents filed.

The increase in the budget allocations to both the ministries have once again reiterated the present Government's intent and resolve to give full support to Science and Technology endeavours for the cause of national development.

It gives me great pleasure, therefore, to dedicate this document that consolidates the achievements of the Ministry of Science and Technology and the Ministry of Earth Sciences during the past four years. Several scientific and technological developments have touched the lives of common people in the last four years.

The Ministry of Science & Technology and the Ministry of Earth Sciences have aligned several of their programmes with the Government of India's ambitious national missions such as Swachh Bharat, Swasth Bharat, Startup India, Make in India, Skill India, Digital India, Doubling Farmer's income etc. During the last four years, both the ministries have developed more and more synergy and started working together for addressing common areas. The mission launched by both the ministries are a judicious mix of fundamental and application science, which include Cyber-Physical-Systems, Supercomputing, Aroma and Medicinal Plants, Sickle cell anemia and Biopharma etc.

Both the ministries have several initiatives for facilitating the farmers and farming activities to improve crop productivity. Several new varieties of resilient crops with improved yields have been developed. Agro-meteorological advisories are being provided to farmers which benefits them in their day to day farming operations. During 2018-19, these advisories will reach 40 million farmers from the present 24 million. Similarly, the 'Biotech Kisan' is another such initiative which is assisting farmers in 15 agro-climatic zones.



The Aroma Mission for cultivation of aromatic plants has benefitted thousands of farmers. Biotechnological interventions have been introduced to improve soil fertility and biological health for high crop productivity

Ministry of Science Technology has been supporting and engaging in Research & Development for economic, efficient and environmentally safe energy generation and management. R&D activities have also been promoted with an aim to provide safe drinking water at affordable cost and in adequate quantity using appropriate Science and Technology interventions evolved through indigenous efforts.

The Ministry of Science & Technology has played a major role in building the Startup innovation ecosystem by supporting innovation research, technology development and product commercialization. There have been major programmes to support the incubation facilities across the country and work with institutes and universities to link them with the Startup and industry.

The Ministry of Earth Sciences has improved the quality of weather, climate, ocean, coastal and seismological services over the last four years. Under the Monsoon Mission, the Ministry of Earth Sciences developed the capability of generating high-resolution weather and climate forecasts including monsoon and tropical cyclones using advanced dynamical models.

The Ministry of Science & Technology has undertaken several initiatives that are people-centric and boost the income of farmers, as well as generate jobs for the socio-economic development of the North-Eastern region.

In this report, the details of achievements made by the Ministry of Science and Technology and Ministry of Earth Sciences in 17 different important themes are elaborated. Both the ministries are fully committed to harness science and technology for the socio-economic and inclusive development of the country.

Jai Hind



(Dr. Harsh Vardhan)

CONTENTS

S.No	Theme	Page
1.	Introduction	i-xii
2.	S&T for National Missions and Significant Sectors	
	Agriculture and Animal Husbandry	1-14
	Health for All: Swastha Bharat	15-36
	Waste to Value: Swachh Bharat	37-44
	Digital India	45-52
	Energy for All	53-66
	Water for All	67-78
	Environment, Climate Change and Natural Disasters	79-96
	Blue Economy: Deep Ocean Mission	97-104
3.	Start-up India: Fostering Innovation, Start-ups and Entrepreneurship Ecosystem	105-116
4.	Make in India	117-132
5.	Knowledge Generation and Discovery Research	133-140
6.	S&T infrastructure	141-148
7.	S&T Human Resources	149-162
8.	Rural and Inclusive Technologies	163-172
9.	Special Initiatives for North East	173-184
10.	Popularising and Communicating Science	185-196
11.	Global Connect: Promoting International Cooperation	197-214
12.	Way Forward	215-218

INTRODUCTION

THE role of Science and Technology in a nation's development is all pervasive. Performance of all sectors like Industry, Agriculture, Health, Energy, Water, etc. is critically linked to science and technology inputs and interventions. In essence, S&T has the potential to transform each of these sectors of economy and improve the living conditions of millions of our countrymen.

Ministry of Science & Technology and Ministry of Earth Sciences cover a very large canvas of R&D from the mysteries of the deep oceans to the Universe. The range encompasses grassroots innovators to top class scientists. The S&T activities impact right from a farmer in a remote corner of the country to sophisticated industries such as aerospace.

To cater to such a large audience, it is necessary that adequate investments are made in scientific research, innovation and technology development. The present Government has consciously given a boost to investment and provided higher allocations for science, technology and innovation promotion. The budget allocation for the Department of Science and Technology for five financial years starting from 2014-15 to 2018-19 was ₹19764 crores which is a whopping 90% increase over the preceding five years (2009-10 to 2013-14). Similarly, there was an increase of 65% for the Department of Biotechnology; almost 43% increase for Council of Scientific and Industrial Research, and 26% increase for the Ministry of Earth Sciences during this period.

S&T investments in India are yielding impressive results. India's 6th position in the world in scientific publications ahead of France, Spain and Italy is one such indicator. India's growth rate of scientific publications is around 14% as against the world average of 4%. India is positioned 3rd globally in nanotech research, which is another healthy sign of our capability in cutting edge areas of science and technology. The Council of Scientific and Industrial Research (CSIR) ranks 9th in the world among the 1207 government institutions in the Scimago Institutions Ranking World Report 2017.

The discovery of Gravitational Waves in 2017 has been hailed worldwide as one of the most fundamental scientific discoveries in recent times. It is a matter of great pride that 40 scientists from 13 Indian institutions are part of the LIGO-Virgo discovery paper published in Physical Review Letters. Scientists from two autonomous institutions of S&T Ministry viz. Indian Institute of Astrophysics, Bengaluru and Aryabhata Research Institute of Observational Sciences, Nainital contributed to this fundamental discovery. Our Government has approved the planned LIGO-India detector to be funded by the Department of Atomic Energy and the Department of Science & Technology.

S&T manpower is the foundation on which the edifice of Research and Development is built. During the last four years, enhancement of capacity building of scientists, teachers, young researchers and attracting

talented students to the study of science and making careers in R&D has been pursued very vigorously. The Department of Science and Technology and Department of Biotechnology are the two major players contributing nearly 66.4% of the extramural R&D support in the country.

Several new schemes have been launched to encourage and attract the scientific community to engage in R&D activities. Some of these new schemes are: Early Career Research Award; National Postdoctoral Fellowship (N-PDF) Scheme; Overseas Visiting Doctoral Fellowship; SERB Distinguished Investigator Award (SERB-DIA); Visiting Advanced Joint Research (VAJRA) Faculty Scheme, and Teacher Associates for Research Excellence (TARE).

During the last four years, many S&T activities have been realigned. Now, there is a judicious mix of fundamental science and application science. This year's budget announcement on Mission for Cyber-Physical-Systems is one such example of application science. Mission based projects on Supercomputing, Aroma, Sickle cell anemia, and Biopharma are some illustrative examples of application and solution science initiatives. The list of such initiatives is very large.

Innovation and start-up activities have received a big support during this period. Business incubation facilities have almost been doubled. During 2018-19 itself, 15 new Biotechnology Incubators and 15-20 new Technology Business Incubators will be established to incubate start-ups. Biotechnology Industry Research Assistance Council (BIRAC) alone would support 3000 additional start-ups next year. In the innovation chain, MANAK (Million Minds Augmenting National Aspiration and Knowledge) is another new initiative to broaden the base of our innovation pyramid to produce future entrepreneurs in large numbers. The programme has been targeted to encourage children to visualise needs of the society and inspire them to devise innovative solutions – 1 lakh top ideas from school children will be awarded every year.

Any S&T intervention that facilitates farmers and farming activities to improve crop productivity makes a huge impact on rural economy. Agrometeorological advisories to farmers is one such mechanism that benefits them in their day-to-day farming operations. During 2018-19, these advisories will reach 40 million farmers from the present 24 million level. Biotech Kisan is another such initiative that is assisting farmers in 15 agro-climatic zones. Similarly, thousands of farmers are getting benefitted under the Aroma Mission for cultivation of aromatic plants. Pt Deen Dayal Upadhyay Vigyan Gram Sankul Pariyojana for integrated development of cluster of villages in Uttarakhand through S&T interventions utilising local resources and local skills to provide opportunities of better livelihood at the local level is another example of a project targeted to benefit the common man.

Water Technology Initiative promotes R&D activities for providing safe drinking water at affordable cost and in adequate quantity using appropriate S&T interventions evolved through indigenous efforts. 174 R&D Projects addressing 20 site-specific challenges covering around 400 habitats across 23 states have been supported. Several affordable technology solutions have been demonstrated and deployed in the field.

Energy remains a critical factor in the socio-economic development of our country. Now there is a growing need for generating more and more clean energy. Programmes like Clean Energy Research Initiative are aimed at producing clean and green energy. Several technologies have been developed by the CSIR such as coal dust collecting and briquetting system, Solar Power Tree, Novel Hydro-electric Cell, etc. The country's first Second-Generation (2G) Ethanol plant has been formally inaugurated and subsequently transferred to Bharat Petroleum Corporation Ltd. (BPCL) and Hindustan Petroleum Corporation Ltd. (HPCL) to build commercial scale biomass ethanol plants based on the home grown technology developed under a project of the Ministry.

Tremendous success has been achieved during the last four years in fulfilling the dream of Swasth Bharat. The first indigenous low-cost Rotavirus Vaccine from an Indian strain was launched by the Hon'ble Prime Minister in 2015. This will save lives of millions of children from diarrhoea. Anti-diabetic herbal formulation viz. BGR-34 developed and approved by the Ministry of AYUSH and licensed to a pharmaceuticals company for commercialisation has been ranked 14th among 6367 drugs launched in Indian Pharma market in the last two years. A large number of drugs, diagnostic kits and healthcare products have been developed and transferred to industry for commercialisation in the last four years. A new programme on Science and Technology of Yoga and Meditation (SATYAM) has been launched to rejuvenate deeper scientific research in yoga and meditation – 60 R&D projects have been supported to address issues related to study of several practices of Yoga & Meditation to treat various diseases.

S&T collaborations with the best in the world benefit immensely our scientific community and R&D institutions. The Ministry being the nodal agency in the country for International S&T Cooperation agreements has vigorously pursued intense S&T engagements with the relevant countries to enhance our S&T capacity and capability. Some noteworthy international collaboration during the last four years are: India becoming a partner in the LIGO project for gravitational wave detection with agreement to set-up the detector station in India; India becoming an Associate Member State of CERN; Establishment of India-Israel Industrial R&D and Technological Innovation Fund (I4F) of US \$40 million; Newton Bhabha Fund – initiated with UK; Launch of India-Canada Centre for Innovative Multidisciplinary Partnership to Accelerate Community Transformation and Sustainability (IC-IMPACTS) programme; etc.

The present report highlights some of the major achievements of the Ministry of Science and Technology and the Ministry of Earth Sciences during the last four years. Activities under several other new initiatives towards Make in India, Digital India, Swachh Bharat, etc. initiated during the last four years have been briefly described in this booklet. It is hoped that the present report will be useful for the masses to appreciate the efforts made by both the ministries which are engaged in finding affordable solutions to problems being faced by the masses.



Ministry of Science & Technology
Government of India



Ministry of Earth Sciences
Government of India



"Science must meet the rising aspirations of our people."
-Narendra Modi

VIGYAN SE VIKAS विज्ञान से विकास

Science and Technology contributing
to National Missions



Swachh
Bharat



Swasth
Bharat



Make in
India



Startup India



Skill
India



Digital
India



Agriculture

60,000+
Scientific Publications
5000+
Products/technologies developed
3,000+
Patents filed
1,000+
Institutes supported



Inspiring
Youth

10,00,000+
Students trained

50,000+
INSPIRE Scholarships for
University-level education

15,000+
PhD fellowships awarded

5,000+
Post-Doc fellowships awarded



Promoting
Entrepreneurship

5,000+
Startups supported

200+
Incubators supported/established

800+
Technologies transferred



Department of Biotechnology
Ministry of Science & Technology



Department of Science & Technology
Ministry of Science & Technology



Department of Scientific & Industrial Research
Ministry of Science & Technology

S & T for National Missions and Significant Sectors



Agriculture & Animal Husbandry





Agriculture

Doubling Farmers' Income – Ensuring Food Security

WORLDWIDE, India ranks second in farm output. Agriculture and allied sectors like forestry and fisheries, which accounted for 17 to 18 percent of GDP in 2017-18, employ about 50% of the total Indian workforce. Agriculture is demographically the broadest economic sector and plays a significant role in the overall socio-economic fabric of India.

But there are significant challenges. There are more than a billion mouths to feed. Problems are mounting in the face of impending climate change, degradation of farmlands, increasing soil salinity, drop in groundwater, pollution of surface water, frequent droughts and so on.

With its resolve of doubling the income of farmers by 2022, the Government has put in place enabling policies. Apart from creating alternate sources of income and ensuring fair price for the produce, the focus in agriculture research is on:

- Reducing input costs
- Enhancing productivity
- Reducing wastage
- Tackling biotic/abiotic stresses

Resilient, High Yielding Crops

Department of Science and Technology (DST)

- Soybean variety MACS 1281 released and notified for cultivation in the Southern Zone. The variety has medium maturity, is resistant to stem fly, defoliators, pod borer and leaf folder, bacterial pustule and bacterial leaf blight.
- Soybean variety MACS 1460 identified for release in Southern (5 states), Eastern (5 states) and North Eastern Hill Zones of India. Shows wider adaptability & disease resistance, is suitable for mechanical harvesting, highly resistant to pod shattering and early maturing (88 days).
- Durum wheat variety MACS 3949 identified for cultivation under timely sown irrigated conditions in Peninsular Zone.
- Durum wheat variety MACS 4028 identified for timely sown rain-fed conditions in Peninsular zone. Has average yield of 19.3 q/ha, good milling quality, better nutritional quality, is resistant to black and brown rusts, and has 1000-grain weight of 47 g.

Council of Scientific & Industrial Research

- New varieties of ornamental and medicinal plants developed
- Include lemongrass, citronella, vetiver and canna lily plant
- Cultivation of these new varieties have significantly enhanced incomes of farmers.

Department of Biotechnology

- Bacterial blight resistant Samba Mahsuri Rice introduced into 90,000 ha in Tamil Nadu, Karnataka, Telangana & Andhra Pradesh
- 12 drought resistant varieties of rice developed
- Maize hybrid with high quality protein (Vivek 9) and increased pro-vitamin A developed
- High zinc rice to be available to farmers in two years after all India trials
- Bread wheat & durum wheat with high yield & high micronutrient concentration in optimum soil zinc developed and undergoing trials
- These varieties have helped improve productivity of the crops, addressed nutrient deficiency issues and high value crops have increased income of farmers.

Varieties developed through DBT sponsored projects

Crop	Variety developed	Trait
Maize	Vivek QPM-9 (improved)	Pro-vitamin A rich maize variety
Rice	PB 1121 'saltol' IWP 'saltol' ADT 43 'saltol'	Salinity tolerant rice variety
	Swarna-sub 1, IR64-sub 1	Submergence tolerant rice variety
	Samba-Mahsuri-sub 1	
	Pusa Basmati 1728	Resistance against xanthomonas
Wheat	Unnat PBW 347	Resistance against rust

New Varieties, Enhanced Income

- Short-duration, high-yielding menthol mint (*Mentha arvensis*) – CIM-Krantihas – fits well into the existing crop rotation without disturbing or replacing food crops. Will enhance productivity and help maintain Indian leadership globally.
- Improved variety of Ashwagandha (NMITLI-101) is rich in major withanolides (active compounds) such as withaferin A, withanone and withanolide A that are responsible for excellent immunomodulation activity.



- New variety of *Artemisia annua*, the only known source of natural artemisinin for treatment of cerebral/drug resistant malaria, contains 1.2% artemisinin (20% increase over the existing variety CIM Arogya) and yields 43-45 quintal per hectare dry herb, an increase of 10-12% in comparison to CIM Arogya, thereby increasing farmers' income by ₹10000 to 15000 per hectare within 3-4 months. The new variety has been licensed to IPCA Lab, Ratlam. Industry is also expected to have the benefit of reduced cost of production by a margin of 20%.



- In collaboration with Narcotics Department, Opium poppy variety yielding 10% thebaine (1-2% normal content) has been developed. India produces 3 tonnes of thebaine annually. Thebaine has a multibillion-dollar market. The demand of opium alkaloids stands at around 300 tonnes per annum.

Seaweed Cultivation – Coastal Wealth

Technologies for cultivation of *Kappaphycus alvarezii* and value addition through simultaneous production of hydrocolloid and liquid biofertilizer have been developed. The fishing community in coastal regions of Tamil Nadu has been trained in cultivation techniques. Presently >800 Self Help Groups (SHGs) are engaged in cultivation, with average income of ₹ 5000 per month per person. The liquid fertiliser is marketed by IFFCO under trade name 'Sagarika'.



Kappaphycus cultivation

Lucrative Floriculture

- New varieties of *Bougainvillea*, *Chrysanthemum*, *Gladiolus*, *Gerbera*, *Cala lily* and ornamental roses have been developed. In Himachal Pradesh, an area of 24.5 acre was brought under cultivation, generating employment of 14,700 man-days and net return of ₹ 1.45 crores during a calendar year.
- CSIR-IHBT has developed package of practices on *Lilium* cultivation including aspects regarding climate, soil preparation, propagation techniques, varietal selection, bulb size, time of planting, planting density, planting depth, irrigation, nutrition, hoeing, weeding, pinching, disbudding, insect and disease management, grading, packaging and transportation of flowers.



Above:
NBRI-HimJyoti
Left:
Bougainvillea

FarmerZone for Smart Agriculture

- A collective open-source data platform for smart agriculture, "FarmerZone" uses biological research and data to improve the lives of small and marginal farmers.
- Multi-purpose window for solutions on climate change, weather predictions, land, soil, disease, pest, water, planting material and marketing available for farmers anywhere in India and the world.
- Farmers can access the service directly or through local co-operatives to directly sell their produce.
- The first sentinel site of FarmerZone on potato crop has been approved for funding and the first sentinel site for potato farmers initiated.



Agro-Meteorological Advisory Services (AAS)

- Ministry of Earth Sciences (MoES) in collaboration with the Indian Council of Agricultural Research (ICAR) provides the Agromet Advisory Services (AAS) for farmers.
- These services help plan operations like sowing, irrigation, application of fertilizer and pesticide, harvest and protection of crops from weather disasters.
- The services are being operated across 608 districts of the country.
- About 24 million farmers are receiving crop-specific agro-meteorological advisories in vernacular languages. By the end of July 2018, it is planned to increase the outreach to about 40 million farmers.
- It is planned to augment the AAS network to sub-district level by setting up District Agro-Met Units (DAMUs) in 530 districts (including the 115 aspirational districts) in the premises of KVKs of ICAR, thus creating a network of 660 units.

National Certification System for Tissue Culture Raised Plants (NCS-TCP)

- Unique quality management system, the first of its kind in the world, that ensures recognition of Tissue Culture Production Facility for the production of quality planting material and certification of end products.
- Around 80 companies recognized for getting their planting material certified from the Accredited Test Laboratories; 2 Referral Centres and 5 Test Laboratories accredited under this system; so far, more than 275 million Tissue Culture plants have been certified.
- Third party assessment by National Council of Applied Economic Research (NCAER) concluded that the annual economic benefit for the farmers cultivating four principal crops (Wheat, Rice, Sugarcane and Cotton) was ₹ 42,000 Crore in 2015.

Position in 2014

About 7 million farmers received AAS in vernacular languages

Position in 2018

About 24 million farmers are currently receiving AAS in vernacular languages

Weather Services Rendered by Ministry of Earth Sciences

1. Weather forecasts, warnings and advisories for agriculture
2. Now casting (up to 6h in advance) for severe weather (covered 350 towns currently)
3. Agriculture (all districts & twice weekly) 5 day forecasts, nowcasts, extended range about 24 million farmers through SMS Economic Benefit more than Rs 50,000 Cr
4. Warnings for Cyclones, Heavy Rainfall, Heat Waves, Thunderstorms/Lightning
5. Forecasts for heavy rainfall up to 2-3 days in advance

#TransformingIndia

f t moesgoi



Biotech-KISAN Impacting Farmer's Lives through Science

- Biotech-KISAN is for farmers, developed by and with farmers; it empowers women, impacts locally, connects globally, is Pan-India, has a hub-and-spoke model and stimulates entrepreneurship and innovation in farmers
- Provides solutions to challenges of small and marginal farmers
- Thematic **Mahila Kisan-Biotech** Fellowships instituted in each zone so that women farmers can work with science laboratories to generate solutions for problems they identify
- Strong Scientists-Farmers Interaction Platform created
- Demonstrates and scales up programmes addressing water, soil, seed and marketing issues of local farmers with validated technologies
- Seven hubs in different agro-climatic zones have been recommended for funding.

Farmer-friendly Technologies

- Swasti Agro and Bioproducts has developed preventive “vaccines”, ecofriendly sustainable technology, and “healthcare system” – android, IOT-based analysis-advice system for plants.
- KN Biosciences has developed a biocontrol agent of a nematode that controls crop pests in an ecofriendly manner. The infective juveniles of nematodes kill the pests within 24 hours and make them inactive.
- Vermicompost fortified with ABM's (*Mycorrhiza*, *Acinetobacter*, *Bacillus megaterium*, *Pseudomonas spp.*) increased 15% yield compared to chemical fertilizer and benefitted more than 1100 farmers.
- **Easy to handle farmer-friendly soil analysis kit assesses the levels of primary nutrients (N-P-K), Electrical Conductivity (EC), and pH.**



Joining Forces Globally

Decoding Wheat Genome for a Healthy Yield

India was part of a strong consortium of 15 countries which joined hands to decode chromosome 2A. Bread wheat, with an estimated world harvest of more than 550 million tonnes, is one of the most important food crops in the world. Wheat breeders, however, have few genetic tools to help them select key agricultural traits for breeding and do not always know the genes responsible for the traits they need. Analysis of the wheat genome, in which India played a crucial role, will give breeders the tools required to select traits for a healthy yield.

Virtual India-UK Joint Centres in Agricultural Nitrogen

These centres were set up for effective management of nitrogen to give a major boost to agricultural research and soil health.

DBT Innovate UK

Post-harvest losses occur between harvest and the moment of human consumption. They include on-farm losses, such as when grain is threshed, winnowed, and dried, as well as losses along the supply chain i.e., during transportation, storage, and processing. DBT and Innovate UK are investing £10 million (£ 5m from Innovate UK and £ 5m from DBT) towards funding of seven projects on “Biotech approaches for tackling challenges in agriculture food sector”, with focus on enhanced rice milling and maximized valorization of rice milling by-products, bio-based packaging for fresh food; electrolyzed water for post-harvest washing and so on.

TIGR2ESS – Transforming India’s green revolution



A new UK-India collaborative programme TIGR2ESS (Transforming India’s Green Revolution by Research and Empowerment for Sustainable Food Supplies) was launched on 3rd February 2018. This £ 7.8 million programme is funded by the UK Global Challenges Research Fund (GCRF) to develop more resilient, equal and diverse food systems in India. It aims to define the requirements for a second, more sustainable, Green Revolution, and to deliver this through a suite of research programmes, training workshops and educational activities.

DBT and Innovate UK are investing £ 10 million (£ 5m from Innovate UK and £ 5m from DBT) towards funding of seven projects on “Biotech approaches for tackling challenges in agriculture food sector”, with focus on enhanced rice milling and maximized valorization of rice milling by-products, bio-based packaging for fresh food; electrolyzed water for post-harvest washing etc.





Aroma Mission – Creating Farmer Entrepreneurs

- CSIR has contributed significantly in the development, nurturing and positioning of the essential oil-based aroma industry in the country.
- This has led to creation of an ecosystem benefitting the farmers, industry, and next generation entrepreneurs.
- For the first time, cultivation has been extended to challenging regions such as Jammu & Kashmir, tribal areas in Chhattisgarh, flood- and drought-affected regions e.g. Cuddalore, Vidarbha, Kutch, North-East.

Jammu Kashmir Arogya Gram Yojana

- Aimed at enabling value-added cultivation of aromatic and medicinal plants.
- The Yojana has covered 10 Districts (Kathua, Udhampur, Reasi, Doda, Ramban, Kishtwar, Samba, Poonch, Jammu and Rajouri) comprising kandi land/rainfed land/ wasteland/unutilized land/snow bound areas.
- 107.82 ha of land was brought under cultivation, which resulted in employment generation of 26,959 man-days, and benefitted 399 farmers through income generation of ₹ 9.625 lakh.
- The efforts targeted at rural skill set enhancement through farm-based activities and technology support, provided training to 1745 personnel on specific agro-technologies.



Animal Husbandry —

Towards Disease-free Healthy Animals

ANIMAL health focuses on collaborative research for new generation vaccines and diagnostics along with translation of existing candidate vaccines and diagnostics for field use around major animal diseases at affordable costs for small and marginal farmers.

Brucella-free Villages – A Mission Approach

Brucella infects cows, buffalos, sheep, goats, deer, pigs, dogs and other animals and also humans. This disease causes



economic losses of about ₹ 28000 Crores/year. 'Brucellosis Free Villages' Mission was launched by Department of Biotechnology in 50 villages of 10 states in a phased manner. DBT also launched three new *Brucella* diagnostic kits.

Cattle Genomics: Improving Indigenous Livestock

India has the largest repertoire of cattle in the world. Indian cattle population is highly heterogeneous. 69% of Indian

cows are owned by the poor. In Phase-I of Cattle Genomics Programme at National Institute of Animal Biotechnology, Hyderabad, whole genome sequencing of five important milch breeds of cattle has been initiated. This will help in identifying pure elite animals of a particular cattle breed in its early age and also finding out traits of economic importance such as milk production and fertility.

Generating Disease Models

Transgenic disease model displaying alpha thalassemia was successfully generated. This will ease the generation of transgenic rats needed to create better human disease models for use in biomedical research.

A transgenic mice model expressing *Echidna* anti-microbial protein (EchAMP) gene in its mammary gland was developed – it was confirmed by expression of EchAMP protein in milk samples of transgenic mice. The study has significant and long-term impact in the area of antimicrobials.



Technologies for Animal Husbandry

- LEPTOLAT for detection of Leptospirosis
- LFA kit for detection of CPV maternal antibody level in pups
- Egg yolk semen extender for cryopreservation of bull semen
- KETOCHECK for detection of Ketosis
- Conductivity meter for detection of subclinical mastitis
- Photolyser and Portable incubator and LAMP device commercialized to M/s Endhiran Innovations LLP, Chennai.



LeptoLAT for diagnosis of Leptospirosis

*Below:
Egg yolk semen
extender for
cryopreservation*

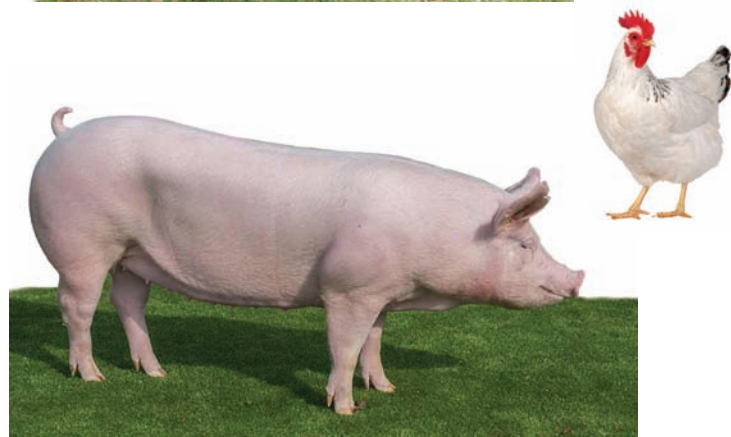


*Left: Rapid
Parvo detect
kit*



*Left: Ketocheck
for diagnosis of
Ketosis*





Improving Semen Quality, Enhancing Reproductive Efficiency

Availability of quality semen is a major constraint in successful implementation of artificial insemination programme. To improve semen quality and predict the fertility status of bull, transcriptomic profiling of bull spermatozoa is being worked out based on sperm parameters such as motility, membrane integrity, and mitochondrial function. Exogenous melatonin administration helped in preservation of semen and also enhancement of fertility rate of mithun.

Translational Research Platform

Translational Research Platform for Veterinary Biologicals in Tamil Nadu Veterinary and Animal Sciences University, Chennai has obtained NABL accreditation (IS/ISO 17025:2005) for diagnosis

of Bovine Trichomonosis & Brucellosis and initiation of cGMP licensing. Among various services, the platform is offering OIE approved diagnostic services of breeding bulls for Brucellosis, Trichomonosis and IBR in line with regulatory needs.

Infectious Bursal Disease Virus Vaccine

A Sub Viral Particle (SVPs) based infectious Bursal Disease Virus (IBDV) vaccine for immunization in chickens has been developed. This vaccine induces protective immunity in specific pathogen free chicks against very virulent IBDV challenge. This vaccine does not cause immunosuppression which was confirmed by an intact histological architecture of the bursa of Fabricius. The vaccine has also been validated in a poultry vaccine company M/s Globion Pvt. Ltd., Hyderabad.



Health For All





Health for All

Swasth Bharat

THE National Health Policy 2017 announced by the Government aims to strengthen and prioritize the road map of the government in shaping health systems. There is a major focus on bringing in new affordable health care interventions for prevention and treatment of diseases for promotion of good health across different sectoral sectors. In addition to health care interventions, there is also a major focus on the health care delivery system with the growing engagement of the private sector, specially startups and small industry. The availability of a proper technology translational mechanism is imperative to facilitate this.

National Biopharma Mission Launched

The first ever industry-academia mission to accelerate biopharmaceutical development in India was launched by the Cabinet Minister for Science and Technology, Earth Sciences, Environment, Forests and Climate Change, Dr. Harsh Vardhan in New Delhi in June 2017. The program, named Innovate in India (i3) is a game changer for the Indian Biopharmaceutical industry and involves an investment of USD 250 million with USD 125 million as a loan from World Bank. It aspires to create an enabling ecosystem to promote entrepreneurship and indigenous manufacturing in the sector.



The Biotechnology Industry Research Assistance Council (BIRAC) in collaboration with World Bank is implementing this mission. It brings together industry and academia to promote entrepreneurship and indigenous manufacturing in the bio-pharmaceutical sector.



In the next five years, the goal of the initiative is to bring five biopharma products vaccine, biotherapeutics, medical devices and diagnostics to the market. An ecosystem to facilitate the pipeline of products is being created.

India as a Leader in vaccine development and manufacture

The first indigenous low cost Rotav Virus Vaccine (RVV) from an Indian strain 116E was launched by the Hon'ble Prime Minister Narendra Modi in 2015. This vaccine is efficacious in preventing severe rotavirus diarrhea in low-resource settings in India. Introduced in 9 states, namely Odisha, Andhra Pradesh, Haryana, Himachal Pradesh, Assam, Tripura, Tamil Nadu, Madhya Pradesh and Rajasthan, the ROTAVAC® vaccine has received WHO prequalification in 2018 and has been included in India's Universal Immunization Program (UIP).

DBT's Indo-US Vaccine Action Programme (VAP) & the Vaccine Grand Challenge Programme (VGCP) scored high with achievements such as the development of the lowest cost rotavirus vaccine, which became part of the Universal Immunization Programme. Furthermore, the program is making major strides towards vaccine for diseases like malaria and dengue. It is estimated that one out of every six children over the world receive vaccines manufactured in India.

Malaria Vaccine: Vaccine for falciparum malaria is under toxicology assessment (JAIVAC 2) and vaccine for vivax malaria has completed Phase I trial (JAIVAC1).

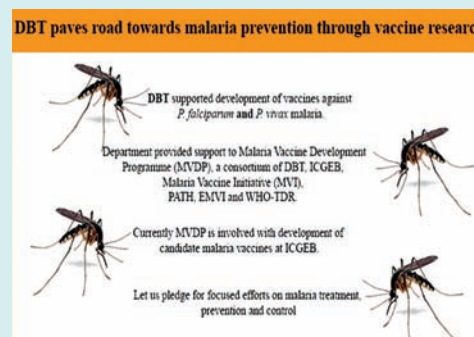


Launching of ROTAVAC® vaccine by Hon'ble Prime Minister Narendra Modi

Dengue Vaccine:

The International Centre for Genetic Engineering and Biotechnology (ICGEB) in collaborating with drug major Sun Pharma to use

the recombinant EDIII-based sub-unit dengue vaccine candidate to develop an injectable vaccine that protects against all four dengue strains that are endemic to India.





On behalf of the Government of India, DBT is a part of the Coalition for Epidemic Preparedness and Innovations (CEPI), a new global alliance among governments, industries, academia, philanthropy, inter-governmental institutions, the World Health Organization and civil society organizations.

Dr. Harsh Vardhan, Hon'ble Minister for Science & Technology and Earth Sciences inaugurated the event in December 2016 in presence of all the stakeholders of CEPI and senior officials of Departments/Ministries concerned, such as the Department of Biotechnology, Ministry of External Affairs, DRDO, Ministry of Health & Family Welfare, Department of Pharmaceuticals, DCGI, etc.

Leading international efforts to address antimicrobial resistance



The India-UK Strategic Group on Antimicrobial Resistance (AMR) was launched in November 2016 by Dr. Harsh Vardhan, Hon'ble Minister for Science & Technology, Minister of Environment, Forest and Climate Change and Minister of Earth Sciences, and the UK Minister of State for Universities, Science, Research and

Innovation Jo Johnson. Prime Ministers of India and the United Kingdom announced a £6.5 million joint contribution dedicated to research on AMR.

DBT is also a member of the Joint Programme Initiative on AMR (JPIAMR), in partnership with the European Union, Germany has also expressed the desire to collaborate with DBT and has invited the Department to join the Global AMR R&D hub as a member of the Interim Board to participate in shaping the hub to maximize the impact of international research activities.

Addressing of anemia through iron-fortified rice

Appropriate technology has been developed on iron-fortified rice premix from broken rice kernels through the extrusion process. This iron-fortified rice premix matches with the normal rice kernel in shape and size, and when mixed with normal rice



Iron-Fortified Rice pre-mix



in the ratio of 1:100, provides approximately 50% of children Recommended Daily Allowance (RDA) of iron. An indigenously designed and fabricated demonstration facility on a pilot scale with a production capacity of producing 100 kg/day iron fortified rice premix was also established at IIT Kharagpur. Sensory studies are ongoing on a second version of the rice fortified with iron, vitamin B12 and folic acid was developed by IIT Kharagpur as per FSSAI guidelines.

Successful trial conducted on anaemic school children fed with iron-fortified wheat flour

Wheat flour fortification with elemental iron is technically challenging, primarily due to poor absorption from elemental iron and the presence of phytic acid. A randomized controlled study carried out by St. John's Medical College, Bangalore in iron deficient school children (6-12-year-old, with a total sample

size of 401 children) fed iron-fortified wheat-based meals during lunch time over a period of 7 months years. The study revealed a reduced prevalence of iron deficiency and iron deficiency anaemia as a result of the intervention.

Technology for double fortified salt composition containing iron and iodine to control both deficiencies

CSIR-CSMCRI has developed an innovative and cost-effective process for iodine and iron containing Double Fortified Salt (DFS) in an effort to combat iron and iodine deficiencies. The developed product retains micronutrient concentration for a prolonged period. Large scale community-based comparative trials are in progress in Bhavnagar and Vadodara to establish its safety and efficacy.

DBT supports food formulations for Severe Acute Malnutrition in Children

- Product made from **100%** local ingredients such as Soybean oil, Sugar, Milk powder & Peanuts
- Caloric dense (**550Kcal/100gm**), high in proteins, vitamins and minerals
- BIBCOLD set up production facility for manufacture of RUTF for rehabilitation of malnourished children



Addressing of Severe Acute Malnutrition in children

In collaboration with the Ministry of Health and Family Welfare (MoHFW) and Indian Council of Medical Research (ICMR), DBT led a National Alliance on Severe Acute Malnutrition (SAM) to generate scientific evidence to inform public health policy. Through this alliance, BIBCOLD, a Public Sector Undertaking (PSU) under DBT has developed Ready to Use Therapeutic Food (RUTF) under the brand name BIB POSHAN with financial support from the Department for the addressal of SAM in children. The product is made from 100% local ingredients and is licensed and registered under FSSAI.

The product is made from local ingredients such as soybean oil, sugar, milk powder and peanuts and is calorie dense, high in proteins, vitamins and minerals.

Improved Samba Mahsuri (ISM): A diabetic-friendly rice

Due to popularization of the Improved Samba Mahsuri (ISM) variety by CSIR, the cultivation area of ISM has been steadily increasing and is estimated to have been cultivated in an area of 130,000 hectares across the country in 2016. ISM has low glycemic index (that is, a value of 50.99), which is amongst the lowest value for several rice varieties tested and thus, is considered highly suitable for consumption by patients suffering from diabetes.



CSIR developed Improved Samba Mahsuri (ISM): A Diabetic Friendly Rice

Recognizing the seriousness of the problem of bacterial blight, CSIR-CCMB and ICAR-IIRR jointly developed resistant derivatives of Samba Mahsuri called Improved Samba Mahsuri (ISM)



It is estimated to have been cultivated in an area of 130,000 hectares across the country

ISM has an unique feature of low glycemic index, making it highly suitable for consumption by patients suffering from diabetes as consumption of foods



CSIR Phytopharmaceuticals Mission

The CSIR Mission on Phytopharmaceuticals aims to increase cultivation to improve the availability of medicinal plants which are in high demand by global and domestic industry involved in the preparation of medicines of Indian traditional systems. Under this mission, it is proposed to prevent exhaustion of medicinal plants from their native locations by identifying the elite germplasm and conserving it by cultivation and in gene

Phytopharmaceutical Mission by CSIR

- Captive cultivation of medicinal plants
- Protection of threatened medicinal plants
- Technology Packages for production of GMP grade medicinal plant extracts
- Phytopharmaceutical development from important medicinal plants
- Intellectual Property generation, valuation and management
- Development of Digital Library of Indian Medicinal Plants
- Licensing of technologies and products



banks. Improved varieties, along with their agro technologies, will be developed to increase productivity and profitability per unit land area, and to make use of such areas which are affected by abiotic stresses such as drought, salinity, flood, shade etc. Efforts would be made to translate the potential clinical leads in different CSIR laboratories to develop them into phytopharmaceutical drugs, which would be made affordable and acceptable at global standards.

CSIR Mission on Sickle Cell Anaemia

Every year, approximately 5,00,000 children are born with Sickle Cell Anaemia (SCA) worldwide, with India accounting for nearly 50% of these cases. CSIR's Mission on SCA approaches the problem a four-pronged strategy of population screening and developing the counselling protocols; discovery and development of new lead molecules for management of SCA; genome editing and stem cell research approach; and affordable diagnostics.

Mission on Innovative Processes and Technologies for Indian Pharmaceuticals and Agrochemical Industries (IMPROTICS)

The Mission aims to develop cost effective, profitable processes for key drugs and agrochemicals. New or non-infringing processes that are free to operate shall be developed for pharmaceuticals. Several key starting materials and intermediates serving as import dependencies for the India pharma industry are identified and processes are proposed to be developed for those. This will enable Micro, Small and Medium Enterprise (MSME) industries to make and supply to Indian and international pharma companies. Thus, the mission would contribute to the 'Make in India' program and lead to improved health and food security for all Indians.

Mission on Nano-Biosensors and Microfluidics for Healthcare

Mission aims to use micro/nano-technologies in integration with micro-fluidics for the development of point-of-care, affordable and easy-to-use systems for healthcare applications such as:

- Rapid test card for Typhoid detection
- Label free, affordable and easy-to-use biosensor for detection of dengue virus infections in patient samples
- Device for the detection of cardiac biomarkers and cardiac risk management
- Devices for early stage Breast Cancer diagnosis
- Devices and nano-probes for early stage detection of Lung Cancer
- Devices for pre-diabetic and diabetic condition detection using invasive and non-invasive techniques
- Devices for detection of bio-markers for Mild Cognitive Impairment/ Alzheimer's disease

The endeavour is aligned with Government missions such as 'Ayushman Bharat' and 'Make in India'.

imported brands in the country was also reduced by about 40%, resulting in a major saving to the Indian consumer and thus, making it within the reach of a common man. The recombinant streptokinase using the recombinant DNA route, has also been developed by CSIR-IMTECH which is roughly ten times more efficient as that of natural streptokinase production technology. The technology was transferred to Shasun Drugs and Chemicals, the development of which has led to making this vital life saver drug available to the consumer at affordable costs. CSIR's programme to develop technology for a domestic clot-buster drug was complicated as clot-buster drugs are not chemical but biotechnology drugs. While technology transfer and commercialisation were difficult, the endeavour led to expanded sales. The economic impact of CSIR streptokinase technologies, or the value that would be lost if CSIR streptokinase were not there, is about ₹ 580 crores for the patients, and based on the value of the life-years of surviving patients, of over ₹ 16,000 crores.

TulyTMRasburicase: TULYTM is a purified and sterile recombinant product of the enzyme urate oxidase, which is generally labelled as rasburicase. It is useful both in treatment and prevention of high uric acid levels. It also reduces the risk of acute renal failure and other life-threatening complications.

Streptokinase

Streptokinase is a vital, life-saver injectable protein drug that saves up to 40% of human lives after heart attacks, if given within a few hours of the onset of chest pain. CSIR-IMTECH has developed a portfolio of streptokinase technology which includes natural streptokinase; recombinant streptokinase; clot-specific streptokinase (third generation thrombolytic molecules); and the new generation clot-buster(s) (fourth generation thrombolytic molecules).

The technology of natural streptokinase of 'British' Pharmacopoeiac grade developed by CSIR-IMTECH was transferred to Cadila Pharmaceuticals. The price of the

Novel processes for Eribulin, Nicotine and Bedaquiline

Serving as important drugs for health care, bench scale processes have been developed for all three molecules, for which synthesis at a large scale is necessary to serve the market demand. In all three cases, the developed routes are new and cost-effective. Eribulin (an anti-cancer drug) fragments are now made in lesser number of steps, Nicotine is made in one-step and Bedaquiline (anti-Drug Resistant TB drug) synthesis was achieved from commercially available starting materials at a low cost.



Non-vascular self-expandable stents

A new class of self-expandable stents based on a novel scroll design has been developed, allowing stents to meet the characteristics of shape memory alloy based stents. These stents could be made at much lower cost than the currently available ones and can be used in the treatment of numerous biliary tract diseases, ranging from benign biliary diseases to malignant structures.

Extracellular matrix, a wound healing matrix from porcine cholecystic, was transferred to Optimus Life Sciences. The product is a scaffold derived from animal tissue meant for wound healing, cornea repair and hernia repair.

Anti-diabetes herbal drug launched: Focused efforts towards affordable healthcare

CSIR has developed an anti-diabetic herbal formulation from a combination of natural extracts derived from six plant species mentioned in ancient Ayurveda texts. The drug, BGR-34, was approved by the Ministry of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy (AYUSH) after it was tested on patients over a period of 18 months across states of Delhi, Himachal Pradesh, Haryana, Punjab and Karnataka. The drug, to be taken

as an add-on or adjuvant to existing diabetes treatment, helps in maintaining normal blood glucose levels, in addition to improving the immune system, releasing antioxidants and checking free radicals. About 67% patients showed normal blood sugar levels within 3-4 days of drug usage. The drug has been licensed to Delhi-based Aimil Pharmaceuticals for

commercialization. The herbal drug costs ₹ 5 per pill and has been launched in parts of North India. During the financial years of 2015-16 and 2016-17, the formulation earned a sale of more than ₹ 100 crores. BGR-34 has also been ranked at 14th position among the 6,367 drugs launched in the Indian pharma market in the last two years as per the survey conducted by All India Origin Chemists & Distributors Limited.



Development of herbal drug for dengue infection

A Technology Transfer Agreement was signed between DBT-ICGEB and an industry partner Sun Pharmaceuticals in May 2016 for taking forward the research lead already developed towards developing phytopharmaceutical drug.

Butea for bone health

A project at The Central Drug Research Institute (CDRI), Lucknow is being developed on regulatory studies of standardized extraction of *Butea monosperma* for bone health (osteoporosis) to enable IND filing as phytopharmaceutical drug based on the research leads generated in earlier DBT funded project.

cGMP Pilot Plant for Herbal Preparations: Addressing country's need for validating and standardizing ayurvedic medicines the first national state-of-the-art cGMP facility for production of herbal preparations has been established in CSIR-IIIM. The facility, based on WHO and USFDA guidelines, has production capacity of 30,000 tablets & capsules per hour and 500 litres of liquid per batch. It has been issued license by the State Regulatory Authority (Drug & Food Control Organization). Recently, CSIR-IIIM also received permission to manufacture and market certain AYUSH drugs using this facility.

Nonclonable ID technology: An effective anti-counterfeit platform for medical product authentication

Counterfeit drugs have serious implications for pharmaceutical companies, government authorities and the general public. CSIR and Bilcare Ltd. have partnered to demonstrate the ability of a novel nonClonableID (nCiD) technology to address unmet needs in medical product authentication and patient compliance.

Affordable monitoring & diagnosis

Efforts are being made to reach affordable methods of monitoring and diagnosis of diseases and of patient care to common people. These include low cost diagnostic kits, technology for monitoring maternal and child health and products to ensure easy patient care in hospitals. Biodesign Programme in collaboration with the Biotechnology Industry Research Assistance Council (BIRAC) has developed several low cost devices for maternal and child care, and patient care diseases detection.

Development of highly sensitive and specific rapid 1- Day Dengue Diagnostic Kit

The highly sensitive rapid 1- day dengue diagnostic kit detects Dengue Virus (DENV) infection from the first day of fever, with a cost of ₹ 145/test to the distributors. The kit's performance was tested by Drug Controller Govt. of India and is currently being exported.

Development of affordable and point-of-need testing diagnostic systems for HIV and TB

CSIR in partnership with an industry has developed and launched a TB diagnostic kit, ReaSLR CSM Kit Ver 1.0. The kit has been made available for evaluation as well as sale. The HIV diagnostic ReaSTAT CD4 kit that has been developed is currently under large scale external validation.



Development of technology for a rapid diagnosis of Celiac Disease (CD) in humans

Diagnostic kits for Celiac

Disease (Celiac Microlisa & Celiac Card) supported by the Department was launched in 2014. These kits were developed through a collaborative, multi-institutional, inter-disciplinary approach and are rapid, sensitive, specific, and are much cheaper in comparison to the imported kits. The participating institutions were ICGEB, New Delhi, Translational Health Science and Technology Institute (THSTI), Gurugram; All India Institute of Medical Sciences (AIIMS), New Delhi, and have been made commercially available by industrial partner J. Mitra and Co. Pvt. Ltd

Highly Sensitive and specific rapid 1-Day Dengue Diagnostic Kit has been developed by ICGEB team with support from DBT



Plasma Gelsolin Diagnostic Kit for prematurity and sepsis

CSIR-IMTECH has developed two mass-production ready plate-based kits to estimate plasma gelsolin levels in humans leading to early detection of pre-term birth. After successful clinical trials, the diagnostic kit has been transferred to an industry for commercialization.

eSKIN: An in-silico Platform for Skin Data Analysis

A sophisticated but user-friendly software tool named "eSKIN" has been developed for skin system which enables modeling, simulations, analysis, and visualization. It has the ability to convert large scale high-throughput omics data into biomedical knowledge. The software is open for use and is available at the online platform of the industry partner, Persistent Systems.

Handheld FOT (Forced Oscillation Technique) device for improved detection and monitoring of airway diseases (PulmoScan)

CSIR-IGIB in partnership with industry has developed the world's first handheld, portable and battery-powered FOT device called PulmoScan, for measurement of lung function. It is a portable device with ability to run from the tablets without electrical supply. Its open tube design ensures disinfectability in Indian conditions where TB is a common problem.

Innovative devices to nurture mother and child health

Sohum helping early detection of hearing impairment in children

Sohum is a non-invasive and safe device for screening of neonates for hearing impairment with high sensitivity and specificity. This product



is licensed to Sohum Innovations and has been launched in India. The company is using seed the market strategy by providing products to various hospitals across India for eliciting feedback and adoption. The company has started making sales with three products sold so far. Sohum has executed a Memorandum of Understanding with the Government of Andhra Pradesh for phase-wise implementation and is in



discussions with other state governments for product procurement.

NeoBreath: Foot-operated Resuscitation Device helping neonatal care

This product is a foot-operated resuscitation system that can free-up a hand of the device operator, thereby allowing use of both hands for holding the mask, leading to effective sealing and better ventilation. NeoBreath is licensed to Windmill Health and has been commercialized in India, as well as top hospitals of South Africa, Nigeria, Kenya and Mali. A few sample units have also been shipped to Rwanda, Chile, Peru and Argentina

and pilot sales in Africa and South America have started. More than 150 units have been sold by the company so far. The technology



has been sub-licensed to Phoenix Medical systems, Chennai for market outreach and sales.

Brun: Feto-maternal Parameter Monitoring System

This device is a safe, easy and cost-effective way to continuously monitor feto-maternal vitals of pregnant women,

which helps to reduce neonatal mortality. The product is licensed to Brun Health. The company has completed design for manufacturing for the product and is validating the technology at AIIMS, New Delhi and the product is yet to be commercialized.



Sishunetra

First-of-a-kind, low-cost wide field eye screening device for premature and term has been developed. The product has undergone extensive field trials and is ready to be launched in the Indian market by 2018.



Fetal Mom

This device functions as a fetal electrocardiogram and monitors uterine activity through signal extraction from maternal electrocardiogram, thereby eliminating the need for use of conventional transducers. The product has undergone clinical validation and is ready for launch.



Infant warmer – Bassinet and wrapper

The product was developed through DSTs support and was transferred to HLL Lifecare.



Innovative technologies for patient care

The focus of this initiative is on the development of devices and related technologies to ease patient care. The targeted categories include screening, diagnostic, surgical and life support equipments for clinical applications in healthcare sector.

Device to manage faecal incontinence, helping patient care in ICUs

This device helps to manage faecal incontinence in aged and infirm patients.



Soft Tissue Biopsy device helps collection of tissue samples with minimum skill for diagnosis

The device provides a safer, easier and cost-effective way to perform percutaneous aspiration needle biopsy.



Device developed to provide for concurrent biopsy and hemostasis

The device offers a safer, easier and cost-effective way to perform percutaneous aspiration needle biopsy, reduces skill and helps obtain consistent tissue samples for definitive diagnosis. helps, concurrent biopsy and hemostasis.

DPortable Device for Hand Sanitization helps patient care

This device is a simple, convenient and effective way for hand sanitization, helping patient care and is useful for hospital staff as well as patient care at home.

FlexiOH

FlexiOH is a breathable, washable and lightweight cast for immobilization of limb fractures.



Ostomy Management Appliance

The Ostomy Management Appliance is a safe, secure, bag-less solution for managing colostomy.

TJay

TJay, currently in the clinical trial stage, is the first of its kind holistic management solution for epilepsy. It consists of a wearable and an app for people with epilepsy (PWE), with a powerful analytic platform for doctors and healthcare professionals.



ACIX100

ACX100 is a microfluids-based immunoassays technology is a fast, accurate, reliable and cost-effective solution to improve healthcare standards of all; especially in remote and resource

limited settings. The technology can perform multiplexing, that is, it can test an array of proteins simultaneously from the same volume of sample.

Mobile Lab

The Mobile Lab is a compact portable clinical laboratory, in the form of a suitcase with a power backup facility. It consists of all essential instruments like Biochemistry Analyzer, Centrifuge, Incubator, Data Recorder/Mini Laptop with Patient Data Management Software, Micropipettes and other accessories.



Scintiglo

A smart, point of care, hand-held diagnostic device for rapid, reliable, economic and accurate quantitative estimation of urinary proteins.



Malaria Rapid Card Test

The kit is designed for differential diagnosis between Plasmodium falciparum and Plasmodium vivax.

AnuPath: Multi-analyte PoC device

AnuPath is a point-of-care medical device for management and early prevention of complications for diabetes, chronic kidney disease, anemia and malnutrition. The handheld medical device utilizes dry test strips for detection of biomarkers related to the respective disease.

Exocan

ExoCan has developed biofluids-based early cancer detection cum diagnosis kit operable at low costs. It is a two-step test to provide complete molecular information.



AINA Glucose Monitoring

The AINA device has been developed and commercialized to measure blood glucose, HbA1C, lipids (HDL, LDL, TrG), creatinine and haemoglobin.

Osteo3D

Osteo3D is a cloud-based 3D printing platform enabling surgeons to create 3D printable medical models online from any mobile, tablet, laptop or desktop computer.

Oral cancer screening camera

The product is a hand-held imaging device that uses trimodal imaging technology combining tissue fluorescence, absorption, and diffuse reflectance for screening and detection of oral cancers.

Prosthetic Leg

PSPR-3D-Tech is engaged in development of technology and manufacturing of affordable below-knee prosthesis innovative reverse engineering and 3D printing technologies enabling high level fit for greater comfort and strength.



Poorti kit:

Post-mastectomy breast prosthetics

The Poorti kit is an affordable and holistic post-mastectomy kit to restore confidence, dignity and femininity of breast cancer survivors.



VAPCare

VAPCare is a novel secretion and oral hygiene management system to reduce the risk of acquiring Ventilator Associated Pneumonia (VAP).

Tro Guard: Hip protective device

Tro Guard is a novel hip protective device developed by IIT-Delhi, with the technology for the manufacture of bone graft materials being transferred in 2016.

Tilting Disc Heart Valve

The second-generation cardiovascular products, namely the tilting disc heart valve and gel-coated vascular graft, has entered into the clinical trial phase.



Technology transfers for _____

The technology for the following innovations has been successfully transferred:

- Preparation of extracellular matrix scaffolds from mammalian cholecyst/jejunum/urinary-bladder
- Calcium Sulphate cement, process for Glutaraldehyde cross-linking of pericardium with anti-mineralization, Poly Vinyl Alcohol (PVA) sponge
- Rapid Urinary Tract Infection (UTI) diagnostic kit with antibiotic sensitivity test
- Fibrin sealant
- Blood/IV fluid warming system
- Vein viewer device

Hand-cranked defibrillator

The world's first electricity and hand-cranked dual powered defibrillator has been developed, serving use in regions without

reliable electricity such as in India, Africa, South America and Asia. Health units such as Primary Health Centres (PHCs) and Community Health Centres (CHCs) as well as emergency response units of security forces would benefit from this immensely. The price of this device would be 1/4th of the big brands, while providing similar or higher quality and reliability levels.

Haemoglobin (Hb) Calculator App

An android-based smartphone app called Haemoglobin (Hb) Calculator was developed for accurate and sensitive measurement of Hb. The application's higher sensitivity, specificity, accuracy and reliability make it an attractive alternative for Hb estimation in resource-limited conditions.

InDiaTel: Diabetic healthcare unit

InDiaTel, a telemedicine-based diabetic healthcare unit, was developed by Vellore Institute of Technology (VIT) in association with TMI Systems and launched in December 2017.

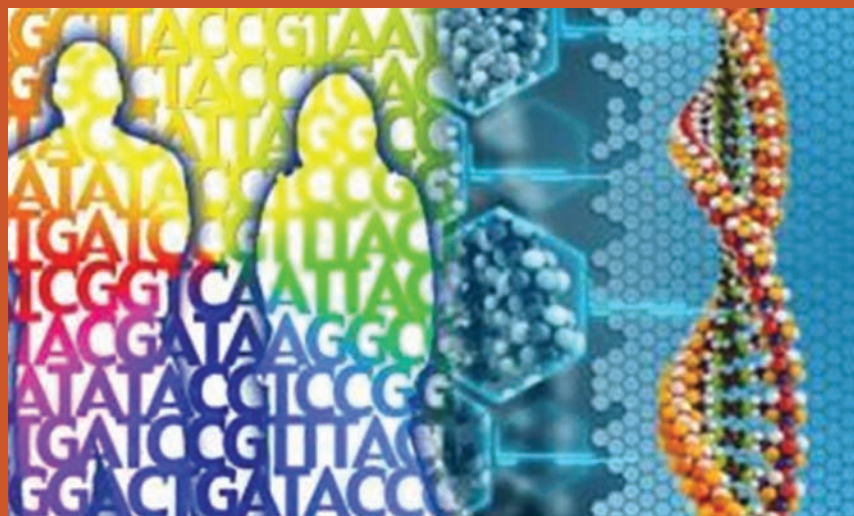


InDiaTel – A Telemedicine based Diabetic Healthcare Unit



Diagnosis & treatment of human genetic disorders significantly augmented

The programme on Human Genetics & Genome Analysis provides genetic diagnosis, improved molecular medicine tools and counselling to families affected by common genetic disorders in India. As of now, 21 Genetic Diagnosis cum Counselling Units have been established, benefitting more than six lakh affected families, including one lakh tribal families.



DNA typing

DNA typing of 25 autosomal markers in 53 ethnic groups (including tribal, caste and religious communities) revealed evidence of human migration from India to South East Asia.

Multi-institutional National Programme on preterm birth launched

The five-year Grand Challenge programme at a total cost of ₹ 48.85 crore envisages a multidisciplinary research effort to predict & diagnose Preterm Birth (PTB) by enhancing the knowledge of the underlying pathophysiological mechanisms. With a goal of enrolling



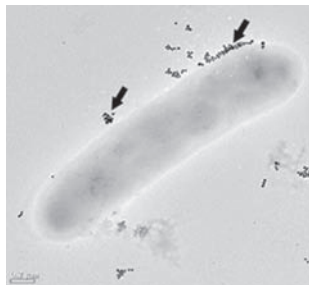
a total of 8,000 subjects, 1,108 women have already been enrolled in the cohort study. Early findings from the cohort study involving 1,000 mothers indicate that indoor pollution is associated with early birth, and that early shortening of the cervix is a risk factor for PTB.

Infectious disease research

DBT has taken up the challenge of addressing the prevention, detection & treatment of a large range and burden of infectious diseases. Recognizing the importance of collaborative research to address regional needs, DBT, in collaboration with DST, and Medical Research Council, Department of Science & Technology and the Government of South Africa, embarked on a collaborative research program on HIV, TB and TB/HIV. DBT has also initiated an inter-institutional HIV Research Program titled 'Cohorts for HIV Resistance and Progression in Indian Children and Adults'.

Indo-South African Collaborative Research Program on HIV, AIDS and TB

The collaborative program is under the framework of the bilateral Science & Technology Cooperation agreement between the Department of Science & Technology, Ministry of Science & Technology, Governments of India and

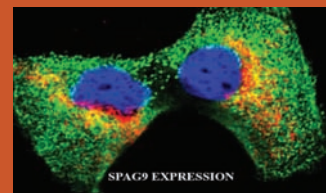


South Africa. Three joint proposals in TB, HIV, TB/HIV have been sanctioned under this collaborative effort.

Cohorts for HIV Resistance and Progression in Indian Children and Adults

This networking program envisages building specific HIV cohorts and a related national database and bio-repository to enable the conduct of studies that will provide a better understanding of the disease to aid in the design and development of novel tools for treatment and prevention of HIV/AIDS.

Contributions to cancer research



DBT has helped identify

causes of oral and breast cancer, the two major cancers affecting the Indian population in order to contribute to an increased understanding of the strategies for cancer prevention and effective treatment. The Department has achieved the following:

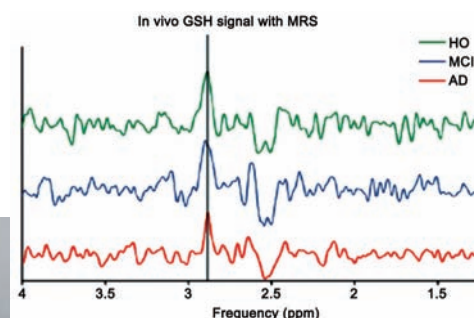
- Funded two Virtual National Cancer Institutes (VNCIs): Oral & Breast Cancer
- Multi-omics Analysis to Decipher Mechanisms of Hormone Resistance in Breast Cancer
- Fully functional Virtual National Oral Cancer Institutes. These are staffed by 5 to 7 investigators holding proven excellence in basic biology, clinical research and technology development
- Implementation of seven Units of Excellence. These units are mandated to extend the advancements made by the principal investigators in basic biology to pre-clinical and clinical areas. 113 pilot project grants for young investigators have been sanctioned and implemented to investigate new hypothesis for establishing proof-of-concept in cancer research.

Tools for diagnosis and management of mental disorders

Given the range of different types of mental disorders afflicting people DBT is working on specific problems that affects India. Dyslexia is a learning disability wherein school children do not achieve adequate reading skills despite normal intelligence, equal opportunity and adequate instruction. It is believed to have a worldwide incidence of 5-20% and in India, the incidence of dyslexia is believed to be 10% which brings our count of dyslexic Indian children to nearly 35 million.

Software for early detection of mental disorders

National Brain Research Centre (NBRC) has developed a software that can screen a person to predict predisposition to Alzheimer's and other mental diseases allowing for improved management of these disorders. The software conducts imaging to find out the chemical changes in the brain.



*Virtual reality based
Social Communication
System for children
with Autism Spectrum
Disorder*

To promote cutting edge research in cognitive science, the Department of Science and Technology has supported around 200 Research and Development (R&D) projects through the Cognitive Science Research Initiative.

DALI (Dyslexia Assessment in Languages of India): Kit for early detection of dyslexia

DALI is a package developed by National Brain Research Centre, Manesar that contains screening tools for school teachers and assessment tools for psychologists in Indian languages to identify dyslexia. DALI will be the first indigenously developed screening and assessment tool to be standardized and validated across a large population of nearly 4840 children. The tools are available in Hindi, Marathi, Kannada and English and is currently being developed in other languages as well.



Science And Technology of Yoga And Meditation (SATYAM) to rejuvenate deeper scientific research in yoga and meditation

60 R&D projects have been supported to address issues related to the study of several practices of yoga & meditation

to treat various diseases such as schizophrenia, epilepsy, depression, early dementia, Mild Cognitive Impairment (MCI), Parkinson's disease, cerebral palsy, rheumatoid arthritis, Type 2 diabetes, Polycystic Ovary Syndrome (PCOS), Chronic Obstructive Pulmonary Disease (COPD), pulmonary function in chest trauma patients, lifestyle diseases, and improvement of quality-of-life. The selected teams involve clinicians, proponents of Yoga and scientists, among other from multi-disciplinary areas.

Award instituted by Technology Interventions for Disabled and Elderly (TIDE) program

The TIDE program instituted an award for the development of the best-assisted device and the Hon'ble Prime Minister gave the inaugural award during the 103rd Indian Science Congress.



Atlas for Visually Impaired (India)



The Union Minister for Science & Technology and Earth Sciences Dr. Harsh Vardhan released the Special Edition of "Atlas for Visually Impaired (India)" in English Braille



This Braille Atlas has been prepared by National Atlas and Thematic Mapping Organisation (NATMO) under Department of Science & Technology

Efforts are being made to make these atlases more cost effective than the current price of ₹ 600/- per atlas with 20 maps now.



@IndiaDST

@IndiaDST



'Ksheer Tester' Handheld GPS enabled device to detect milk adulteration

In order to address the issue of milk adulteration, a low-cost portable electronic system, named 'Ksheer-Scanner' and 'Ksheer Tester' have been developed which detects contaminants such as urea, salt, detergent, liquid soap, boric acid, caustic soda, and hydrogen peroxide in just 40-45 seconds. The device enables any person to track the location of the tested sample of milk and receive the test results through SMS on the device. The technology has been transferred to 2 companies for commercialization.



Degumming of Rice Bran Oil

A process of enzymatic degumming that produces prime quality rice bran oil has been developed. This eco-friendly process reduces phosphorus levels in rice bran oil from 0 to 5 ppm, enables more oil recovery at better quality while requiring less water and releasing less liquid effluent.



The process technology is commercialized and has also been demonstrated to 19 industries and 8 project engineering companies.

Carbonated Fruit Juices as an Alternative to Soft Drinks

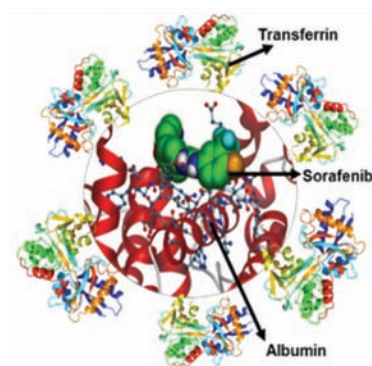
Standardized carbonated drinks based on grape, pomegranate, sweet lime, sugarcane and neera (coconut palm sap) flavours have been created by the technology



for carbonation of fruit juices. The fizzy fruit juice formulations, promoted as 'healthy' and 'nutritious' drinks are suitable for all age groups, and particularly suited to the carbonated preferences of the younger generation of consumers. The products have a shelf life of about 2-4 months at room temperature. The laboratory estimates indicate the cost of production of 300 ml of fruit juice to ₹ 16.

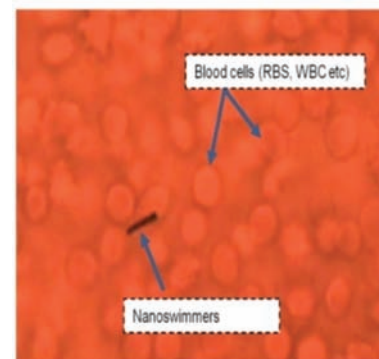
Protein Nanomedicine

A novel protein nanomedicine formulation was developed with tunable pharmacokinetic and bio-distribution properties achieved by gold (Au) cluster doping technology. The negative charge of human serum albumin nanoparticles (nAlb) was modified by doping with 25-28 atom clusters of gold. This study enabled loading of small molecule drugs at single molecule form.



Nanoswimmer

A system of artificial paramagnetic nanostructures was developed that can be manoeuvred remotely in bodily fluids, such as human blood, using small externally applied rotating magnetic fields. The novel system is being explored for clinical applications in cancer diagnostics and therapeutics.



Waste to Value: Swachh Bharat





Waste to Value: Swachh Bharat

HON'BLE Prime Minister Shri Narendra Modi launched the ambitious 'Swachh Bharat Abhiyan' (Clean India Mission) on 2 October 2014 on the 145th birth anniversary of Mahatma Gandhi. The Ministry of Science & Technology is contributing towards new technology development for many initiatives under Swachh Bharat.

In addition, many new technologies that have been successfully demonstrated are now being transferred for commercial scale-up to the user agencies and departments. Various initiatives are being taken forward with the local Municipal Corporations and the Ministry of Drinking Water and Sanitation, as well as the Ministry of Urban Development under the Swachh Bharat Mission. Special initiatives for cleaning of

waste water have contributed significantly to the *Namami Ganga* project.

There has also been a major focus on conversion of waste to value. The effort is to demonstrate new technology that can help in the conversion of waste to value.

Under 'Swachh Bharat Abhiyan' (Clean India Mission), the Ministry of Science & Technology is contributing towards new technology development for many initiatives under Swachh Bharat.



Collaboration with Netherlands to Clean Delhi's Barapullah Drain

Swachh Barapullah Drain

Department of Biotechnology partners with Government of the Netherlands and DDA to clean the open sewage water of Barapullah drain leading to river Yamuna.



- Reuse water for on site toilets
- Recover wealth: metals, organic compounds
- Reuse water for water park on site Sun Dial park
- Reuse water for irrigation, industrial purposes
- Potable water

PROJECT LOTUS:
Local Treatment of Urban Sewage Streams For Healthy



Department of Biotechnology India

Department of Biotechnology

@DBTIndia

DBT has collaborated with Netherlands to initiate a project for cleaning Delhi's Barapullah drain. The project aims at 'new' wastewater management to ensure good quality fresh water, free of risk-causing contaminants and promoting productive, safe reuse of water.

A wastewater treatment plant to make dirty water potable is to be set up, apart from ensuring removal of heavy metals from the water body for reuse. Barapullah Nullah is a 12.5 km-long storm water drain responsible for about 30% of pollution in the Yamuna River collecting domestic sewage and polluting waste from small industry from the South zone to the East zone in Delhi.

Green Remediation Technology for Wastewater Treatment

A DBT supported project has developed a phytoremediation treatment process for the degradation of dyes from textile industrial effluents. The study showed that *macrophytes*

Ipomoea aquatica, *Alternanthera philoxeroides* (a massively rooted macrophyte), and *Salvinia molesta* showed a potential for textile dyes and effluent treatment at large scale (constructed wetland system) through rhizofiltration approach.



Empowered Septic Tank for Wastewater Treatment

Birla Institute of Technology and Science, Goa, has developed a financially affordable and simple-to-operate decentralised wastewater treatment system using bio-electrolysis for a community of 100 individuals.

Extensive testing of the effluent is underway.

BioUrja

BioUrja is a modular, compact and customizable bio-methanation system to handle various organic wastes developed by a startup GPS Renewable, through support from DBT and BIRAC. Easy to use, automatic, highly efficient and low footprints are key features that have helped BioUrja achieve worldwide recognition. With MIT and WWF recognizing the innovation, world-renowned partners and multiple patents, BioUrja promises a sustainable future for waste management.

Novel Bio-toilet Technologies

DBT, BIRAC and The Bill & Melinda Gates Foundation launched a 'Grand Challenge Call' focused on reinventing the toilet. Innovative Bio-toilet design ideas were generated focused on innovative solutions for less water usage, pathogen free and odour free discharge and bio-digestion of waste.

A demonstration has been set up in 100 schools in the North East using the new bio-toilet design. This is an off-grid, self-sustained, modular, electronic toilet for use in slums. It utilises solar energy and is integrated with mixed waste processing unit to ensure water and energy/fertilizer recovery.



Easy to assemble cost-effective toilets: A technology for low cost, light weight (<500 kg) toilet with long shelf life (25-30 years) has been developed using textile reinforced concrete (TRC) panels for areas where toilet coverage is still incomplete. It is made in-situ and assembled in less than five hours. An MoU was signed with M/s. Smart Built Prefab Pvt. Ltd., Hyderabad, for technology transfer and manufacturing.

Precast ferrocement toilet core unit: A novel technology for industrial production of Precast Ferrocement Toilet Core (TOCO) units at an affordable cost has been developed. The technology involves casting of components of the structure at the manufacturing or production site, rather than location and transporting and assembling components at the site where the structure is to be located. This technology is useful for mass production of high quality toilet core units to cater to the needs of the people, and combines good design with modern high-performance components and quality controlled manufacturing procedures.

Molasses spent wash treatment gives algal biofuels:

Algae biofuels may provide a viable alternative to fossil fuels. A new technology supported by BIRAC has been developed that can remediate pollution from wastewater of sugar or distillery industry and use it for enhanced production of algal biofuel. The fungus that produces enzymes for decolourisation of the polluted water has been grown and other microbes to be used in this process have also been screened and isolated.

Innovative Bio-toilet design ideas were generated focused on innovative solutions for less water usage, pathogen free and odour free discharge and bio-digestion of waste. Demonstration has been set up in 100 schools in the North East using the new bio-toilet design

Anaerobic digester converts household organic kitchen waste to biogas: An Anaerobic Digester has been developed for converting household organic kitchen waste to biogas. It has a capacity to convert up to 3 kg per day bio-degradable kitchen waste to 400 litre biogas, that can



be utilized as used as fuel. In the process, it will discharge about 2.5 litres of manure which can be used for building a kitchen garden. The technology has been transferred to Mailhem Ikos Environment Pvt. Ltd. and will also be utilised by Thiruvananthapuram Corporation.

Recycling waste plastic bags into tiles: A simple and novel process for recycling waste plastic bags and bottles to turn them into decorative coloured tiles has been developed. Such tiles can be used in building structures for the public. The technology has been transferred to M/s Shayna Ecounified India Pvt. Ltd., Delhi.



Bio-filter odour control for municipal solid waste treatment plants: Solid

Waste (SW) treatment plants are facing public protests due to odour in Municipal SW treatment plants. CSIR-NIIST has developed design of odour control ventilation system and bio-filters for treatment of large volume exhaust air from solid waste treatment facilities. The biofilters are operational at several locations.



Food waste digester cum biogas plant:

A food waste digester cum biogas plant (40 kg food waste/day) has been developed for treating large quantity of organic waste. The product has an automatic control system for more efficient biogas production and its utilization. About 40 kg food waste/day unit can generate around 7 M3 biogas daily (average biogas was 160-180 L/ Kg food waste, methane content >60%). It has been installed in schools, Regional Cancer Center, Marthoma orphanage in Thiruvananthapuram, CPCRI, Kayamkulam and Kavaratti island in Lakshadweep.

Disposal of municipal solid waste utilising high temperature plasma: The technology has been developed for effective & eco-friendly disposal of municipal solid waste material generated on daily basis and generation of fuel gas containing predominantly CO and H₂ utilising high temperature (>3000°C) Plasma arc. The technology has been licensed to M/s Positronics Innovation Pvt. Ltd., Kolkata for commercialisation.

Biogas Purification & Bottling Technology for vehicular application developed at Indian Institute of Technology, Delhi has the capacity of generate upto 100 m³/day biogas and is in the process of demonstration and commissioning at Bhopal.

Waste Treatment Technology Development

DBT is supporting many demonstration programmes for conversion of waste to energy. The focus is on conversion of both municipal solid waste and municipal liquid waste to bio-oil, bio-CNG and bio- methanol. A demonstration plant has been set up at BPCL, Refinery, Chembur, Mumbai at 1 ton/day. In addition, two other demonstration plants have been set up at GHMC site, Hyderabad and BITS Pilani, Goa. Both these are at 2-5 ton/day. On successful completion of demonstration, these technologies would be scaled up for commercialisation.

New Hybrid Kiln (Novel Bio-toilet Technologies)

New Hybrid Kiln has been developed which incorporates features for natural draft and induced draft kiln, with higher efficiency at less fuel consumption. The patent has already been filed for "New Hybrid Kiln with zig- zag technology". Hybrid kiln reduces the energy consumption and also maintains the required production level throughout the operating season of brick kilns.



DST Waste Management Technologies (WMT) Programme

“Waste Management Technologies (WMT)” programme was initiated in October 2015 to provide innovative technological solutions for challenges around solid waste management, including, hospital waste, plastic waste and e-waste – **19 projects were initiated in the first phase and 18 projects in the second phase.** DST has recently invited Expression of Interest (EoI) for considering joint and scale up projects under solid waste management. The overwhelming response of investigators was reflected in 780 EoIs received by the Department.

Hybrid light weight, high strength and glossy finish, polymeric composites from marble & granite waste stream makes green composites by utilisation of marble



Landfill Reclamation: DST has constituted a scientific advisory committee on the request of the Government of Delhi for the reclamation of a sanitary landfill site. The committee recommended short term, medium term and long-term measures and action plans to the concerned municipal bodies. A comprehensive assessment of available technologies for solid-waste management has also been completed and shared with MoUD to aid in the future deployment of these technologies.

and granite wastes. The hybrid green composites can be used as viable alternatives for timber, synthetic wood and plastics for use in civil infrastructure. To generate awareness and confidence, an Industry Institution Enclave (IIE) 2017 was organised in Coimbatore where hybrid green composites made from marble wastes were showcased. Networking with select promising entrepreneurs and start-ups have also been established for commercial exploitation.





Digital India





“We want to have one mission and target: Take the Nation Forward, Digitally and Economically”

Shri Narendra Modi, Hon'ble Prime Minister of India

Digital India: Progressive India

DIGITAL India is a flagship programme of the Government of India, with a vision to transform the country into a digitally empowered society and knowledge economy. Ministry of Science and Technology and Ministry of Earth Sciences have been implementing many programmes and activities supporting the Digital India Initiative, which are:

High Performance Computing (HPC)

Ministry of Earth Sciences has augmented its HPC facility by 6.8 Peta Flops (PF) which has been installed at two of its constituent units namely, Indian Institute of Tropical Meteorology (IITM), Pune with 4.0 Peta Flops capacity and National Centre for Medium



Range Weather Forecasting (NCMRWF), Noida with 2.8 Peta Flops capacity. **The HPC facility 'Pratyush' at IITM and "MIHIR" at NCMRWF were dedicated to the nation by Dr. Harsh Vardhan, Minister for Earth Sciences on 8 January 2018 and 30 January 2018, respectively.** With this facility, a paradigm shift in weather and climate modeling activity for operational weather forecast has been achieved.

The HPC system will be a national facility for improving weather and climate forecasts and services under the umbrella of the Ministry of Earth Sciences (MoES), Govt. of India. India's ranking has moved from the 368th position to around the top 30 in the Top 500 list of HPC facilities in the world. India is now placed at the 4th position after Japan, UK and USA for dedicated HPC resources for weather/climate community.

This facility is part of Ministry's continuous endeavour to provide world class forecast services to the citizens of India through its various operational and research and development activities. The Ministry of Earth Science has developed several services for societal benefits catering to a variety of sectors of economy by building state-of-the-art systems for multi-hazard risk reduction from cyclones; floods/droughts; heat/cold waves; earthquakes and tsunamis.

The HPC facility 'Pratyush' at IITM and 'MIHIR' at NCMRWF were dedicated to the nation by Dr. Harsh Vardhan, Minister for Earth Sciences on 8 January 2018 and 30 January 2018, respectively.

National Supercomputing Mission

It is a visionary programme to enable India to leapfrog to the league of world class computing power nations. The NDA Government approved the Supercomputing Mission at a total cost of ₹4500 cr in March 2015. The Mission envisages installing a vast supercomputing grid comprising more than 70 high-performance computing facilities. The Mission also includes development of highly professional High-Performance Computing (HPC) aware human resource for meeting challenges of development of these applications. Supercomputing capability would add a great value to realise the goals of Digital India. The six supercomputing systems in Phase I are to be made operational shortly.

Interdisciplinary Cyber-Physical-Systems (ICPS)

DST has identified Interdisciplinary Cyber Physical Systems (ICPS) as one of the emerging fields, progress in which is expected to have significant impact on health care, urban transportation, water distribution, energy, urban air quality, manufacturing and governance. The complex socio-technical systems, involving interactions between 'cyber' and 'physical' are addressed by CPS technologies. The R&D activities envisioned under this program will provide a great fillip to Indian manufacturing through invention of new products and services, and creation of skilled human resource at all levels (from technicians to researchers, and entrepreneurs). It is also expected to become a key contributor in realizing the vision of a **"Digital India"** and for economic growth.

The ICPS division is working on the development of the National Mission on ICPS (NM-ICPS). CPS and the associated streams, and all aspects of research will be coordinated under the umbrella of NM-ICPS.



Science and Heritage Research Initiative (SHRI)

The objective of SHRI is to promote the scientific research and intervention to preserve, restore and develop of new material/methods/tools to strengthen Heritage Science in sectors such as textiles, metal works, crafts, ceramics, etc. and diffuse this to artisan clusters. The programme was launched by Hon'ble Minister of S&T on 13th October 2017 during IISF-2017. Around 100 proposals were received under the first call for proposals closed in February 2018.

Indian Heritage in Digital Space (IHDS)

The Indian Digital Heritage (IDH) project is a unique initiative of the DST supporting collaborative projects between researchers in the areas of technology and humanities for the digital documentation and interpretation of tangible and intangible heritage. The project highlights the art, architecture and cultural legacy of the world heritage site of Hampi in Karnataka, the medieval capital of the Vijayanagar dynasty.

As an outcome of the IDH Scheme, a total of 37 generic technologies, 7 prototypes and scaled models have been developed and demonstrated. These technologies are generic in nature and thus can be applied on any monument. Developed technologies broadly relate to Murals, Knowledge bank, Interfaces, Intangible, Memorialization, Design, Crafts, 3D Printing, Features, Resurrection, Ontologies, Representation, 3D Surface, Preservation, Immersion, Reconstruction, Haptic, Walkthrough, Scaling etc. Three Start-up Companies have been spun off from IDH research and technologies.

Networked Programme on Imaging Spectroscopy and Applications (NISA)

Network Programme on Imaging Spectroscopy & Applications (NISA) is a cluster based multidisciplinary networked scheme to promote research on various aspects of Imaging Spectroscopy and Applications (ISA). This scheme is expected to evolve reference standards, protocols, database and research methodologies for adaptation in various fields relevant to society. This networked scheme has 37 projects in seven theme areas (such as geology, agriculture, forestry, water, snow and glacier ice, urban & built-in materials and algorithms). 70 JRFs are working towards their PhDs in this advanced field of Imaging Spectroscopy & Application. Outcome of this project will add new dimension to India's natural resource exploration strategies and resource inventory. The scientific understanding in each thematic area emerging from this networked project will also fill the gaps in present understanding on this subject globally. ISA being the current and futuristic technique, the proposed networked project will certainly pave way for technology development, generating human resource in the country.

New Directed Research Programme on “Quantum Information Science and Technology (QuST)”

Quantum Information Science and Technology (QuST) promises to revolutionise the future computation and communication systems which will ultimately have an immense impact on the Nation and our society. To evolve and finalise the research topics & thrust areas of QuST, two brainstorming meetings were organised, the first one at the Centre for High Energy Physics, IISc, Bangalore and the second one at HRI, Allahabad.

ICPS Division has initiated a new directed research programme on “**Quantum Information Science and Technology (QuST)**” with the following broad objectives:

- Development and demonstration of quantum computers
- Development and demonstration of quantum communication & cryptography
- Development of quantum-enhanced and inspired technology
- Development of advanced mathematical quantum techniques, algorithms and theory of quantum information systems.

The development of a cluster based networked programme under directed research to meet the QuST objectives is going on.

AutoCEPH: A software for 2-D Computerised Cephalometric Analysis

CSIR-CSIO and AIIMS have jointly developed software to carry out 2-Dimensional Lateral and Posterior Anterior (PA) Cephalometric Analysis— AutoCEPH. It can perform 16 standard Lateral, 3 PA analyses and superimpositions. The software can be utilised by orthodontics specialists and cosmetic surgeons for patient diagnosis and treatment planning.

eProMIS: A web enabled Project Management Information System

A web enabled project management information system called **eProMIS** has been designed and developed essentially to keep a track of the funds being distributed geographically and area wise and to effectively manage as well as monitor the extramural research. This system has also enabled paper — less communications through auto-generated emails to PIs, reviewers and task force members. Very recently, this system has been adapted by Department of Science and Technology.

DivyaNayan – Portable Reading Machine for Visually Impaired and Low-literacy Populations

A personal reading machine for visually impaired is a machine that can read any printed and digital books available in Hindi and English. DivyaNayan has been tested with many visually impaired individuals from different age groups, and has gained wide popularity. Due to the increase in demand, many public and private industries are interested in the manufacturing this technology. Currently, pilot production of the developed technology is on and very soon the technology will be available to users.



Car Driving Simulator

This research-based simulator has been developed in association with Faros Simulation Systems Pvt. Ltd., Gurgaon, to evaluate a driver's driving abilities and skills, as well as psychophysical and cognitive driving capacities. The technology serves as a useful tool for multiple stakeholders including transport authorities, and training institutions responsible for evaluating driving traits of the drivers before issuing driving licenses.

Digital Ocean

Digital Ocean being developed by Indian National Centre for Ocean Information Services (INCOIS) is a dynamic framework of a set of applications to efficiently integrate and manage heterogeneous ocean data and to provide advanced visualisation and analysis tools to facilitate improved understanding of oceans in multi-disciplinary approach. In a nutshell, the Digital Ocean is the representation of the ocean that is georeferenced and connected to all diversified digital data archives on ocean parameters (for example, temperature, salinity, oxygen, acidity, etc.). In addition, the Digital Ocean built on the real relief of ocean characterised by abyssal plains, ridges, trenches, continental slopes, continental shelf and coasts, that will help in viewing the evolution of ocean parameters in time and space (in 3D).

The Digital Ocean will be fed by data generated by various programmes using diverse platforms and sensors. The idea of the Digital Ocean is that all data irrespective of source, sensor or platform should be made available for analysis on a single platform so that the analyst can develop better feel for data and improve his understanding on the working of oceans. For example, the temperature of the ocean is usually measured/recorded using different sensors and platforms like bucket thermometers, versatile Argo floats, CTDs, sensors attached to Gliders and moored buoys and satellite based sensors. The alpha version of the application is under progress and the project is expected to be completed by June 2018.

BTISnet Across the Country

The Biotechnology Information System Network (BTISnet) is now spread across the country with around 170 centres. The BTISnet includes 6 Centres of Excellence (CoEs), 12 Distributed Information Centres (DICs), 49 Distributed Information Sub-Centres (DISCs) and 103 Bioinformatics Infrastructure Facilities. The network also consists of one supercomputing facility for Bioinformatics and six interactive graphics facilities. A large number of bioinformatics R&D projects are being supported through this programme. The network supports 6 teaching programmes in M.Sc., M.Tech. and PhD in Bioinformatics and Computational Biology to generate skilled manpower. Further, the BTISnet centres conduct short term trainings and workshops for the benefit of the research community including experimental biologists. The centres also provide Bioinformatics and Computational Biology services to the scientific community.

BABRONE — for Northeast India

An online human resource repository of Biotechnology and Bioinformatics Resources of North East India (BABRONE) has been created and located at College of Veterinary Sciences (AAU), Khanapara, Guwahati (Assam). It is a freely accessible e-learning server developed as a common platform for uploading learning materials, sharing of information and as an online discussion forum at <www.babrone.edu.in>. Details of more than 1300 researchers, faculty and teachers from NER are available there on the portal.

NER-DeLCON

DBT's e-Library Consortia for North Eastern Region (**NER-DeLCON**) was established in the year 2010 through which access is available to more than 900 high impact e-journals. The facility is being offered to 18 selected NER institutions free of cost. It is being extensively used by scientists, faculty and students of these 18 institutions.





Energy For All





Energy For All

ENERGY forms the part of matrix that defines the quality of life. Currently, India's energy requirements are met to a major extent by fossil fuels and to a small extent by hydel, nuclear and renewable sources.

The Ministry of Science Technology is engaged in R&D for economic, efficient and environmentally safe energy generation and management, and has made significant contributions to the energy sector. A host of technologies have been developed pertaining to energy from fossil fuels on one hand and renewable sources on the other.

First Biomass to Ethanol Plant and its commercialization

The Institute of Chemical Technology (ICT), Mumbai has developed India's first home grown technology to convert biomass to ethanol with speed and efficiency. The technology which converts agricultural waste into ethyl alcohol, or bio-ethanol, is superior as the rate of conversion is four times faster than other technologies

currently available in the international market, it produces about 300 litres of ethanol per ton of biomass in 18-20 hours. The country's first Second-Generation (2G) Ethanol plant was inaugurated by Union Minister Dr. Harsh Vardhan at Kashipur in Uttarakhand and subsequently transferred to Bharat Petroleum Corporation Limited (BPCL) and Hindustan Petroleum Corporation Limited (HPCL) to build commercial scale biomass ethanol plants based on the technology. The plants are scheduled to be operational by 2018.

Certification for Coal used in Power Plants



CSIR entered into an MoU with coal supplying companies and power utilities for quality analysis of coal being supplied to power utilities by coal supplying companies. This collaboration will enhance efficiency of use of coal by power sector. The MoU was signed on June 28, 2016 at Anusandhan Bhawan, New Delhi, in the august presence of Union Minister Dr. Harsh Vardhan, Vice President, CSIR, and Mr. Piyush Goyal, Hon'ble Minister of State (IC) of Power, Coal and New and Renewable Energy.



Supercritical CO₂ Brayton Cycle Test Facility at IISc Bangalore

Supercritical Carbon dioxide Brayton cycle Test Loop Facility

Union Minister Dr. Harsh Vardhan, inaugurated the supercritical carbon dioxide brayton cycle test loop facility at IISc, Bengaluru in February 2018.

This lab scale test loop, the first of its kind in India, was developed by a research group at the Interdisciplinary Centre for Energy Research, IISc, as part of the Indo-US consortium SERIUS. Funding for this endeavour was provided by DST under the Indo-US Joint Clean Energy Research and Development Centre (JCERDC) programme.

The supercritical carbon dioxide based power generation offers a highly efficient and compact alternative to conventional steam-based power plants. This is India's first supercritical-CO₂ Brayton cycle test bed, and perhaps the first ever coupled with a solar heat source. This early stage research could potentially be useful for meeting the future energy needs of the country and reduce the carbon footprint of power generation significantly.

“The availability of advanced technologies will define a future global energy mix that is clean, affordable, and reliable”



India participates in Mission Innovation, a Global Initiative to Double Clean Energy R&D

Mission Innovation (MI) is a global initiative of 22 countries and the European Union to dramatically accelerate global clean energy innovation. As part of the initiative, participating countries have committed to seek to double their government’s clean energy R&D investments over five years, while encouraging greater levels of private sector investment in transformative clean energy technologies. This will accelerate the availability of the advanced technologies that will define a future global energy mix that is clean, affordable, and reliable.

India is a member of the Steering Committee and is also a member of all seven innovation challenges, with DBT coordinating all Mission Innovation activities for India.



Mission Innovation (MI) Smart Grid Challenge

DST organized the MI India Workshop on Smart Grid in May 2017 at IIT-Delhi to identify R&D themes relevant to challenge objectives. A Funding Opportunity Announcement (FOA) was announced in June 2017 earmarking US \$ 5 million for collaborative projects with MI countries at MI Ministerial-2 in Beijing, China.

DST also participated in the International Workshop to identify areas for collaboration. A synthesis document was also prepared detailing spectrum of activities, institutions and research priorities of participating countries.

India conducted the second International MI Smart Grids Workshop on 16-18 November 2017 at IIT Delhi. An exhibition was also conducted in November 2017 to showcase the work under taken by Government bodies as well as Industries.



Participants of Second International Mission Innovation Smart Grids Workshop on 16-18 November 2017

The outcome of the MI international workshop was:

- Release of a country report on MI Smart Grids activities, strategies and vision
- Launch of UI ASSIST India US Collaborative Programs
- Identified R&D tasks to be launched by 2018.



Participants of Clean Energy Workshop at TERI, New Delhi



SEGES PIS showcasing their research at Second International Mission Innovation Smart Grids Wprkshop on 18 November 2017

The first MI-India Workshop on “Clean Energy Materials Innovation Challenge” was organized on 17th August 2017 at TERI University, New Delhi in order to identify country’s research priorities in conformity to the goals of Innovation Challenge for Clean Energy and develop the country status report in this area.

The Department also participated in Mission Innovation’s (MI’s) Clean Energy Materials Innovation Challenge, an International Experts’ workshop at Mexico City in the month of September 2017. The aim of the workshop was to support the Innovation Challenge’s goal of accelerating the exploration, discovery and use of new, high-performance, low-cost clean energy materials by at least ten times.



Solar Power Tree

The solar power tree is an intervention designed and developed for utilizing minimum land to harness maximum solar energy.

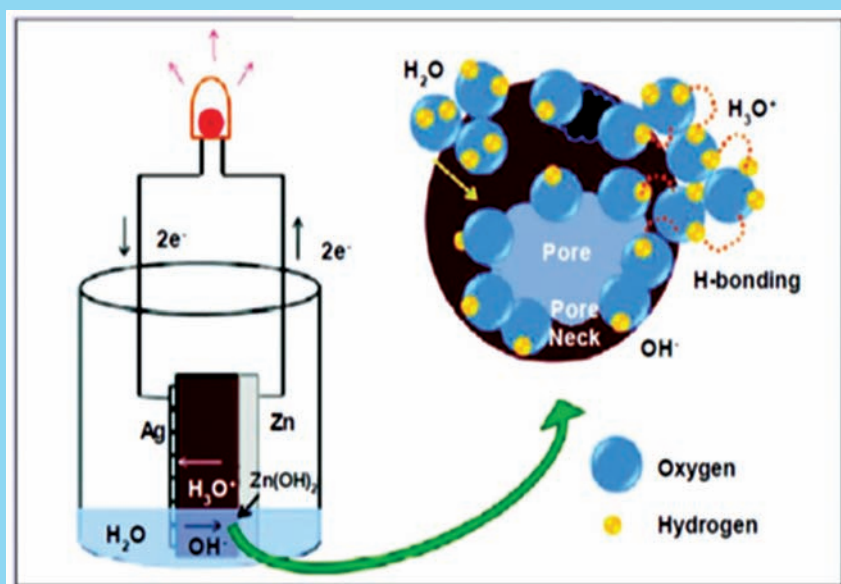
IoT-ready Smart Solar Tree

Two 500 W IoT-ready smart solar trees have been developed and installed by CSIR. The IoT-ready smart solar tree occupies only 0.25 m² of ground space and is a decentralized power generation system which can be scaled and configured according to the location and application. The development is in line with the 'Smart City' Mission of the Government of India.



Fuel Cell Technology d=Development: Towards sustainable energy solutions

Indigenous know-how was developed to make technology components and the process for building Proton Exchange Membrane Fuel Cell (PEMFC) multi-cell stack of desired power output up to 3.0 kW. The fuel cell test facility has been commissioned to provide plenty of useful data for testing and developing indigenous fuel cells at low costs for commercial applications.



Novel hydro-electric cell as a source of **Green Energy**

Hydroelectric cell has been developed which operates at room temperature, produces no excessive heat and greenhouse gases, and being made of inexpensive precursors, is cheaper than fuel cells.

Lithium Ion Battery: India's First Fabrication Facility by CSIR

India's first Lithium ion battery fabrication facility was established based on indigenous novel materials for making 4.0 V/14 h standard cells at CSIR-CECRI Center, Chennai. The facility is being used to develop technologies related to Li-ion batteries for their possible commercialization.

Eco-friendly and safe Rechargeable Magnesium Battery

A rechargeable magnesium battery with natural graphite was developed, which is suitable for stationary devices like UPS and Inverters. It could be an efficient substitute to the lead-acid battery used commonly at present. The materials used in the electrode are both re-usable and bio-degradable.

Coal dust collecting and briquetting system

A coal dust collecting and briquetting system was developed that controls air pollution in mining and industrial areas, effectively reducing health problem related to air borne dust in mining and industrial areas. A significant number of employees will be engaged in manufacturing and operation of the system in mines and other industrial areas.



Smart Plug

A device specific energy monitoring through smart plug (5/15 Amp) has been developed to monitor and control individual high power consuming electrical appliance through a smartphone.

Smart MeTER

The smart phone integrated Smart MeTER is an 220 V/ 30 Amp AC energy meter that can be installed at the user's premises through a Wi-Fi hotspot. The meter operates on a pay-and-use mode and real time data related to consumption is available through a smart phone.

Solvent free/high solids Thermal insulation coatings

CSIR-IICT has developed an eco-friendly process technologies for platform thermal insulation coatings, effectively reducing surface temperatures. The coatings can be used on inner roofing materials for low cost housing to benefit masses in the rural and urban settings.

Bio-energy: Fueling India's growth

While the government is garnering efforts to make India the clean energy world capital, the Department of Biotechnology (DBT) has flagged clean energy and waste-to-energy as two of its key missions. DBT has recently achieved significant milestones in bio-energy research and scale up from fundamental research to applications, to ensure nimbleness and constant access to the best technologies. It has developed cost effective and efficient ways to convert waste to energy and has set up plants for scaling up the production of energy in different forms.

Capacity-Building in Bio-energy

- **10 post doctoral fellows attracted back to India under the Energy Bio-science Overseas Fellowships**

They are now placed in some of the centres of excellence on bio-energy in the country.

- **Launching Bio-energy awards for cutting-edge research**

India and United States have joined hands to support a fellowship that will allow a group of fellows and interns to pursue cutting edge research in various areas of bio-energy in US institutes of repute. This will help build capacity in clean and environmentally safe energy.

- **Indo-US Joint Clean Energy Research and Development Centre**

DBT is supporting a bio-fuel consortium led by IICT Hyderabad and University of Florida from the US. This programme is being coordinated by DBT along with US Department of Energy under an MoU signed between both countries in November 2010.

- **Mission Innovation Challenge - Affordable Heating and Cooling of Buildings**

DST with CEPT University and Alliance for Energy Efficiency Economy (AEEE) organised a workshop on Affordable Heating and Cooling of Buildings in August 2017 in New Delhi. The objective of the workshop was to create awareness about Innovation Challenge #7 and discuss India's priorities in the area of affordable heating and cooling of buildings and explore possibilities for India's R&D initiatives. DST also participated in International Workshop at Abu Dhabi and made important contribution in all six thematic subareas including storage and physiological studies in which India is taking a lead.

- **Energy demand reduction in the Built Environment**

A joint India and UK research programme has been initiated to help reduce energy demand in UK & India's built stock, with a commitment of £ 3.8 M with matching support from DST to support R&D projects in the area of energy demand reduction in the built environment. Total 22 proposals have been received against the call and four proposals have been initiated.

Materials on Energy Storage (MES)

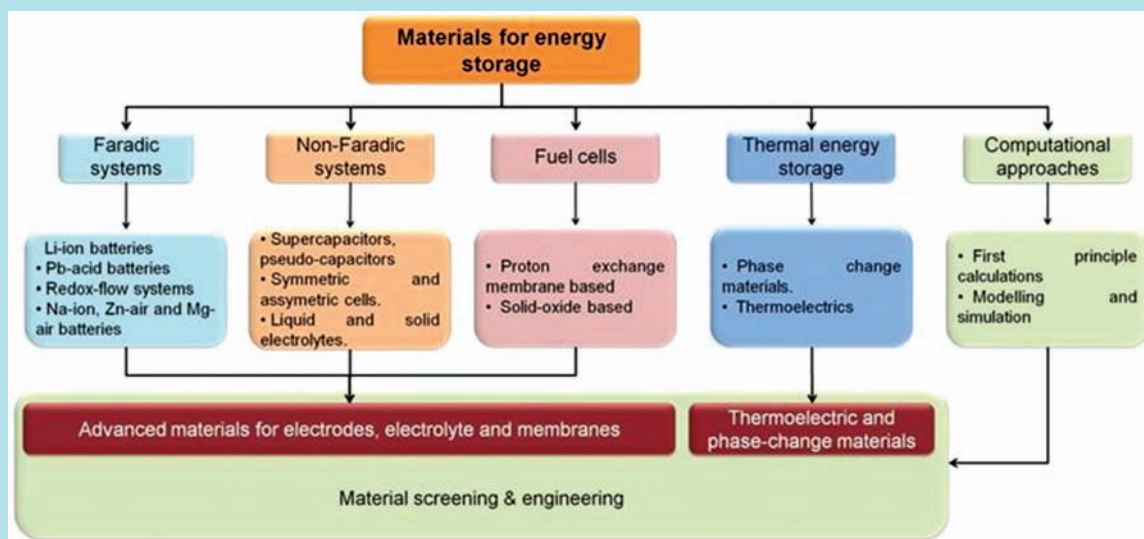
A new programme was launched to support R&D activities aimed at innovative materials for energy storage, and to build energy storage device with enhanced output for multifunctional applications. The prime objective of the initiative is to aim at the efficient use and further increase of

renewable energy and demonstrate its value in terms of flexibility in the energy systems.

130 proposals were received and 18 were approved for funding with a total cost of ₹ 16 crores.

The programme focused on supporting basic, applied research and technology development, improve tools and methodologies needed to understand and predict the characteristics and performance of energy storage materials, components, devices and systems, under different conditions and at different length and time scales.

125 proposals were received and 33 were approved for funding in the year 2016-17.



Research stream classification of materials for energy storage

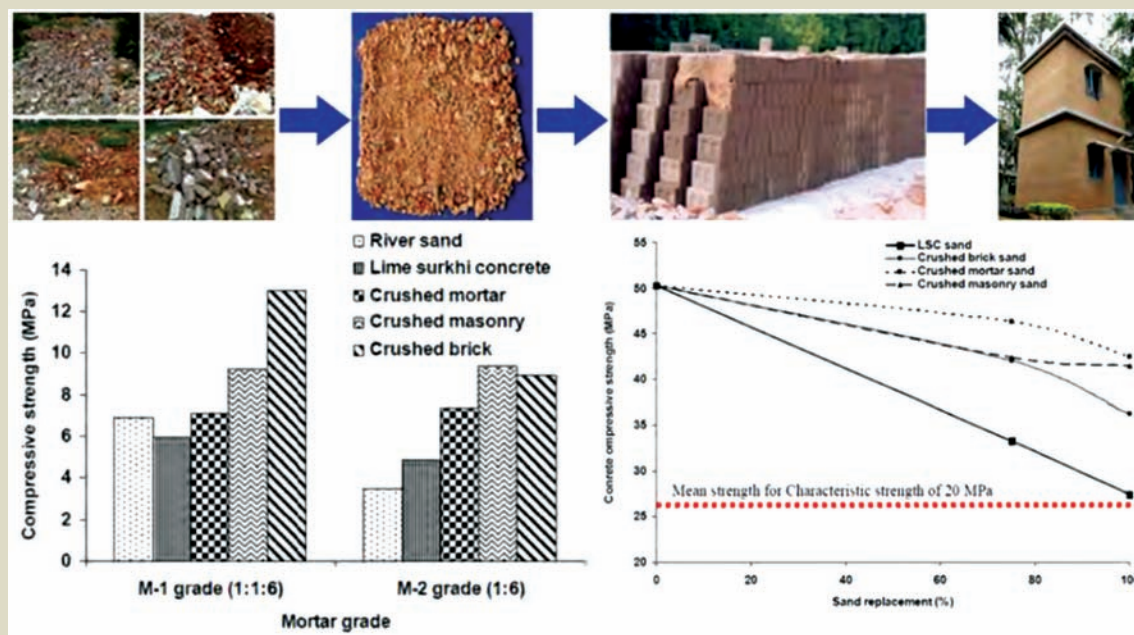
Materials for Energy Conservation and Storage (MECSP)

A theme-based initiative to support research and development for entire spectrum of energy conservation and storage technologies from early stage research to technology breakthroughs in materials, systems and scalable technologies to maximize resource use efficiency was initiated in the year 2016-17. The objective of the initiative was to underpin recognized centres of energy materials research, to encourage

those centres to link with new research groups working in complementary areas and to link centres into a coordinated national network and to create a strengthened energy materials research community that covers the full breadth of energy research areas that is strongly linked both nationally and internationally. A total of 52 proposals are under consideration for support.

Initiative to Promote Habitat Energy Efficiency (I-PHEE)

A new national programme on “Initiative to Promote Habitat Energy Efficiency (I-PHEE)” to improve energy performance of buildings and cities was launched. The programme would support enhancement of knowledge and practice to save energy in design, construction and operation of buildings. Till now, 30 projects have been initiated.



Mission Programme on Methanol and Dimethyl Ether

The Methanol economy holds promise to help India to mitigate its petroleum import cost and at the same time counter the problems associated with global warming due to excess CO₂ emission. An International Seminar on India's Leap to Methanol Economy— Opportunities and Options for Energy Security' was held for knowledge sharing and aggregation for chalking out a strategy for preparing a road map on Methanol & DME economy for the country. DST actively contributed in preparation of roadmaps for Methanol DME and Dimethyl ether. A survey report on Production & Utilisation issues of Methanol & DME was finalized. DST initiated research programme on methanol and DME, which evinced great interest and 94 proposals were received out of which 9 have been supported.

Advanced Ultra Super Critical (AUSC) Thermal Power Plant –R&D Phase

A consortium of three government entities, namely Bharat Heavy Electricals Limited (BHEL), Indira Gandhi Centre of Atomic Research (IGCAR) and National Thermal Power Corporation (NTPC) have formulated a R&D project for the development of AUSC technology for thermal power plants of the future. The project envisages reduced coal consumption as well as carbon di-oxide (CO₂) emissions. The project has a time cycle of two and a half years, with an estimated cost of ₹1554 crores. Two proposals have been supported by DST to IGCAR, Kalpakkam-BHEL to develop advanced rotor testing facility and spin test rig for Dadri Plant using indigenous material.

Joint Virtual Centre for Clean Energy

India and UK have collaboratively set up a virtual Joint Clean Energy Centre on Clean Energy focusing on integration of intermittent clean energy with storage for stable power supply at grid as well grid isolated communities at a total investment of £ 10 million. Two research proposals were supported.

Collaboration on National Mission for Electric Mobility

The Department has formalized a collaboration with the Department of Heavy Industry (DHI) on working jointly for implementation of R&D component of DHI's National Mission for Electric Mobility. A Joint Technology Platform for Electric Mobility (TPEM) has been set up in the Department of Science & Technology to implement the programme.



Water For All



Water For All

Water and air quality monitoring is one of the most important initiatives of the Government towards scientific social responsibility. DST is supporting the development and application of advanced tools and techniques by leading Indian and US institutions for real time water monitoring. DST and Intel have jointly initiated a research programme titled, "Research Initiative for Real-time River Water and Air Quality Monitoring" to develop low-cost and low-power autonomous wireless sensor technologies for sensing,

communication and analysis of large-scale data collected from autonomous networks of perpetual/ long-lived sensor nodes. The development of these technologies will be followed by integration and deployment for water and air quality monitoring in real-time. This real-time data will significantly strengthen and complement the Missions of national priority like Namami Gange, by serving as critical data feeders for pre- and post-treatment analysis.

DST-Intel Collaborative Research for Real-time River Water and Air Quality monitoring

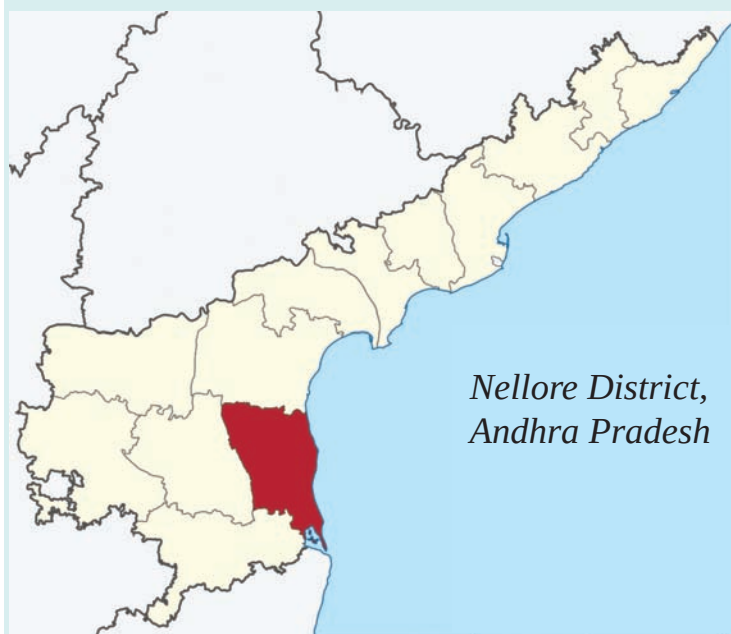
The project has been initiated as a new joint programme at a cost of ₹ 33 crores on a 50:50 cost sharing basis in Public-Private Partnership (PPP) mode. The project will develop low cost compact smart sensors with on-board power and communication for real-time analysis of water and air quality over large areas.



Improving Water Quality and Reusing Waste water



Water Treatment System at Buja Buja, Nellore District, Andhra Pradesh



Building upon the Thames-Ganga Partnership and recognising the importance of clean and potable water, DST and Research Council of UK, have agreed to launch a new collaborative programme on 'Improving Water Quality and Reusing waste water'. Eight projects focusing on Sensing, Treatment and fate of pollutants have been launched.

Water Technology

Initiative aims to promote R&D activities for providing safe drinking water at affordable cost and in adequate quantity using appropriate Science and Technology interventions evolved through indigenous efforts. Since quality is the main consideration of safe drinking water, processes which imply nano-material and filtration technologies have been focused. The initiative also includes the pilot testing of credible number of products and referencing of selected technologies, to the social context of the application region. During 2014-18, a total of 174 R&D projects, addressing 20 site specific challenges covering around 400 habitats across 23 states were supported.



Water Treatment Facility & Waste Water Treatment Plant at Thirupattur, Vellore, Tamil Nadu

Integrated Water Management intervention in drought affected regions of Marathwada

DST has supported quick deployment and demonstration of a mobile water purification unit developed by CSIR-CSMCRI for producing potable water for drinking. It was demonstrated in Latur, Marathwada region which was facing severe scarcity of drinking water during year 2016 drought period. Based on these interventions, an integrated waste water management system has been developed in Ausa district, in Marathwada Region.

Development of Mobile Water Purification and Desalination Unit on Wheels for Marathwada Region

Latur, Maharashtra

28 May - 4 June, 2016



Deployment of cost effective bio-sand filter technology for promoting community health by addressing incidence of waterborne diseases in select villages of Bihar

Innovative b-sand (JalKalp) water filter technology is being promoted to address arsenic, iron and pathogens in water as an innovative and cost-effective alternative. 204 villages have been approached for sensitisation and awareness building. Sensitisation and awareness building is being carried out through small meetings with village communities. So far 337 meetings involving 5438 males and



4879 females carried out. Sensitization and awareness building is also being carried out in village schools for children. So far 37 sessions in different schools were carried out, involving students of class 5th and above. 688 households adopted the JalKalp water filters and are satisfied with the performance of filter and the quality of filtered water. A safe water storage container has also been designed, produced and distributed to filter users.





Desalination plant operational in three islands of Lakshadweep

Fresh Water-ocean Thermal Energy Conversion

Considering the importance of fresh water for islands, Low Temperature Thermal Desalination (LTTD) plants of 100 m³/day capacities were established in the Kavaratti, Minicoy and Agatti Islands in the Union Territory of Lakshadweep, where cold water is moored from 400 m water depths. Considering socio-economic advantages including health of the islanders, installation of LTTD-based desalination plants in six more islands of India including Amini, Chetlēt, Kadamath, Kalpeni, Kiltan and Andrott is now undertaken by National Institute of Ocean Technology (NIOT), Chennai.

Being close to the equator, the sea surface is always fairly warm in Indian waters. The difference in temperature between the sea

surface and at a deeper depth can be utilized to harness energy by running a Rankine cycle based power plant with suitable working fluid. This is called Ocean Thermal Energy Conversion or OTEC. NIOT has taken up the challenge of establishing OTEC powered desalination plant in Kavaratti Island of U.T. Lakshadweep in the near future. Design of a 100 kW open-cycle OTEC-powered LTTD-based desalination plant of 100m³/day with a low differential pressure steam turbine with cold water input of 8.5°C and cold-water pipe of 1m diameter has been also undertaken. A laboratory having the capabilities to simulate various process scenarios for OTEC, desalination and both together, has been established at NIOT.

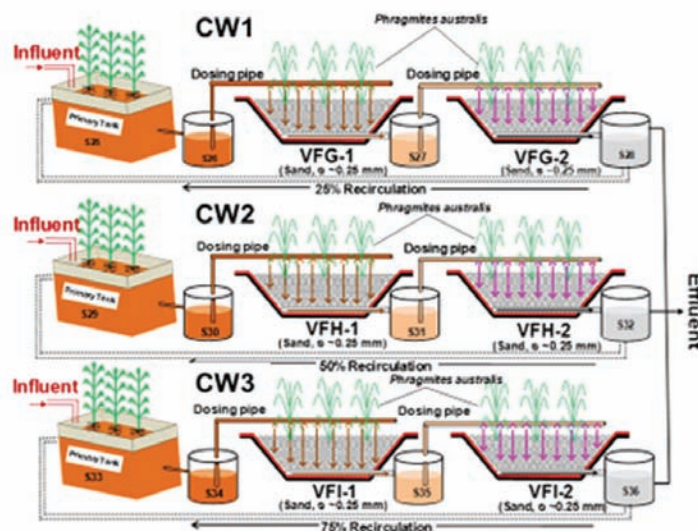


Indian consortium partners have demonstrated the use of constructed wetland. The initiative involved 11 Indian institutes and 21 EU institutes to bring about better management of water, land & crops aimed at a viable, stronger & sustainable green economy at an amount of 19 Million Euros

The European Union and Government of India co-funded project, Integrating Bio-treated Wastewater Reuse with Enhanced Water Use Efficiency to Support the Green Economy in EU and India. It has shown remarkable success in reducing water scarcity and helping safe reuse of wastewater in agriculture. By constructing wetlands with water plant and weed species the chemical oxygen demand in wastewaters have been reduced by 30.92%. Moreover, yield evaluations have shown increased crop yields (14 to 40%) of crops like okra, brinjal and chilly irrigated with treated wastewater as compared to fresh water.

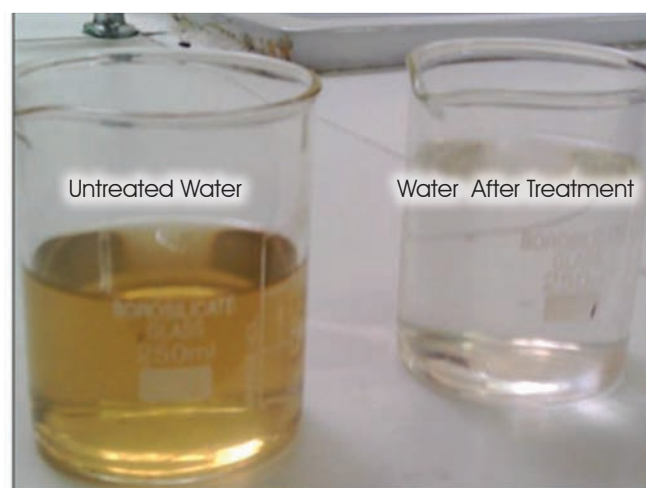
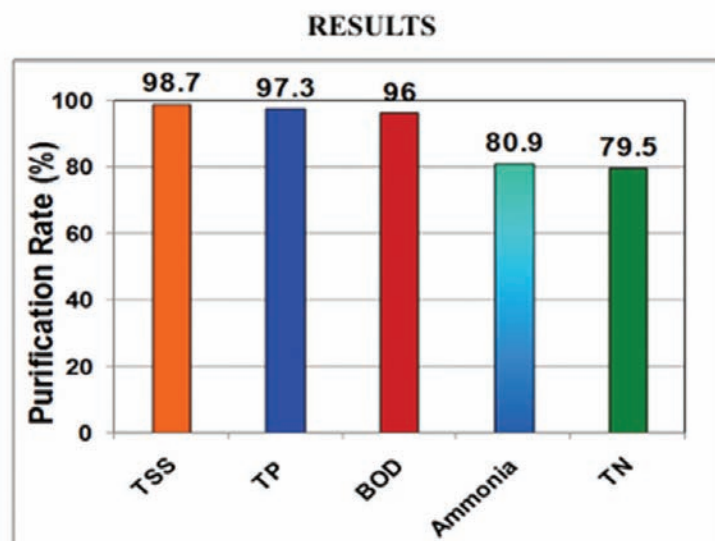
Technology for Treatment of Dairy Wastewater

Constructed Wetland (CW) based wastewater treatment technology has been developed. Different designs of Vertical flow Sub-surface Constructed Wetland (CW) units were operated to assess the most appropriate design which can provide the maximum removal of pollutants such as BOD, TSS, Total Nitrogen, Total Phosphorous, Ammoniacal Nitrogen, Total dissolved solids(TDS) from dairy wastewater. All the CW units showed good removal efficiency of pollutants from dairy wastewater. There was remarkable reduction in the average concentrations of all the pollutants (BOD, TN, NH4-N, TP and TSS) in all the CW units. The present research findings may help in reducing the size of CW units yet providing higher removal of water pollutants from dairy wastewater coming out from dairy premises.



Vertical Sub-surface Flow Constructed Wetland unit 1, 2 and 3

Performance of Vertical Flow Constructed Wetland Unit Treatment of Dairy Wastewater



Technologies Transferred

Mercury — Free UV Lamps for Water Purifiers

Mercury-free plasma (MFP) UV-lamp for water disinfection systems has been developed to provide water free of environmentally and health hazardous mercury. The technology can also be used for sterilization of food, medical equipment, surfaces, ill-skin conditions, air-conditioners and air fresheners for hospitals, etc. The technology has been transferred to two companies — M/s YOUWE (UV) Purifiers, Jaipur and M/s ARKIN Technologies Pvt. Ltd., Pune for its mass production.

Oneer — a Novel Solution for Safe Drinking Water

Oneer is useful for the treatment of drinking water supplies that have microbial contamination to disinfect pathogenic micro-organisms and to provide safe drinking water to communities as per National and International standards. Cost of treated water is less than 1 paisa per litre.



Domestic Iron Removal Filter

A domestic/household type iron removal filter of ~2 L/hr capacity has been developed which is suitable for a family of 4-5 members. The filtration unit can remove iron from groundwater (below the WHO limits 0.3 ppm), foul odour and bad taste. Technology has been transferred to M/s Bargachiya Cluster of Metal Product, Bargachiya, Howrah for mass deployment.

AMRIT — Water Purification Filters using Nanotechnology

The Indian Institute of Technology-Madras has developed energy free, water purification systems for arsenic & iron removal using nanotechnology (AMRIT - Arsenic & other Minerals Removal by Indian Technology). It functions without electricity. This technology has already been commercialised. The group has also developed purification technology for removal of pesticide and other contaminants in water, which is also commercialised. AMRIT water filters installed in 750 locations in West Bengal, Uttar Pradesh, Bihar and Karnataka provide arsenic-free drinking water at a cost of less than 5 paise per litre to nearly 5 lakh people. Ministry of Drinking Water and Sanitation had recommended the replication of the nanotechnology-based purifier in all states where drinking water is contaminated with arsenic.



Environment, Climate Change and Natural Disasters





Environment, Climate Change and Natural Disasters

THE world is facing the biggest environmental challenge our generation has witnessed. Over the past 100 years, we have changed the sensitive energy and ecological balance of our planet by burning fossil fuels and human activities like deforestation. Conserving natural resources is a basic requirement for sustainable development and improving the quality of human life. Climate change has many adverse

consequences like floods, droughts, heat waves, sea level rise and glacier and sea ice melting.

Ministry of Earth Sciences (MoES) and Ministry of Science and Technology are working on many facets of climate change including basic sciences, climate change projections and technology development for climate change mitigation.

System of Air Quality Forecasting and Research (SAFAR)

In view of the emerging challenge of pollution, the MoES has introduced a critical national initiative titled, "System of Air Quality and Weather Forecasting and Research" known as "SAFAR". This has been created with a focus on metropolitan cities (Delhi, Mumbai, Pune and Ahmedabad) to provide location specific information on air quality in near real time and its forecast upto 1-3 days in advance.

SAFAR-Ahmedabad an integrated early warning system of air quality, weather and health System was launched by Dr. Harsh Vardhan, Hon'ble Union Minister for Science & Technology and Earth Sciences along with several state minister's and dignitaries on 12 May 2017 in Ahmedabad.

The current observations and forecasts are disseminated through various user-friendly communication media such as SAFAR-Air (Mobile app for Android and i-phone), SAFAR Toll free no.1800 180 1717, SAFAR-India web portal (<http://safari.tropmet.res.in>), and LED display boards.



Inauguration of the SAFAR-Mumbai

Environment Monitoring and Research

Environment Monitoring and Research Center (EMRC), a division of IMD conducts monitoring and research related to atmospheric constituents that can force change in the climate of the Earth, and may cause depletion of the global ozone layer, and play key roles in air quality from local to global scales. EMRC also provides specific services to Ministry of Environment, Forest & Climate Change and other Government Agencies in the assessment of air pollution impacts. IMD contributes in the field of atmospheric environment to the World Meteorological Organization (WMO) Global Atmosphere Watch (GAW) programme. The National Ozone Centre of IMD is designated as secondary regional ozone centre for Regional Association II (Asia) of World Meteorological Organization. The centre maintains a network of ozone monitoring stations including Maitri and Bharati in Antarctica. The Black Carbon Monitoring Network of 16 stations for measurement of Spectral Aerosol Absorption Coefficient, Equivalent Black Carbon Concentration and bio-mass burning component has been established during 2016.

Climate Change Research

The Centre of Climate Change Research (CCCR) was launched in 2009 with the support of the Ministry of the Earth Sciences, Government of India. At present, the CCCR is part of the Indian Institute of Tropical Meteorology (IITM) located at Pune. The CCCR focuses on development of new climate modeling capabilities to address global and regional issues concerning the science of climate change. The salient achievements made by the Centre are:

E-Nose to Detect Toxic Fumes – Sensors based Innovative Solution for Monitoring Environmental Pollution

Electronic-nose can sniff out volatile organic compounds (VOCs) potentially harmful to human life in a very short time. It measures odour concentration and intensity, besides identifying individual chemicals causing the foul smell. This has been the first attempt in India to develop such a product using odour sensors that make use of intelligent software to identify odorous molecules. The E-nose is being used at Mysore Paper Mills, Karnataka; Tamil Nadu Newsprint and Paper Mill, Karur; and International Paper Private Limited, Andhra Pradesh.

- The IITM Earth System Model (IITM-ESM) - a radiatively balanced global modeling framework for long-term climate investigations was developed indigenously. The IITM-ESM is the first climate model from India to contribute to the Coupled Modeling Inter-comparison Project Phase-6 (CMIP6) experiments and the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6).
- The centre is the nodal agency for the Coordinated Regional Downscaling Experiment (CORDEX) – an International Project under the World Climate

Research Programme (WCRP), World Meteorological Organization. Under this programme, CCCR has generated an ensemble of high resolution downscaled projections of regional climate and monsoon until 2100 for the IPCC climate scenarios (RCP4.5 and RCP8.5) at CCCR, IITM using a regional climate model (ICTP-RegCM4) at 50 km resolution, by driving the RegCM4 regional model lateral and lower boundary conditions from multiple CMIP5 global atmosphere-ocean coupled models http://cccr.tropmet.res.in/cordex/files/data_on_esgf.jsp].

- Climate Data Portal and Earth System Grid Federation (ESGF) data node (http://cccr.tropmet.res.in/cordex/files/data_on_esgf.jsp) were established for archiving and dissemination of the CORDEX South Asia datasets as well as CMIP6 outputs to users and stakeholders for application studies and impact assessments. The ESGF is an international project that develops and maintains software infrastructure for management, dissemination and analysis of model output and observational data (<https://pcmdi.llnl.gov/projects/esgf-llnl/>).
- High resolution simulations were performed using a variable resolution global atmospheric model with telescopic zooming (grid-size ~35 km) over South Asia for the 20th century (1886-2005) and future projections for the 21st century, following the IPCC scenario RCP4.5. The high-resolution experiments are also being used for detection and attribution of recent decadal changes in monsoon precipitation over India due to natural and anthropogenic forcing.
- Different aspects of monsoon variability, tele-connection mechanisms, climate drivers (ENSO, Modoki, IOD, Ningaloo, etc), long-term trends and

dynamics of precipitation extremes were investigated using atmosphere and ocean observations, reanalysis products and model experiments. This has resulted in important scientific publications with lead authors from CCCR.

- Proxies of past climatic variations over the Indian subcontinent were generated through dendroclimate studies, stable isotope analysis of climate archives (e.g., tree rings, corals, speleothems, etc). Tree ring analysis of *Cedrus deodara* D.Don from Western Himalaya (India) has enabled climate reconstructions during the past few centuries. Monsoon rainfall variations have been reconstructed using analysis of Teak tree rings from Kerala during the past 500 years. In addition, isotopic analysis of speleothems (Cave deposits from Kadappa caves, in Andhra Pradesh) have enabled reconstruction of past rainfall variability during 1200 BC – 300 AD (approx. ~ 1500 years) at annual resolution.
- Several training workshops, summer schools, were organised by CCCR jointly with various national and international partner institutions that includes participants and faculty from India and abroad. The training workshops primarily focused on analysis of observed data, evaluation of model outputs, hands-on training, quantification of uncertainties, bias correcting climate model outputs to drive application models, earth system modelling summer school, Eddy-Covariance techniques for flux measurements and several others.
- A high-end Greenhouse Gas (GHG) measuring laboratory has been established in IITM and near-continuous records of $p\text{ CO}_2$ ($[\text{CH}_4]$) are being measured. The GHG data provide insight about the causative mechanisms that control their variability.

- CO₂ and H₂O fluxes are being measured at a deciduous forest in Assam and evergreen forest in Darjeeling and the aqueous environment of the Pichavaram mangrove. Results indicate that the deciduous and evergreen forest ecosystems act as a net sink of CO₂ during the summer-monsoon season. On the other hand, the aqueous Pichavaram mangrove ecosystem appears to act as a source of CO₂ to the atmosphere, apparently driven by anthropogenic activities.
- Detailed studies were conducted to understand the transport pathways of water vapor, NOX, aerosols in the summer monsoon upper troposphere anticyclone were investigated using satellite data and Chemistry Transport Model (CTM) simulations.

Dr. Harsh Vardhan, Hon'ble Union Minister for Ministry of Science & Technology and Ministry of Earth Sciences released a report "Climate Change over India" - an interim report on Foundation Day of Ministry of Earth Sciences in New Delhi on 27 July 2017.

This Interim Report on Climate Change for India prepared by CCCR in the Indian Institute of Tropical Meteorology (IITM), Pune, is intended to provide a brief overview of — (a) Updated assessment of observed climate change over India, (b) Future climate projections over India, (c) Development of the IITM Earth System Model to better understand and quantify climate change and its regional impacts. The three topics, which are among the core research activities of the CCCR at IITM, have been presented as three chapters in the interim report, and an updated report is planned to be submitted early 2019.

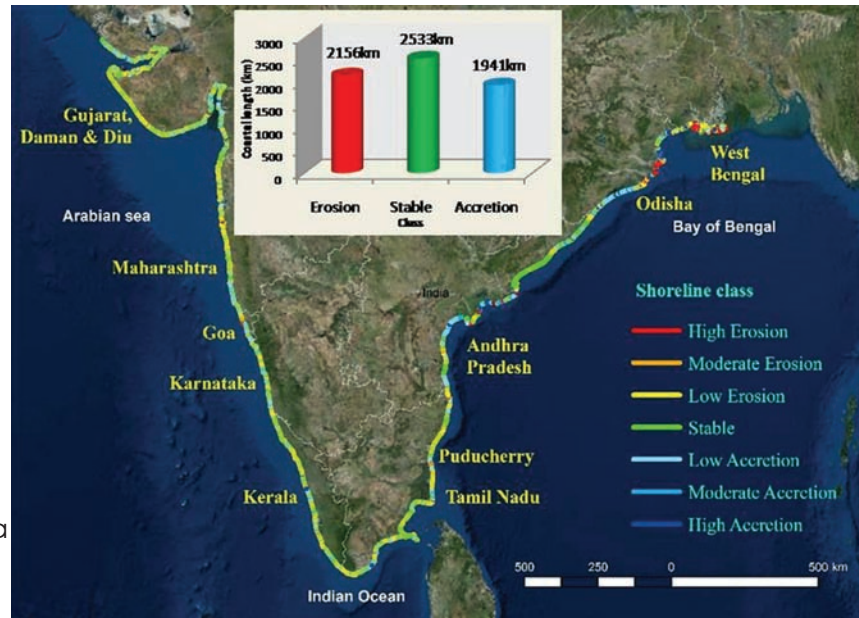


Dr. Harsh Vardhan, Hon'ble Union Minister, Science & Technology and Earth Sciences, releasing the climate change report on 27 July 2017

Monitoring and mapping the shoreline changes along Indian coast

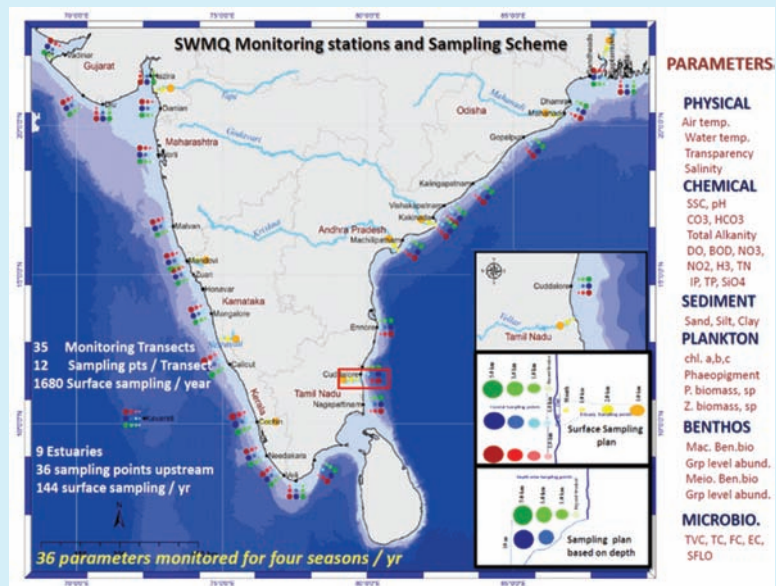
India has more than 7500 km long coastline which undergoes change due to natural and human interventions. Regular monitoring of shoreline and its spatial and temporal trends are required to address the coastal erosion and management related aspects. The shoreline changes, its behavior, erosion, accretion status and related morphological characteristics of Indian coast is being monitored as baseline data using remote sensing, field and mathematical modeling and GIS tools. A GIS based interactive

database was created and 517 maps depicting cumulative shoreline changes for the years 1990-2016 were generated. The shoreline changes vulnerability was classified in 7 classes i.e. 3 each for accretion and erosion and 1 for stable. The analysis of last 26 years data suggests that about 33%, 38% and 29% coast is eroding, accreting and is stable in nature respectively.



Coastal Water Quality

Quality (25 parameters) of coastal water is being monitored by MoES at 22 locations along the Indian coast to assess the health of coastal waters. Sea Water Quality Criteria (SWQC) for heavy metals have been prescribed for limiting the pollution levels to protect the marine organisms and being considered by the Ministry of Environment, Forests and Climate Change for notification in the Environment Protection Act (1985) amended in 1998.





The Union Minister for Science & Technology and Earth Sciences, Dr. Harsh Vardhan and the Minister of State for Environment, Forest and Climate Change (Independent Charge), Mr. Anil Madhav Dave flagging off the Science Express Climate Action Special (SECAS), in New Delhi on February 17, 2017.

Science Express Climate Action Special (SECAS II)

SECAS, intends to contribute towards increasing understanding of the science of climate change, the observed and anticipated impacts, and different possible responses. It is an innovative mobile science exhibition mounted on a 16 coach AC train, which has been custom-built for Department of Science & Technology (DST) by Indian Railways.

The SECAS II is a unique collaborative initiative of Department of Science & Technology (DST), Ministry of Environment, Forest & Climate Change (MoEFCC), Department

of Biotechnology (DBT), Ministry of Railways and Vikram A Sarabhai Community Science Centre (VASCSC).

The exhibition will convey a message about climate change and will also be a good opportunity to generate a dialogue and discussion. The state-of-the-art exhibition on board the SECAS aims to create awareness among various sections of society, on how climate change can be combated through mitigation and adaptation. The exhibition was witnessed by nearly 24.72 lakhs visitors.



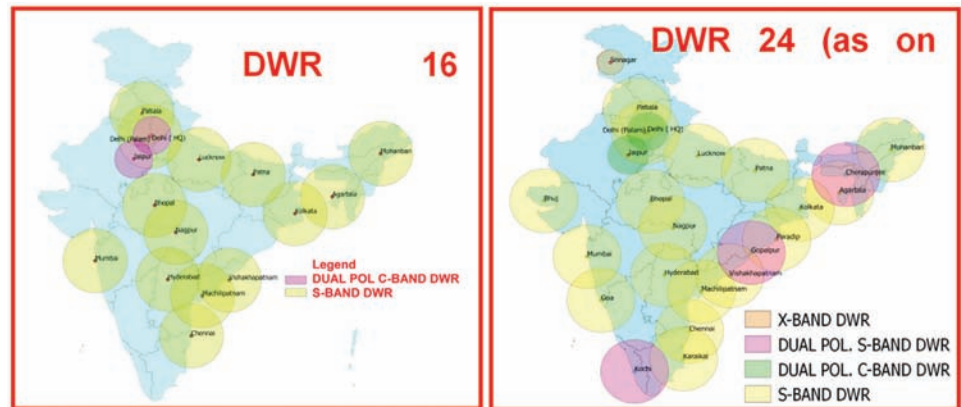
Natural Disasters — Early Warning Systems

The Indian region is frequently affected by a variety of hydro-meteorological disasters such as heavy rains, tropical cyclones, tsunamis, storm surges, severe local storms like thunderstorms, hailstorms, cloudburst, tornadoes, floods, heat and cold waves. There are 13 coastal states/UTs encompassing 84 coastal districts which are affected by tropical cyclones. The states within the periphery of "India Flood Prone Areas" are West Bengal, Odisha, Andhra Pradesh, Kerala, Assam, Bihar, Gujarat, Uttar Pradesh, Haryana and Punjab. Heat waves are more frequent over the Indo-Gangetic plains of India. Northern and

eastern states are affected by cold waves. Thunderstorms are more frequent and intense over east and north-eastern India and severe fog occurs over the Indo-Gangetic plains in the winter season.

India Meteorological Department (IMD) is the National Meteorological Service of the country responsible for monitoring and providing warnings for severe weather phenomena as mentioned above. INCOIS/MoES provides tsunami warnings whenever such occasions arise. IMD issues weather warnings for different temporal ranges and spatial domains. MoES has undertaken many initiatives over the last four years to provide improved multi-hazard early warnings for management of natural disasters.

Over the last four years, IMD had improved the warning services by augmenting an observational network, adopting weather prediction models of higher resolution and improved data assimilation. There has been an enhancement of Doppler Weather Radar network from 16 in 2014 to 24 in 2018. The network of Automatic Weather Stations (AWS) has increased from 675 to 711 in 2018 and the network of Automatic rain-gauges has increased from 1160 to 1350. There is also improvement in use of Satellite data for numerical weather prediction with recent launch of INSAT 3D/3DR satellites. Quantum of satellite data used in weather models has increased exponentially over the last 4 years. Satellite data contributed 90% of the total data used for data assimilation in weather prediction models. In 2014, IMD was using a weather prediction model with 25 km

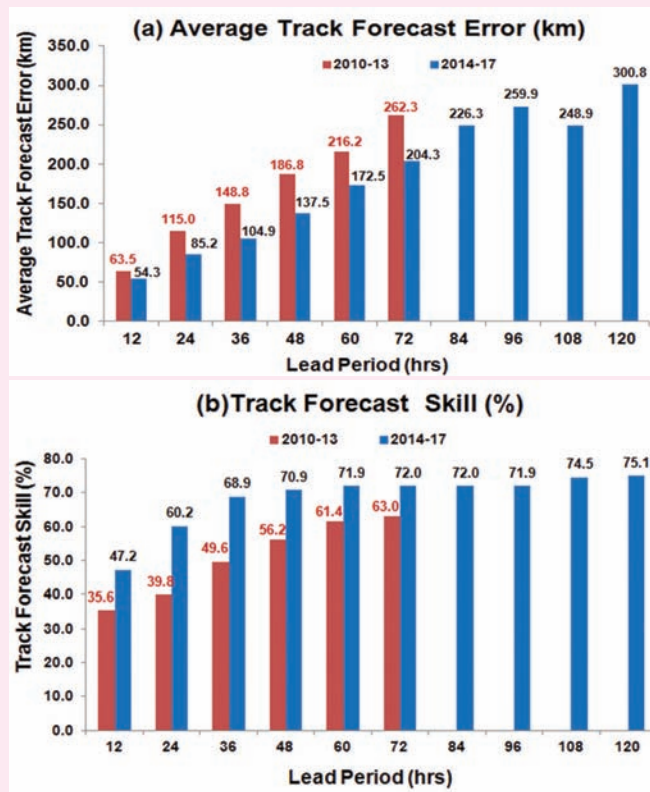
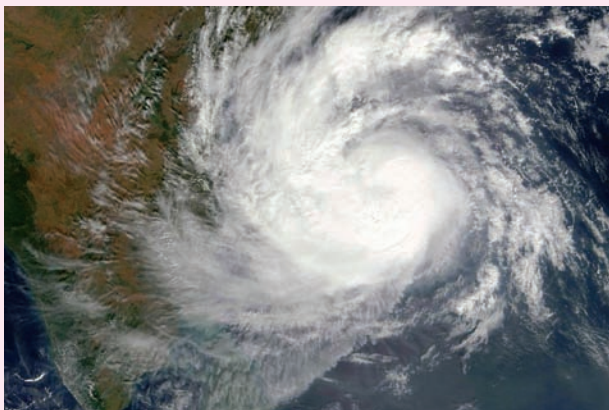


resolution, which has been improved to the resolution of 12 km by 2017. IMD now plans to use this higher version of the model with at least 20 ensembles to generate ensemble forecasts by June 2018 for generating probabilistic forecasts. With this effort, India will have the one of the best weather warning systems in the world.

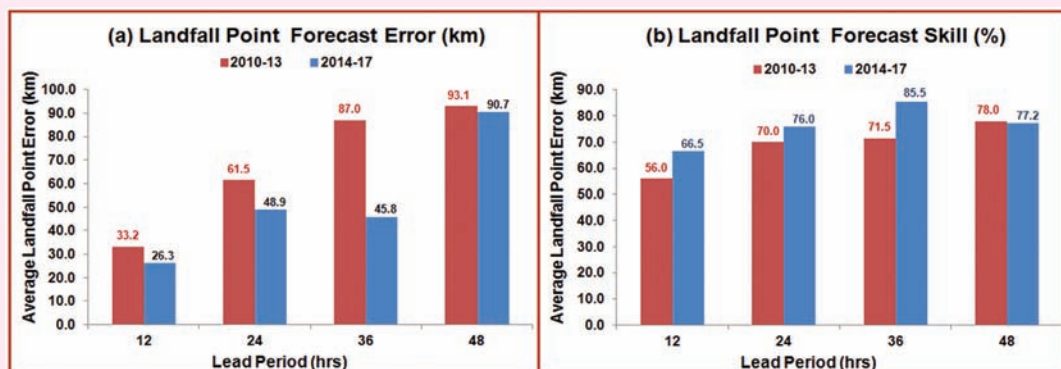


Cyclone warning services

There has been continuous improvement in forecast accuracy with decrease in track and landfall forecast errors and increase in skill over the last 4 years. During 2014-17, the 24, 48 & 72 hours track forecast errors were 85, 137 & 204 km respectively which are 22-26% less than the errors during 2010-13. The track forecast skill during 2014-17 for 24, 48 & 72 hours lead period was 60.2, 70.9 & 72% against 39.8, 56.2 & 63.0% during the period 2010-13.



Comparative analysis of (a) track forecast errors and (b) skill during 2010-13 and 2014-17



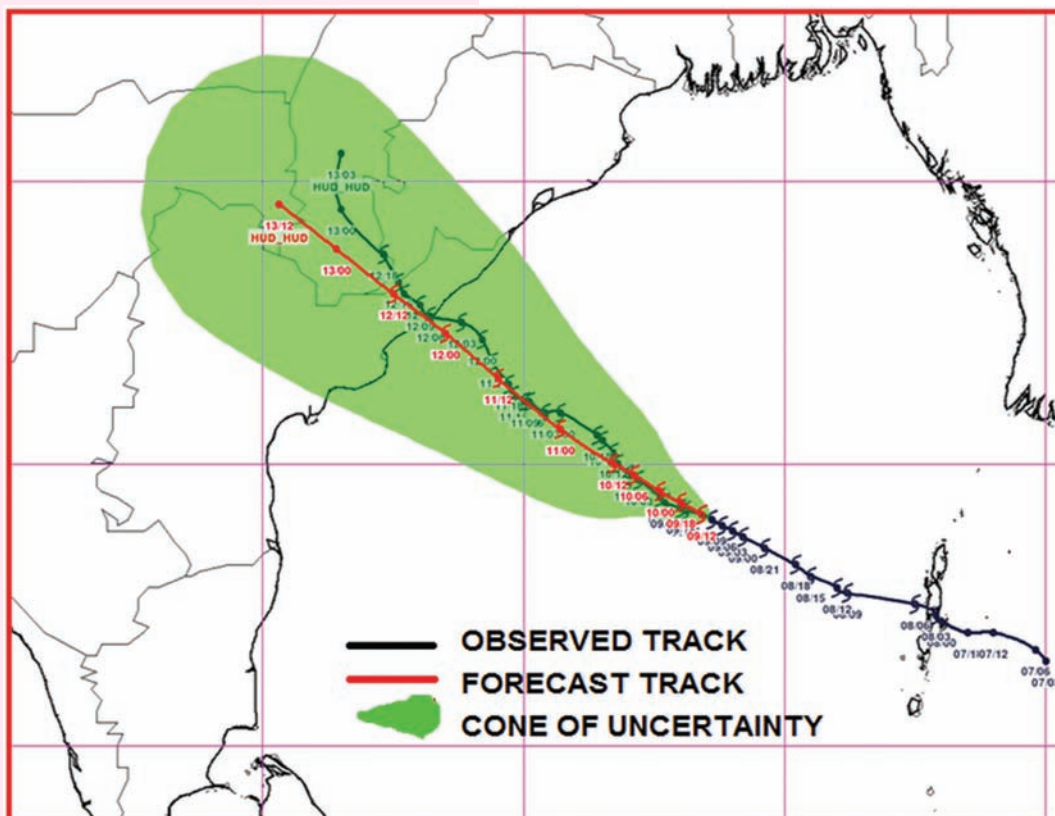
Comparative analysis of landfall point forecast error & skill during 2010-13 and 2014-17

The landfall point error during 2014-17 for 24 lead periods is 48.9 km which is 20% less than the errors during 2010-13. Landfall Point forecast skill during 2014-17 for 24 & 48 hours lead period is 76% & 77% which is about 6-15% greater than the skill during 2010-13 for all lead periods except for 48 hours lead period.

Increase in lead period of forecast increased from 72 to 120 hours for track, intensity and size forecasts. Issue of Probabilistic Genesis forecast was introduced to a lead period of 72 hours from 2014. An example of improved forecast in case of cyclone Hudhud is demonstrated here, indicating negligible error in landfall forecast.

More importantly, there has been a significant reduction in loss of human life and reduction in the cost towards evacuation and payment of ex-gratia to affected population.

INCOIS/MoES started issuing INCOIS-IMD Joint Bulletins during the occurrences of cyclones in 2013. As part of this, INCOIS disseminates forecasts on the state of the ocean along with the forecasts on marine weather and storm surges in these bulletins. From April 2014 to present, INCOIS issued joint bulletins for 17 cyclone/depression which formed over the northern Indian ocean. INCOIS issued several warnings during the latest cyclone "OCKHI", which passed through the southern coast of India from 28 November 2017 onwards. More than two lakh users in the west-coast were alerted directly by INCOIS about the possibility of rough seas during the passage of cyclone.



Tsunami Early Warning

The Indian Tsunami Early Warning Centre (ITEWC) monitored 143 earthquakes of magnitude ≥ 6.5 during the period April 2014 to March 2018. Out of these, 12 moderate earthquakes occurred in the Indian ocean region. In relation to these earthquakes, ITEWC disseminated the bulletins as per standard operating procedure to its regional (Indian Ocean Countries) and national (India) stake holders through Email, FAX, GTS and SMS. The new Decision Support System (DSS) version 2016 was tested extensively during IOWave16 tsunami mock exercise and made operational in December 2016.

The new DSS is integrated with the necessary metadata layers, latest version of Area of Service (AoS), Earthquake Source Zone (ESZ), CFPs and CFZs. As part of the Tsunami Warning System, INCOIS/MoES has completed mapping the highly vulnerable coastal regions to natural disasters such as tsunami and storm surges using 3D GIS technique for several locations in the east coast of India. A visualization and analysis system for 2D and 3D geospatial data (3DVAS) was developed by INCOIS/MoES. This application integrates all geospatial data pertaining to coastal zone including the outcomes of the 3D-GIS Mapping, which can be effectively used in the events of Tsunami and storm surge events.



Dr. Harsh Vardhan, Hon'ble Union Minister, Science & Technology and Earth Sciences at INCOIS on 26th December 2014

Fog Prediction

There has been a drastic Improvement in the fog monitoring and forecasting systems at IGI Airport (IGIA), New Delhi during Winter of 2014-18 compared to those of 2010-2014 because of successful and effective implementation of three new projects initiated by the Ministry of Earth Sciences as mentioned below:

- (i) Installation of thirteen Indigenous runway-visibility measuring instrument-Drishti
- (ii) Winter fog experiment (WIFEX),
- (iii) Forecast Demonstration Project-Fog in 2014-2018.

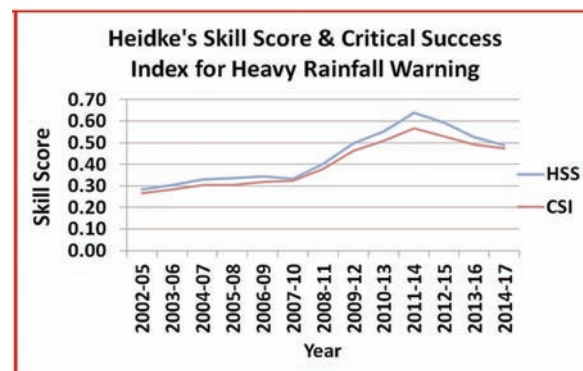
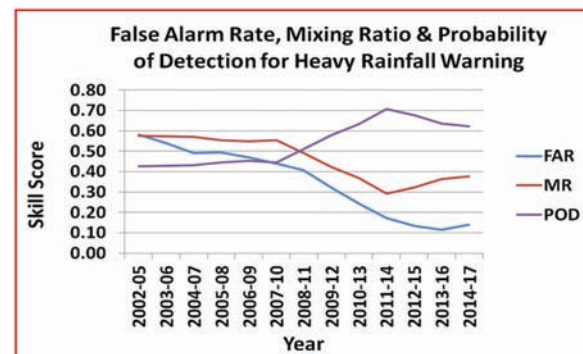
Installation and integration of 13 Indigenous Drishti RVR with their live visibility have improved user outreach and better runway based fog reporting to air traffic control and airlines. Successful and effective implementation of WIFEX in 2015-2018 consecutively for three winters jointly by IITM and IMD with world class observational facilities helped to improve fog prediction. There has been a nominal improvement of fog forecast skill (generic forecast) during the recent 4 years.



Heavy rainfall warning and meteorological support for flood forecasting

To meet specific requirements of flood forecasting by Central Water Commission (CWC), the India Meteorological Department (IMD) provides services for flood warning through Flood Meteorological Offices (FMOs) at 13 locations and the Damodar Valley Corporation (DVC). FMOs provide valuable meteorological support to the CWC for issuing flood warnings in respect of the 43 rivers of India covering 146 river basins. IMD increased lead period to 3 days during 2014-2018 in River Basin/Sub-basin wise Quantitative Precipitation Forecast (QPF) with outlook for subsequent 4 days.

There is significant improvement in heavy rainfall warnings over India during the monsoon season as shown below:



Skill of heavy rainfall warnings

Heat wave warnings

Since 2016, IMD has started hot weather season forecast outlooks for March-May temperatures. A bi-weekly outlook is also issued every Thursday. IMD also issues heat wave alerts and warnings for 5-7 days and outlook for subsequent 7 days with daily updates on heat waves experienced. Since 2016, the 'Heat Action Plan' has been implemented in cities across central India including Ahmedabad, Surat, Nagpur, Akola, Gondia, Chandrapur, Nanded, Jalgaon, Bhubaneswar and Cuttack. It is a comprehensive early warning system and preparedness plan for extreme heat events which has resulted in the number of deaths.



Heat Wave Related Mortality in India since 2015	
2015	2422
2016	557
2017	220

Thunderstorm warnings

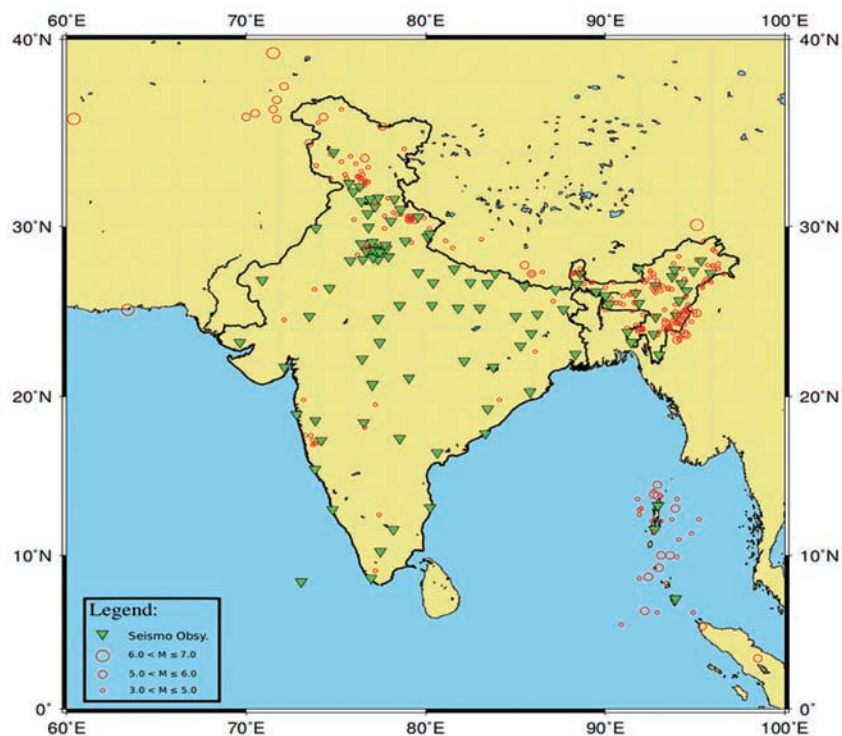
Thunderstorm and associated lightning is a severe weather event, which can affect public life, aviation and power systems. It is very difficult to predict thunderstorms due to their smaller spatial scale (a few kms) and life time (up to one hour). In 2012, IMD introduced Nowcasting (predicting for next 6 hours) for thunderstorms in major cities. By March 2018, 399 stations were covered so far for nowcasting purposes. Nowcast messages are also sent by SMS to registered users.



Real Time Monitoring of Seismic Activity

National Center for Seismology (NCS) is the nodal agency of Government of India, primarily responsible for monitoring seismic activity in and around the country. The operational task of the Center is to quickly estimate earthquake source parameters immediately on occurrence of an earthquake and disseminate the information to all the user agencies including the concerned State and Central Government agencies responsible for carrying out relief and rehabilitation measures. The earthquake information is transmitted to various user agencies including public information channels and media using different modes of communication, including SMS, fax, e-mail and department website. For automatic earthquake parameter dissemination, India Quake, a mobile App was launched for a faster way for communicating earthquake information with no restrictions on the number of recipients.

NCS is maintaining a country-wide National Seismological Network (NSN). In 2014, a decision was taken to upgrade the national seismological network. This includes adding more seismological observatories and upgrading all analog observatories. This has led to increase in observatories from 84 in 2014 to 110 as of today. This number will further increase to 116 by June 2018. We propose to increase to 150 by end of 2019. Un-scrutinized events are the earthquake whose parameters have been estimated automatically by the software using the incoming wave form data from



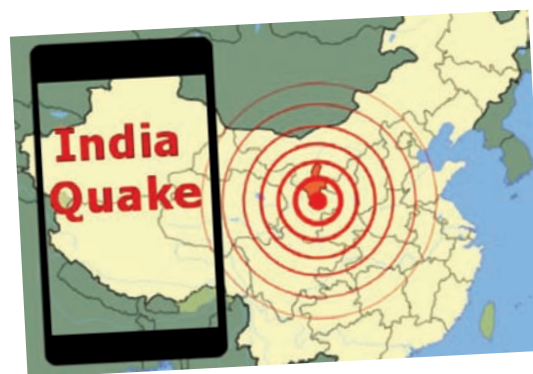
Current seismological observatories in the country along with earthquakes of past 1 year

remote stations. These solutions are scrutinised and confirmed by NCS, which form the category of scrutinised events

Towards mitigating seismic hazard in a few targeted cities lying in seismic zone III, IV and V, a project of seismic microzonation of 30 cities has been approved. Microzonation of these identified cities has been initiated by NCS. In 2016, NCS completed the seismic hazard microzonation of NCT Delhi. Microzonation of a few more cities (Jabalpur, Guwahati, Bengaluru, Kolkata and Sikkim state) has also been completed through MoES sponsored projects.

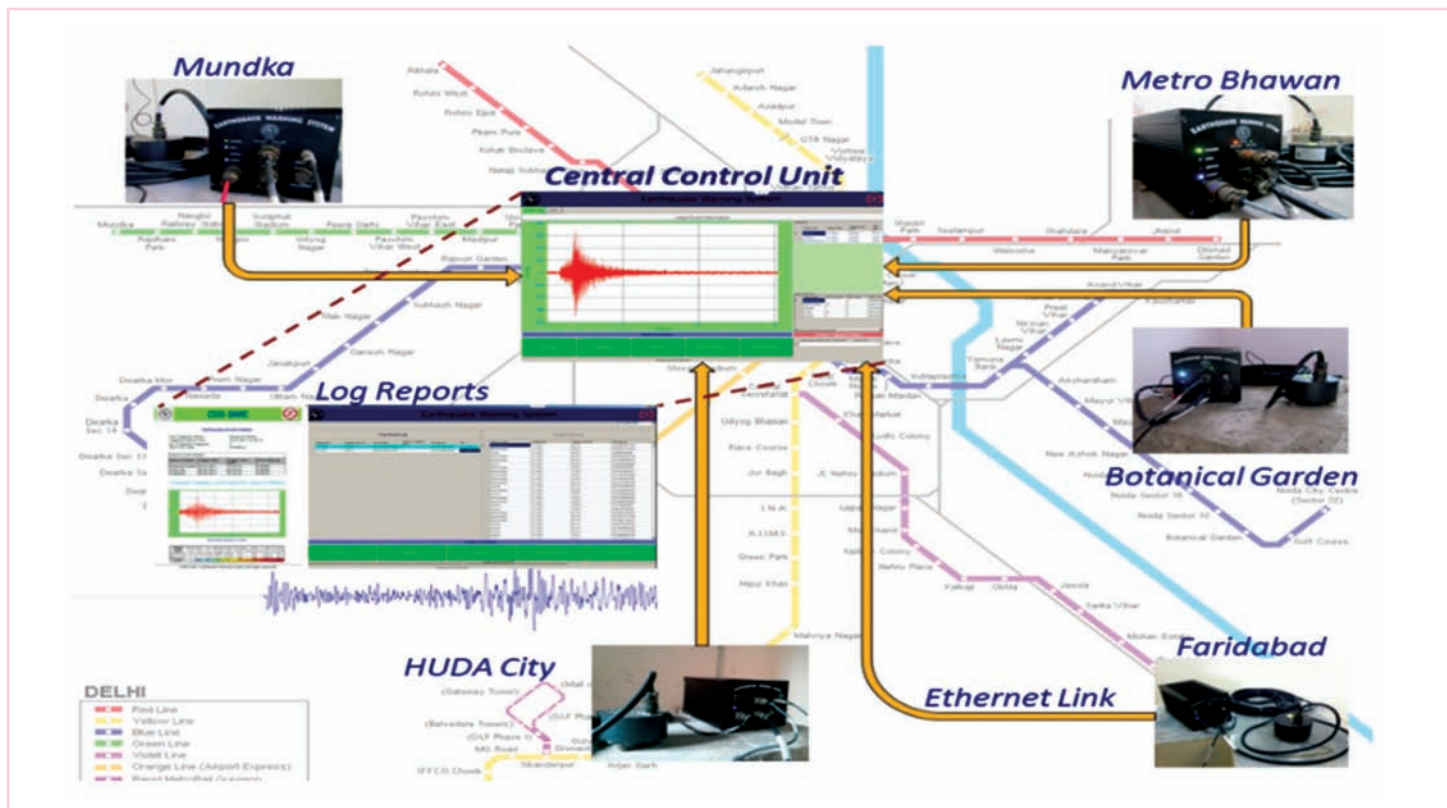


Dr. Harsh Vardhan releasing Mobile App for Earthquake Monitoring



Earthquake Warning System deployed in Delhi

An Earthquake Warning System (EqWS) has been developed and deployed by CSIR-CSIO in Delhi Metro. System comprises five sensors installed at Mundka, Botanical Garden, Huda City Centre, Metro Bhawan and Faridabad. During early April 2016, the Earthquake Warning System helped stop the Metro services after the tremors hit the national capital. The system sensed and recorded the event and generated SMS to the concerned action points, in real time. The same technology will be tested in Greater Noida Metro line through M/s Siemens.



Blue Economy





Blue Economy

Deep Ocean Mission

THE blue economy encompasses sustainable use of ocean resources for economic growth, improved livelihoods and jobs and health of the ocean ecosystem. It involves programmes for sustainable harnessing of ocean resources, R&D in oceanography, assessment of stock marine resources like minerals, introduction of marine aquaculture, deep sea/long line fishing and biotechnology and development of human resources.

Potential Fishing Zones (PFZ) and Tuna Advisories

- Potential Fishing Zone advisory is a flagship programme of the Indian National Centre for Ocean Information and Services (INCOIS)/MoES which benefits tens of thousands of fishermen and their family.
- Information on regions with fish availability is generated and advisories disseminated in smart map and text form on a daily basis.

- PFZ advisories are reaching more than 4 lakh users every day. However, efforts are on to reach out to all the almost 9.27 lakh fishermen involved in actual fishing, either full or part time.

Sagarvani – Words of Caution

- 'Sagarvani' is an integrated Information Dissemination System (IDS) that includes Multi Lingual SMS, Voice Call/ Audio Advisory, Mobile Apps (User/Admin modules), Social Media (Facebook, Twitter, etc.), Email, GTS, Fax, Digital Display Boards, Radio/Television broadcast units, IVRS, Cloud Channels, etc.
- High Wave Alerts and Tsunami early warnings are being disseminated to fisherfolk through 'Sagarvani'.
- The system also provides access to various stakeholders (NGOs, State Fishery Departments, Disaster Management Authorities, etc.) for further dissemination of ocean information and alerts to the user community.
- The number of users has increased fourfold during the last 4 years.
- Total annual net economic benefits due to the scientific identification of PFZs is estimated to lie in the range of ₹ 34,000 to ₹ 50,000 crore.

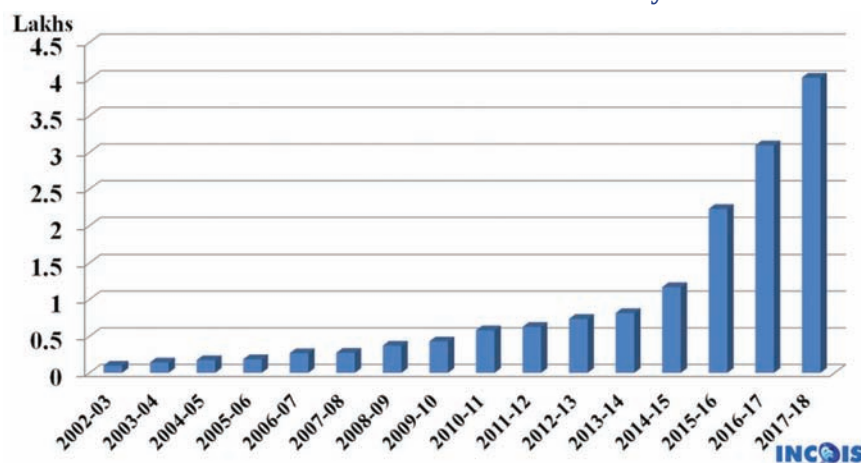
Ocean State Forecasts

- Ocean State Forecasts (forecasts of waves, currents, sea surface temperature, etc.) are provided to a wide spectrum of users which include fishermen, ports and shipping industry, defence, oil and energy exploration agencies, and disaster management authorities.
- OSF services are also being provided to several Indian Ocean rim countries including Sri Lanka and Seychelles under the umbrella of Regional Integrated Multi-Hazard Early Warning System (RIMES) for the Afro-Asian Region.
- Currently, the ocean state forecasts are provided to approximately 16.7 lakh users on a daily basis.

Oil-spill Advisory

- Oil-spill advisories predict the trajectory of the oil-spill.
- Oil-spill off Ennore port due to the collision of two ships on 28 January 2017 at 13.228° N, 80.363° E spilled around 20 tons of HFO oil. The Indian Coast Guard used the oil-spill advisory to plan and execute the clean-up operations.
- Recently Inaugurated Online Oil-Spill Advisory (OOSA) version 2.0 gives a high resolution trajectory prediction (for continuous and instantaneous spills) along the west coast.

Growth of INCOIS PEZ users over the years



Total annual net economic benefits due to the scientific identification of PFZs is estimated to lie in the range of ₹ 34,000 to ₹ 50,000 crore.

The number of users has increased fourfold during the last 4 years.

High Wave Alerts and Tsunami early warnings are being disseminated to fisherfolk through 'Sagarvani'.



Dr. Harsh Vardhan, Hon'ble Minister of Science & Technology and Earth Sciences, dedicating SARAT to the Nation during the XV National Maritime Search and Rescue (NMSAR) Board meeting held at Vigyan Bhavan, New Delhi on 27 July 2016

Search and Rescue Aid Tool

- Search and Rescue Aid Tool (SARAT) developed to track objects/ persons lost at sea.
- Predicted ocean currents and surface winds at the last known location are used to estimate the probabilities of finding the missing object/person in the sea.
- Mobile App also developed for handy use of SARAT. This App can assist with searching of over 64 types of missing 'objects' in the ocean including boats, ships, man-on-board, etc. App is available for download from Google Play Store under the name "SARAT".

Support to Off-shore Industry

INCOIS/MoES regularly provides ocean state information and forecasts for the support of off-shore industries. Recently, based on a request from Oil & Natural Gas Corporation Limited, Eastern Off-shore Asset, Kakinada, INCOIS/MoES conducted a detailed study for their proposed drilling well located off Kakinada (Andhra Pradesh). ONGC has also expressed a desire to support its offshore operational activities by taking the regular ocean state forecasts from INCOIS/MoES.

LIDAR-based platform in Gulf of Kutch

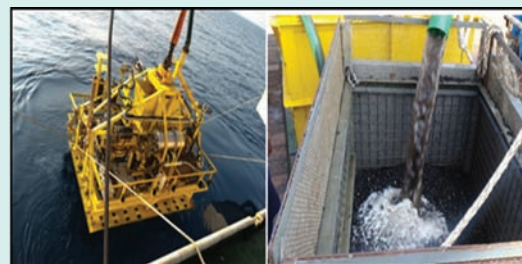


Energy from the Oceans

- Ocean energy harnessed from waves, tidal currents, tidal range and salinity and thermal gradient is a green and renewable energy.
- India has a large coastline and hence a huge potential for ocean energy.
- The National Institute of Ocean Technology (NIOT)/MoES and Ministry of New and Renewable Energy (MNRE) designed and installed a LIDAR-based data collection platform in the Gulf of Kutch and Gulf of Khambhat during 2017 for measuring wind parameters at 20 m elevation from sea level. Subsea structure optimization studies are being undertaken for turbines of 3 MW capacities.
- As part of the floating wave energy system, Backward Bent Ducted Buoy (BBDB) based on oscillating water column principle was developed for port navigation applications and is now available for commercialization.
- For efficient energy harvest from low speed marine currents prevailing in Indian locations, after successful demonstration of a smaller turbine at the Andaman Islands, development of a 5 kW capacity ocean current based hydrokinetic turbine with directly coupled slow-speed permanent magnet synchronous alternator has been undertaken.

Mineral Wealth from the Oceans

- Minerals such as gas hydrates, polymetallic nodules, and polymetallic sulphides are abundant in the Indian EEZ and Indian Ocean. Polymetallic nodules, which are rich in Cobalt, Nickel, and Copper are available at about 5500 m water depth in the Central Indian Ocean Basin. MoES is involved in exploration and harvesting of these resources.
- An area of 75,000 sq km was allotted to India by the United Nations after India conducted an extensive survey of 150,000 sq km of the Central Indian Ocean.
- A crawler-based mining machine with a flexible riser is being developed for mining nodules from 5500 m water depth. A seabed crawler-based mining machine has already been developed and demonstrated at a depth of 500 m.
- A mining machine is now even being developed for 6000 m water depth.
- To test the strength of the soil at those depths an in-situ soil tester has been developed and deployed up to a maximum depth of 5462 m at the polymetallic nodule site in the Central Indian Ocean.
- Remotely Operated Vehicle (ROV) developed to aid the exploration of the deep ocean minerals at 5500 m depth.



Pumping tests during 2017 at 400 m depth off Chennai

Sustainable use of Marine Resources

- Effective bio-remediation technologies developed for tackling waste disposal.
- Biotechnological potential for bio-prospecting of high value products & pharmaceuticals explored.
- National facility for Marine Cyanobacteria (NFMC) in Trichy upgraded with 500 marine cyanobacterial strains.
- 30 marine green algae collected from Indian Ocean & potential microalgae identified & characterized.
- Bio-prospecting, inventorisation, characterization, and value addition explored for novel genes, gene products & compounds.
- Drugs from microbes launched in a unique public private partnership under the Grand Challenge Mission programme on microbial prospecting.
- International Depository Authority at National Center for Cell Science established.



A sea cage deployed at Kothachathram (Andhra Pradesh)

Open Cage Culture

- Large scale fish production through mariculture is essential to cope with the ever increasing demand for fish proteins.
- An open 9 m diameter High Density Polyethylene (HDPE) cage with multipoint mooring was designed and developed for commercially important marine finfishes suitable for Indian sea conditions – deployed and tested in the North Bay (Andaman Island), Olaikuda (Tamil Nadu) and Kothachathram (Andhra Pradesh) representing fully protected, semi-protected and open sea environments, respectively).
- Open sea cage culture technology generate considerable employment opportunities and helps meet the fish food production targets of the nation.
- Innovative concept of rearing post larval fishes in a specially designed nursery cage in open sea also developed.
- Geospatial analysis of Indian seas conducted to estimate the fish farming potential of the country.



Andaman and Nicobar shelf system has been identified as one of the 'hot spot' for organisms found on the seabed. Around 75 different species of deep sea organisms were recorded. The fauna comprised of deep sea fishes, crustaceans and sharks including chimeras, other invertebrates such as echinoderms, sea pens, sponges, polychaetes, anemones, etc.

Scouring for Marine Living Resources

- Comprehensive database containing about 1,20,000 records of more than 6500 marine species in the Indian Ocean created with details of location, depth, taxonomic classification and hydrographic data.
- Dataset is available at Ocean Biogeographic Information System (OBIS) hosted by IODE/IOC program.
- Digital catalogue on new marine species including species which are described as new to science from the Indian Ocean region has been created and the total record stands at 1104.
- Andaman and Nicobar shelf system has been identified as one of the 'hot spot' for organisms found on the seabed. Around 75 different species of deep sea organisms were recorded. The fauna comprised of deep sea fishes, crustaceans and sharks including chimeras, other invertebrates such as echinoderms, sea pens, sponges, polychaetes, anemones, etc.
- Fifty coral species have been identified in the Palk Bay Coast.



Before Implementation



After Implementation

Preventing Erosion — Protecting Shore Lines

Coastlines face severe problems of erosion. Seawalls and groins constructed by the Puducherry government to mitigate the coastal erosion problem, only resulted in shifting the erosion further North.

Based on long-term shoreline change analysis, detailed processed based measurement and numerical modelling a hybrid solution with two submerged reefs and beach nourishment were identified to restore the lost beach along Puducherry. Currently, the beach has already formed south of wedge reef to an extent of 600 m and with the steady progress of the project the city's coastline can soon travel back in time to its sandy past.

Surveillance in Coastal Waters

CSIR-NIO has developed an autonomous robotic system that carries an acoustic transponder and standard oceanographic sensors on its hull to measure water column properties in its upward ascent from the seabed to the sea surface. The development throws open novel applications in environmental monitoring of monsoon processes, and also strategic long-term surveillance in coastal waters.

Products from Fresh Marine Macroalgae

Seaweed farming has been initiated by CSIR-CSMCRI using the seed germplasm maintained by it for production of various chemicals of commercial value through biorefinery model to augment the declining agar production and enable India to emerge as a leading producer as well as supplier of agar/agarose and agarophytic resources to the global market.



Start-up India





Start-up India

Fostering Innovation, Start-ups and Entrepreneurship Ecosystem

THE Ministry of Science & Technology has played a major role in promoting the flagship programme on Startup India. There has been a major focus on building the Startup innovation ecosystem and major activities have been supported through DBT, DST and DSIR/CSIR in creating this ecosystem through supporting innovation research, technology development and product commercialisation. There have been major programmes to support the incubation facilities

across the country and work with institutes and universities to link them with the Startup and industry.

ISRO's GPS 'NavIC' synced with Indian Standard Time (IST)

The Timescale of Indian GPS (NAVIC - NAVigation with Indian Constellation) developed by Indian Space Research Organisation (ISRO) is being synchronised to the Indian Standard

Time (IST) generated by the "Primary Atomic Clocks" of CSIR-NPL, New Delhi. The indigenously developed system is likely to eliminate the dependence on America backed GPS system used by many commercial taxi aggregators.

Start-ups at Venture Centre in CSIR-NCL

The Venture Center, which is CSIR-NCL's technology business incubator, helps in incubation of start-ups. Dr. Harsh Vardhan, Union Minister for Science & Technology and Earth Sciences visited CSIR-National Chemical Laboratory (CSIR-NCL), during February 1-3, 2016.

DST Innovation and Start-ups

- MANAK (Million Minds Augmenting National Aspiration and Knowledge) – 1 lakh top ideas from school children awarded every year.
- Speed and scale of support to Innovation and Entrepreneurship programmes increased by two to three times during the last two years; 15 new Technology Business Incubators are getting established every year.
- Number of persons trained also increased from 5000/yr to 15,000/yr.
- Over 100 innovators supported under PRAYAS and 100 start-ups per year getting enhanced seed and acceleration support.
- Budget grew from ₹ 60 cr in FY 2014-15 to ₹185 cr in FY 2017-18.
- The India Innovation Growth Programme 2.0 launched on 10th March 2017 at the Festival of Innovations at the Rashtrapati Bhavan.
- Indian Heritage in Digital Space (IHDS) - 37 generic technologies, 7 prototypes and scaled models have been developed and demonstrated. Hampi digital reconstruction demonstrated. Three start-up companies spun off.



National award winners of DST INSPIRE Award - MANAK showcased their projects at 'Festival of Innovation' at Rashtrapati Bhavan



India Innovation Growth Programme 2.0 launched on 10th March 2017 at the Festival of Innovations at the Rashtrapati Bhavan.



Products licensed to Industry, Hospitals and Institutions by the TBI at IIT Bombay – BETiC (Biomedical Engineering & Technology (Incubation) Centre)

Atal Innovation Mission (AIM)

Atal Innovation Mission (AIM) including Self-Employment and Talent Utilisation (SETU) is Government of India's endeavour to promote a culture of innovation and entrepreneurship. Its objective is to serve as a platform for promotion of world-class Innovation Hubs, Grand Challenges, Start-up businesses and other self-employment activities, particularly in technology driven areas.

The Atal Innovation Mission has two core functions:

- **Entrepreneurship promotion** through Self-Employment and talent utilisation, wherein innovators would be supported and mentored to become successful entrepreneurs.
- **Innovation promotion** to provide a platform where innovative ideas are generated.

CSIR endeavours for Atal Innovation Mission

The Council of Scientific & Industrial Research (CSIR) has been taking actions on both the core functions proposed in the Atal Innovation Mission.

Entrepreneurship Promotion: CSIR has been promoting entrepreneurship and incubation activities. DSIR/CSIR have led a national effort and have developed the desired mechanisms operational under the umbrella "Encouraging Development and Commercialization of Inventions and Innovations: A New Impetus". The mechanisms in place enable scientific establishments in the country to take up new initiatives for:

1. Permitting researchers working in Scientific Establishment to have an equity stake in scientific enterprises/spin-offs while in professional employment with their research and academic organisations;

2. Permitting the scientific establishment to invest knowledgebase as equity and/or loan in an entity;
3. Encouraging the scientific establishment to set up incubation centers; and
4. Facilitating mobility of researchers between industry and scientific establishment.

The scheme is operational in CSIR.

Innovation Promotion: Incubation Centre Scheme is operational in CSIR. National Chemical Laboratory (NCL), Pune has operationalised an incubation centre/venture centre wherein about 40 companies are being incubated. Indian Institute of Chemical Technology (IICT), Hyderabad has also set up such a centre. In CSIR, more than a dozen incubation centres are operational. It is expected that about 20 more incubation centres will be opened in CSIR laboratories. While an Incubation Centre aims to provide high quality infrastructure and environment to entrepreneurs and knowledge workers, at the same time it also helps incubate novel products, technologies, knowhow(s), process(es) and other patentable knowledge into marketable goods.

CSIR hosts Atal Incubation Centre

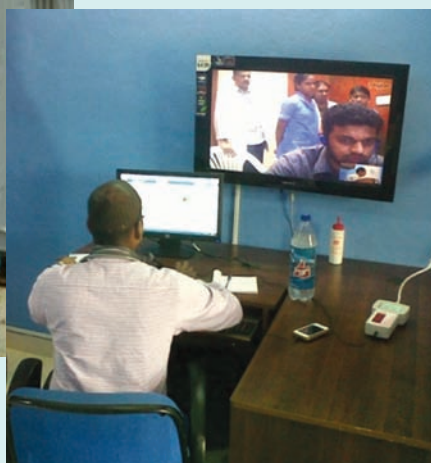
CSIR-CCMB has been identified as one of the ten organisations in the country to host an Atal Incubation Centre supported by NITI Aayog. The initiative is part of the Atal Innovation Mission set up by Union government to promote innovation and entrepreneurship in the country. CSIR-CCMB would offer its scientific expertise, infrastructure and business management to the start-ups.

eHealth Centre

The **eHealth** Center (eHC) is housed in a standard shipping container which can be quickly transported to remote areas of the country by air, rail or by land transport. It is a fully integrated cloud-enabled healthcare solution set up to provide affordable and preliminary healthcare in remote areas that have no immediate access to primary healthcare. The solution integrates



medical instruments that collect basic patient health data with an eHC Health Cloud and enables medical diagnosis through remote consultation using built-in video-conferencing options. This initiative is



pursued by CSIR-IGIB in collaboration with Hewlett Packard for the fourth paradigm of science, data-intensive discovery, while bringing affordable healthcare services to the doorstep of people. Till date, Hewlett Packard Enterprise India has installed a total of 79 eHCs and 113 Mobile eHCs spread across 18 states in India which has more than 385000 registered patients.

Nutra-Phyto Incubation Centre

A technology incubator, Nutra-Phyto Incubation Centre has been established in collaboration with the Government of Karnataka for working with/incubating industries in the domain and take them forward towards successful commercial ventures in the area of nutraceuticals and functional foods in the country. The entrepreneurs/incubatees will have access to state-of-art facilities for basic research, scale-up and efficacy studies all through a single point of access.

Setting up a Common Facility Centre (CFC) on Weaving and Textile Product Manufacturing (CSIR-NEIST, Jorhat)

A Common Facility Centre (CFC) has been established for Weaving and Textile products in Sonowal, Jorhat aimed at providing economically backward village women access to

simplified plant machineries, equipment and other facilities and training along with marketing assistance for their development on a self-sustainable basis. About 435 women have benefitted. Average income per person is about ₹ 9000 per month. The products are retailed in Jorhat through NGO outlets. Products from the 49 weaving centers have been exhibited at trade fairs like **Mahila E-haat** organised by Rashtriya Mahila Kosh, Surajkund International Crafts Mela, Haryana, etc.

NGCMA certified GLP Test Facility @ CSIR-CDRI

CSIR-CDRI received GLP compliance certificate from National Good Laboratory Practice Compliance Monitoring Authority (NGCMA) in November 2017 for conducting safety pharmacology and acute toxicity studies. The GLP certification is a testimony to the high-quality research work that has been carried out in the Institute.

CSIR-Centre for High Altitude Biology (CSIR-CeHAB) —Reaching the Unreached

A food processing unit has been set up at CSIR-Centre for High Altitude Biology (CSIR-CeHAB) in the remote tribal region of Lahaul and Spiti. A brining unit has been designed and prototype developed for the preservation of locally and abundantly produced peas and cauliflowers. The know-how was showcased at the district level Tribal Fair at Keylong and training organised for 15 progressive farmers in making novel products from Buckwheat and also brining of the peas which is a major crop.

National Initiative for Developing and Harnessing Innovations (NIDHI)

- Umbrella programme initiated in 2016-17, aims to nurture knowledge-based and technology-driven innovative ideas into successful startups.
- NIDHI focuses on building a seamless and innovation driven entrepreneurial ecosystem. Different programmes have been designed and are being implemented to address the gaps in the ecosystem.
- Programmes range from providing fellowships to students opting for entrepreneurship, 'Proof of Concept' support for converting ideas into prototypes, business development support through accelerators, seed support to ventures and creating world class infrastructure for incubating start-ups through Technology Business Incubators and Centres of Excellence.
- Not only provides technological solutions for the pressing needs of the society but also targets creation of new avenues for wealth and job creation.
- During the last four years, 45 Technology Business Incubators (TBIs) have been established at various national institutions, apart from public and private institutions across the country. 10 TBIs supported with Prayashshalas and 30 TBIs supported with seed support to enable the start-ups to take their ventures to the next level.
- Establishment of a Research Park at IIT Gandhinagar has been supported at a cost of ₹ 90 crore.

India Innovation Initiative (I3)

Joint programme of DST, Confederation of Indian Industries (CII) and the All India Council for Technical Education (AICTE), I3 aims to promote scientific thinking and problem solving amongst the youth. It encourages them to apply theories and methods of science to carve out high impact and disruptive solutions for industry and social challenges. In I3 final event top innovators identified through intensive scrutiny at regional workshops participate and many of them win various awards & prizes sponsored by several partners & associates. Also, an enabling mechanism has been created for commercialising the best and home-grown initiatives through support mentorship, investors and industry connect.

DBT Industrial Innovation and Startups

Fostering and Nurturing Entrepreneurs

- Biotechnology Industry Research Assistance Council (BIRAC) is a Public-Sector Undertaking set up by the Department of Biotechnology (DBT), Government of India as an interface Agency with the aim of strengthening and empowering emerging Biotech enterprises to facilitate them in undertaking strategic research and innovation that addresses nationally relevant product development needs. BIRAC along with DBT is playing an important role in the implementation and delivery of the flagship programmes of the Indian Government especially **'Make in India'** and **'Start-up India'** and has a crucial role in transformation of the Indian Bioeconomy to US \$ 100 billion by 2025.
- The pioneering programmes of BIRAC such as BIG, SBIRI, PACE and BIPP have given a significant boost across the value chain of product development from ideation to commercialisation.

BIRAC Impact

- BIRAC has supported over **700** Biotech companies, Research Institutes, Small and Medium Scale Enterprises (SMEs), which includes **500 start-ups** and entrepreneurs; generated about **155** Intellectual Property Rights (IPs); supported **30** Bio-incubators across India and around 100 products/technologies developed.
- BIRAC's BIG programme has become one of the largest early stage programme and has supported more than **230** startups and entrepreneurs. Many of these BIG grantees have been able to generate follow-on funding from both public and private agencies.
- These products have exhibited positive impact on a wide range of healthcare, sanitation, food & nutrition, agriculture, industrial biotechnology challenges & renewable energy and contributing to India's action for Sustainable Development Goals (SDGs).
- **Biotechnology Innovation Equity Fund - AcE Fund** launched to scale-up R&D and innovation in biotechnology domains and infuse more than 350 cr in the Biotech Innovation Start-up Ecosystem.



- BIRAC is implementing National Bio-Pharma Mission, an industry-academia collaborative mission of DBT in collaboration with World Bank, with a corpus funding of 250 Mn USD for accelerating discovery research to early development of Biopharmaceuticals.
- BIRAC and DBT efforts have led to the Start-ups definition being amended by DIPP where an entity shall be considered as a Bio-technology Startup for up to 10 years from the date of its incorporation/registration. For others it is 7 years.

BIRAC Bio-innovations: Propelling the Bio-economy

Through BIRAC's support, more than 100 technologies and processes have been developed and more than 50 novel products are in the market. These affordable products impact society at large and have contributed to the healthcare, agriculture and industrial biotech sectors. Some successful examples are:

- **Pandorum Technologies – Synergy of life science and engineering competencies:** *In vitro* 3D human liver tissues were designed and are undergoing validations. This product can be used for *in vitro* medical research – hepatotoxicity & drug metabolism.
- **Bugworks Research India – Strategy for antibiotics to bypass efflux pumps:** The company is developing a first-in-class Novel Chemical Entity (NCE) that exhibits potential of killing superbugs resistant to colistin, beta-lactams, cephalosporins, carbapenems, fluoroquinolones and other pathogens difficult to treat. It is now under preclinical development and is planned to enter clinical development in 2019.
- **Aarna Biomedical Products – Affordable high-quality post mastectomy kit:** An affordable high-quality biodegradable post mastectomy kit was designed for

breast cancer patients who have lost their breast as part of surgical intervention boosting physical and mental wellbeing and preventing postural and gait issues.

- **Jeevtronics – Low-cost defibrillator that works without electricity:** The company has developed the world's first dual powered defibrillator that works in areas without electricity and will be priced at 1/4th the price of big brands, while maintaining similar or better-quality levels.

BioUrja Technology for Waste Management

The company has developed a sustainable solution for waste management. BioUrja is a modular, compact and customisable biomethanation system to handle various organic wastes..

Natural Fibers: Waste to Wealth

After harvesting banana punch, the remaining portion of the tree becomes an agricultural waste. The technology extracts valuable silk grade fibers from the waste. The shelf life of the extracted fiber will be more than 20 years. This innovation has strong market potential and has gained lots of traction.

Promoting Women Scientists & Entrepreneurs

For promoting science and entrepreneurship among young women, a conclave on 'Women Scientist & Entrepreneurs' was inaugurated by the Hon'ble Union Minister Dr. Harsh Vardhan as a part of the India International Science Festival (IISF, 2017). The conclave brought together around 350 scientists, researchers and entrepreneurs from across the country.

Furthermore, the BIRAC Women Bio-Incubator was inaugurated at the Golden Jubilee Women Biotech Park, Chennai.

New Millennium Indian Technology Leadership Initiative (NMITLI)

CSIR's NMITLI Programme seeks to catalyse innovation-centred scientific and technological developments as a vehicle to attain for Indian industry a global leadership position in selected niche areas by synergising the best competencies of publicly-funded R&D institutions, academia and private industry. Through the programme, several technologies have been developed, which include:

MicroPCR: A battery-operated hand-held MicroPCR for diagnosis of diseases such as salmonella, tuberculosis, malaria, dengue, chikungunya, hepatitis B and H1N1. It has been patented in over 130 countries. The device currently costs a tenth of a conventional real-time PCR and a fifth of existing NAAT tests in the market – can be further brought down with scale and early adoption by governmental programmes. The product is available in Indian and global market and ICMR has deployed 100 devices at various health centres in the country.



Johne's Disease (JD) Vaccine: Vaccine against Johne's disease approved by the Drugs Controller General of India (DCGI), with issuance of drug manufacturing license by the State Drug Authority of Karnataka. Two formulations of vaccine i.e. JD Oil and JD Gel have been developed under the CSIR-NMITLI Scheme. The vaccine is manufactured and marketed by M/s Biovet Private Limited, Bengaluru. JD may be



the major cause of reduced productivity in Indian animals, which number over 200 million. It is endemic in the ruminant population of India and has also been reported from human beings. The vaccine will lead to increased milk and meat production and improved health of cow, buffalo, sheep and goat. The vaccine was launched by Union Minister Dr. Harsh Vardhan on CSIR Foundation Day (September 26, 2015). This is the third vaccine for JD in the world after Mycopar, US and Gudiar, Australia.

Towards Cleaner Leather Processing: The world over, leather is made employing technologies that involve using large amounts of industrial chemicals and a wide variety of specialty chemical formulations, often resulting in severe environmental pollution. Under the NMITLI programme, a paradigm shift has been brought about in beam house operations in leather manufacturing through bioprocessing as opposed to the currently used chemical processes. The salient features of the technology are:

- Enables reduction in COD, TDS and energy requirement
- Avoids lime sludge and
- Fiber opening without osmotic swelling leads to more area.

The technology developed by CSIR is the first in the world and offers substantial reduction in pollution. The cost of leather processing is slightly higher but there are environmental

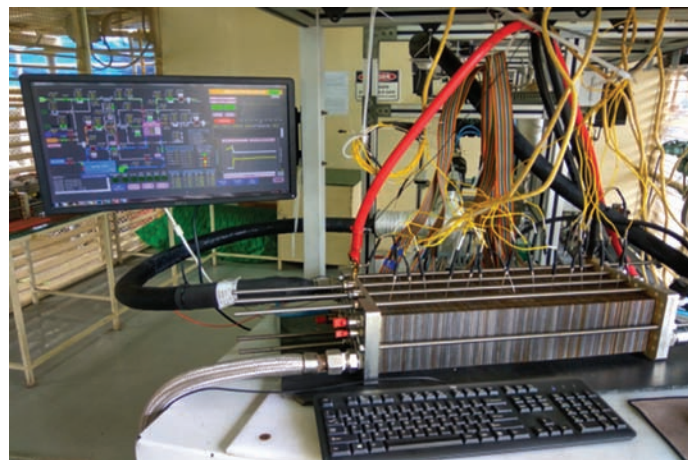


benefits. CSIR is demonstrating the technology to DIPP and CPCB to make the process mandatory in the country.

All-Fiber Supercontinuum Light Source: Supercontinuum Source for generating white light with wide wavelengths of 400 nm –2200 nm and the Broadband Confocal Microscope are unique with multiple applications in fluorescence spectroscopy, coherence tomography, biomedical imaging and analysis. The industrial partner, Vinvish Tech. Ltd., has become the third company in the world and the first company in India to come up with such high tech products by using specialty Photonic Crystal Fibers (PCF).



Fuel Cell: CSIR has designed and developed many prototypes of 500 W, 1.0 kW, 1.5 kW, 2.0 kW and 3.0 kW Polymer Electrolyte Membrane Fuel Cell (PEMFC) systems. It has also conducted a comprehensive testing and benchmarking process of a 3.0 kW system on a test bed in collaboration with Reliance Industries who is a major player in 4G telecommunications. It is expected to enable the development of a cost effective PEMFC system for targeted application for the first time in the country. CSIR is continuing its efforts in this green technology area by developing even vendors for critical components of the fuel cell technology in the country.



Electrical Three-Wheeler “SoleckshawLite”



A sustainable and affordable electric three-wheeler 'Soleckshaw Lite' has been developed for urban local transport. It is designed for a top speed of 40-45 kmph and a driving range of over 100 km per charge. After rigorous testing and trials at ARAI, Pune, Central Motor Vehicle Rule (CMVR) certification for Soleckshaw Lite has been obtained. 'Soleckshaw Lite' is the country's first electric auto rickshaw which has obtained CMVR certification under L5M category with a speed of over 40 km/h. 'Soleckshaw Lite' would be an ideal product for short to medium distance transport in urban cities with a low running cost for auto rickshaw owners as well as users considering rising fuel prices, dwindling resources of fossils fuels and the threat of global warming.

Integrated Technology Solutions for Security and Operations based on UV sensor:

An indigenous process technology for offset inks, UV curable screen, stamp pad, digital inks, plastic pills and new UV sensitive materials (single and bi-fluorescent) has been developed. New materials with offset ink type products developed have already been commercialised by Security Printing and Minting Corporation. (wholly owned by GoI). Various prototypes of Programmable Invisible Marker Authenticating Device (Pi-MAD) for the detection of UV tags by integrating the hardware (optics/electronics) and software were also designed and developed for providing integrated solution by detecting the fluorescence with a high signal to noise ratio.



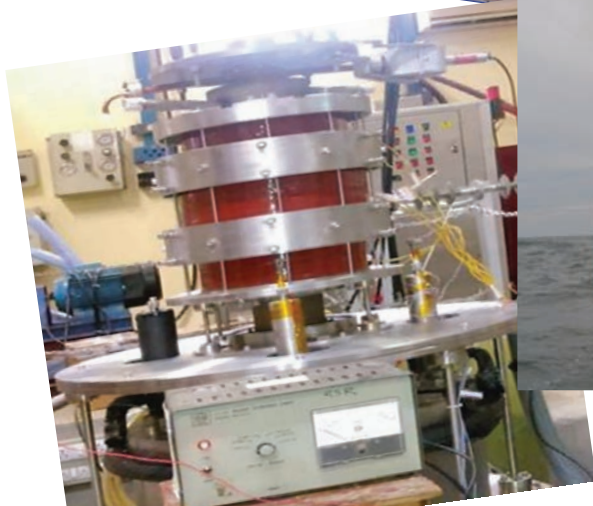
nonClonableID Technology for Medical Product

Authentication: CSIR has demonstrated the ability of a novel nonClonableID technology for medical product authentication and patient safety. The nonClonableID technology, based on novel aspects of material science and utilising the law of randomness, creates unique non-duplicable fingerprints. These fingerprints when processed, digitised and activated function as unique identification tags. These tags can be utilised for establishing product accountability through secured traceability from the point of origin to the point of dispensation, authenticity check and establishing e-pedigree.

Dental Implants: A completely indigenous dental implant system has been developed along with complete prosthetic and surgical kit to serve the treatment needs of an edentulous or partially edentulous Indian patient. In addition, various other components including surgical and prosthetic ancillaries have been developed. The implants have undergone phase II clinical trials after receiving permission from DCGI. The technology for dental implants has been licensed for commercialisation.



Antibody against NAMPT — eNAMPT: A biotherapeutic platform to generate antibody against any antigen within 30-40 days has been developed. Under the NMITLI project, the world's largest naïve human phage display libraries (2079×10^{11} cfu) was compared to Berkeley (2.5×10^{11} cfu) and a fast panning process was developed. The project has expanded the reach of Indian scientists in this new area of R&D.





“Make in India”



“Make in India”

for a Better India

THE “Make in India” initiative was launched by the Prime Minister in September 2014 as part of a wider set of nation-building initiatives. Devised to transform India into a global design and manufacturing hub, “Make in India” quickly became a rallying cry for India’s innumerable stakeholders and partners.

It was a powerful, galvanising call to action to India’s citizens and business leaders, and an invitation to potential partners and investors around the world. It represents a comprehensive and unprecedented overhaul of outdated processes and policies. Most importantly, it represents a complete change of the Government’s mindset – a shift



from issuing authority to business partner, in keeping with Prime Minister's tenet of 'Minimum Government, Maximum Governance'.

The Ministry of Science and Technology and Ministry of Earth Sciences have made significant contributions to the "Make in India" initiative, some of which are illustrated here.

Wax Deoiling Technology - Will Save ₹ 500 Crore Every Year

This technology which can produce waxes from petroleum streams has won international competition for adoption by Numaligarh Refinery Ltd (NRL). A plant based on this technology has been set up with an investment of ₹ 750 crore at NRL and dedicated to the Nation by Hon'ble Prime Minister in February 2016. This newly set up plant will produce 50,000 MMTPA of high value Paraffin Wax and 4,500 MTPA of Microcrystalline Wax that will help cut down the wax import by 50% and save foreign exchange of about ₹ 500 crore/annum.



“Make in India” represents a comprehensive and unprecedented overhaul of outdated processes and policies. It represents a complete change of the Government's mindset – a shift from issuing authority to business partner, in keeping with Prime Minister's tenet of 'Minimum Government, Maximum Governance'.

Equipping Indian Railways with Ultra-modern Technologies

Technology Mission for Indian Railways (TMIR) – an initiative of the Department of Science and Technology (DST), Ministry of Railways (MoR), Ministry of Human Resource Development and Ministry of Industry – will take up research projects to develop state-of-the-art technologies for use in Indian Railways on an investment sharing model. DST has agreed to contribute ₹ 75 crore in the TMIR.

An Eye over the Oceans



Sindhu Sadhana – India-built Vessel to Study Indian Seas

For the first time, a state-of-the-art Oceanographic Research Vessel “RV Sindhu Sadhana” has been built and commissioned. This multidisciplinary research vessel addressing R&D in the

domains of food, energy, minerals, climate and environment will expand the reach of Indian oceanographers to understand the oceanographic process in the seas around India and to translate this knowledge to benefit the nation. RV Sindhu Sadhana sailed for its first oceanographic research cruise on July 19, 2014 from Visakhapatnam after sea trials.



Floating Wave Powered Navigational Buoy

National Institute of Ocean Technology (NIOT) has built an all-weather floating buoy in sea for powering a beacon lamp on top of the buoy and oceanographic related components using energy extracted from the ocean waves. The floating buoy can be used as a navigational buoy in ports and harbours. Indigenously built, the buoy has been deployed and tested off Kamarajar port in Chennai. It can be used in place of imported solar powered buoys.



Turbine Generates Electricity from Ocean Currents

NIOT has developed an ocean current turbine for harnessing kinetic energy from seawater currents. All the sub-components were indigenously designed and fabricated locally. It is to be scaled up for off-grid units for remote coastal locations. Forest outposts in Andaman require small off-grid power modules of under 5 kW capacity.



"The floating buoy can be used as a navigational buoy in ports and harbours"

Ocean Drifters

Ocean drifters have been developed for the measurement of sea surface temperature and other parameters. Trial production by Indian industries (Astra Microwave, Hyderabad and Komaline Industries, Ahmedabad) is underway.

Autonomous Underwater Profiling Drifters

Autonomous Underwater Profiling Drifters have been developed for measuring salinity and temperature up to 2000 m water depths. Trial production by Indian industry (Data Patterns, Chennai) is underway.

Remotely Operable Vehicles (ROV)

An agreement was signed for transferring the deep water Remotely Operated Vehicle (ROV) technology to the Indian industry (L&T Heavy Industries, Mumbai) through NRDC. These ROVs can be used for carrying out scientific investigations up to 6000 m water depths.

Robo Coastal Observers

Robo Coastal Observers are used for data collection in coastal waters and aiding in rescue/assisting of swimmers. An agreement has been signed for transferring the Robo Coastal Observer to CT Control Technology through NRDC.

Met-ocean buoy system

Met-ocean buoy system has been developed to collect surface meteorological and oceanographic parameters. The system is being operated and maintained in the Indian seas.

“Make in India”



Augmenting Aviation

SARAS takes “Make in India” to New High

SARAS – the 14-seater aircraft designed and developed by CSIR-NAL – took to the skies on January 24, 2018. The maiden flight was the first of 20 flights to evaluate the system performance, the feedback from which would be used to freeze the design of the production version aircraft. The aircraft in its production version will have a capacity of 19 seats capacity and will be certified for civil and military use.

HANSA-NG — Indigenous Pilot Training Aircraft

Pilot training in India is set to get a boost with CSIR-NAL's Hansa-3 aircraft, which was handed over to M/s Mesco Aerospace. HANSA NG will be certified within 18 months and will then be taken over for production. According to a third-party market survey by CSIR-NAL, the potential requirement is about 70 to 100 aircraft by 2020.





Multi-role, Multi-mission Aircraft Developed

NM5 or C-NM5, a multi-role, multi-mission aircraft being jointly developed by CSIR-NAL and Mahindra Aerospace Ltd., is a five-seater civil aircraft and an extension of the Hansa project. The NM5 has been entirely designed and developed by CSIR-NAL and Mahindra Aerospace on a 50:50 partnership basis. The NM5 can be used as a trainer, for transporting cargo, medical evacuation, tourism, VIP travel and for training pilots.

Monitoring System Boosts Aviation Safety

CSIR-NAL jointly with India Meteorological Department (IMD) has developed and deployed the first Indigenous Aviation Automatic Integrated Weather Monitoring System. The system is functional at the Mangalore International Airport. It measures Wind Speed, Wind Direction, Pressure, Temperature and Relative Humidity along with Visibility which are critical for aviation safety. The indigenous effort has accomplished saving of foreign exchange to the country.

Dr. Harsh Vardhan, Union Minister for Science & Technology, inaugurated the Airport Instrumentation Facility



Drishti Enhances Airport Runway Visibility

Drishti, an indigenous, innovative, and cost effective visibility measuring system has been developed by CSIR-NAL. It guides pilots in times of low visibility on the runway. Drishti is suitable for all categories of airports viz., CAT I, CAT II, CAT III A & B and measures visibility down to 4 meters.

India's First Research Tunnel

A Micro Air Vehicle Aerodynamics Research Tunnel (MART) has been set up at CSIR-NAL. It's a joint development with DRDO and ISRO. The state-of-the-art tunnel would address all the aerodynamic, propulsion and aero-elastic issues related to MAVs. The tunnel will be used to test the fixed-wing, flapping-wing and rotary-wing MAVs in the 500 mm wingspan category.

Jet Fuel from Biomass: Towards Green Aviation

A complete process and catalyst has been developed for production of jet fuel from biomass derived non-edible oil. The process can be integrated into the current refinery structure. The biojet fuel matches all major specification for aviation fuels, helping the aviation industry reduce its carbon footprint.



Strengthening the Nation's Security

Critical Technologies for Indigenous Combat Aircraft

When India's indigenous Light Combat Aircraft (LCA) – Tejas – soared into the skies for the first time in January 2001, it was a proud and exhilarating moment for the country. LCA is 'light' largely because of CSIR-NAL's innovative development of composite airworthy parts. LCA technologies are extremely critical & sophisticated and have dramatically narrowed the gap between India and Western countries in fighter aircraft design and development. CSIR-NAL has contributed in designing and developing two parts – Fin and rudder assembly.

Helping Armed Forces Hone their Marksmanship Skills

CSIR-NAL has developed an Acoustic Based Hit Identification and Analysis System (ABHIAS) for marksmanship training of the Armed Forces – Army, Navy and Air Force, CRPF, CISF, NSG, BSF, etc. The system is currently under ruggedization with the armed forces, and an MoU is at a final stage with BEL, Bengaluru for production, marketing and after-sales service.

Head Up Display (HUD) for Fighter Pilots

Head-Up Display (HUD) is an essential aid for aircraft pilots, especially fighter aircraft. HUD displays flight information such as altitude, airspeed, angle of attack, navigation, weapon aiming and other flight information in collimated form so that the pilot is able to view the information with his head "up" and looking forward, instead of looking down on other instruments mounted in the cockpit.

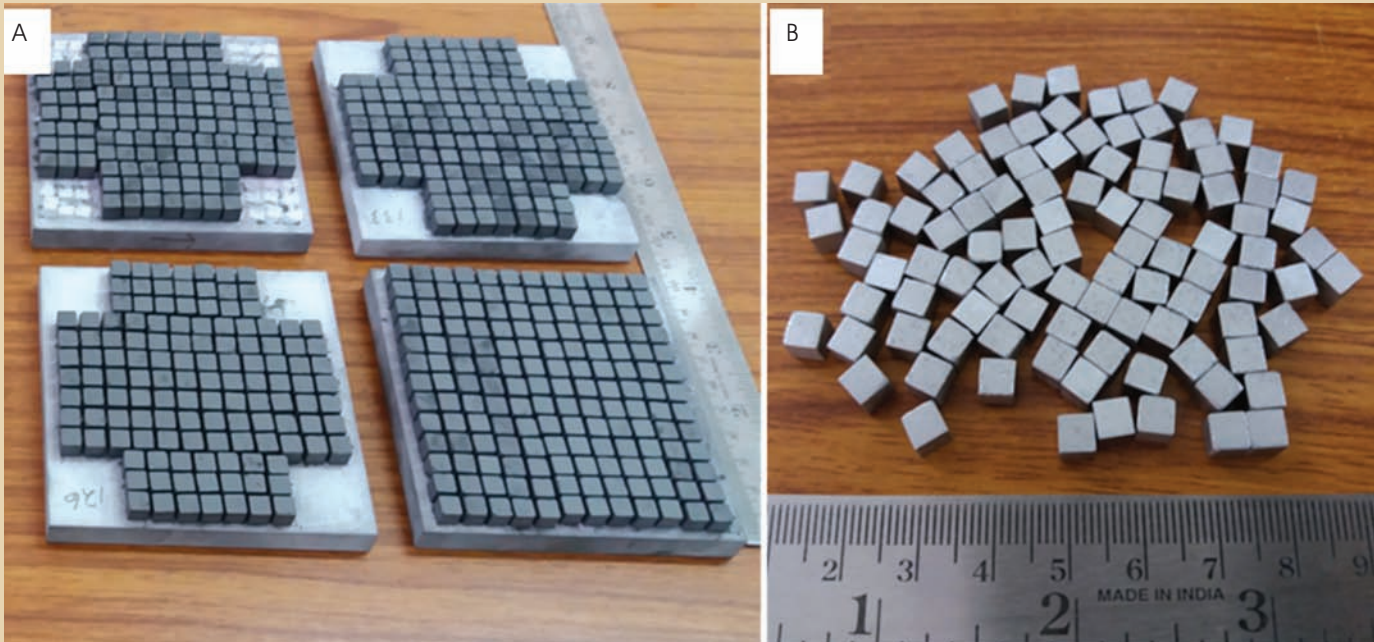


Military Aviation Head Up Display Test Platform (MAHTP)

Military Aviation Head Up Display Test Platform (MAHTP) makes automated testing & debugging less time consuming for ground staff of Air Force and Maintenance Personnel using Intermediate Level (I-Level) & Operator Level (O Level) MAHTP at Air Force Base Station.

Tungsten Alloy Cubes for Missiles

A process has been developed for manufacturing tungsten alloy cubes in 10 kg scale for DRDL for their R&D requirement in armour piercing penetrator in the missile programme. Scale up of the process at 100 kg scale is underway.



Tungsten Alloy (TA) Cubes Green (A) and Sintered (B)

Contributions to Space Programmes

CSIR-NAL has played a crucial role in the acoustic qualification of subsystems for the indigenous cryogenic stage used in GSLV-D5. These tests helped in the first successful flight of the GSLV Mark II using the indigenously developed cryogenic engine, the CE-7.5 by ISRO. CSIR is also proud to be associated with the successes of ISRO's Mars Orbiter Mission (MOM) programme.

Thyratron, Klystron, Magnetron & Gyrotron

- CSIR-CEERI developed 25kV/1 kA Thyratron, later expanded to 35 kV/3 kA Thyratron, as per the requirement of BARC. It is to be used for strategic purposes.
- CSIR-CEERI has developed 6 MW S-band Klystron which would serve as Radio-Frequency power source for LINAC being developed by BARC for Cargo scanning; Food processing; Cable hardening and Gem colourization.
- Water-cooled mechanically tunable pulse magnetron, with peak power 3 MW in S-band, was successfully developed in joint collaboration with DAE. This is intended primarily for use in LINAC/ Microtron.
- A 42 GHz Gyrotron with indigenous design, development and characterisation technology as well as infrastructure has been developed by CSIR-CEERI. The Gyrotron is the first of its kind to be developed in the country.



World's Lightest Electric Car – e2o Plus

Under a CSIR supported project, M/s Mahindra has developed and launched the world's lightest and lowest cost, no-compromise 4-door, 4-seater battery operated electric car. It is the first four-door electric vehicle indigenously designed, developed and commercially produced in India and meeting global automotive quality standards. India's first indigenously developed off-board fast charger has also been developed under the project. The car is designed for a top speed of about 100 kmph and a driving range of about 150 km. The car has significant export potential.



Broad Spectrum Confocal Microscope

CSIR-CGCRI along with M/s Vinvish has designed and developed Broadband Confocal Microscopes. It will be used to obtain three dimensional features at microscopic level and play vital role in scientific understanding of nano-materials, biological objects, etc. It is a world class product based on the uniqueness of reflectance spectroscopy.

Country's First Amorphous Alloy Production Unit

CSIR-NML is setting up a pilot plant for production of amorphous electrical steel with funding from Ministry of Steel. Amorphous based electrical steels are a new class of soft magnetic

materials with high electrical resistivity, low coercivity, low core loss and find extensive applications as core material (transformers, stators, motors, generators), magneto static shielding, choke coils, actuators, etc. This will be the first of its kind pilot plant in India to produce transformer-grade wide amorphous ribbons.

Catalysis for Sustainable Development

The mission endeavours to find the demand supply gaps of chemicals and processes pertinent to Indian chemical industry and develop cost effective, environmentally friendly processes for them. It will focus on alternative and renewable feedstock for chemical synthesis and intends to develop chemical products and processes utilizing renewable raw materials (in-edible biomass, carbon dioxide, water and shale/natural gas, etc.) instead of the conventional fossil fuels. It will be ensured that all the processes/technologies developed have minimum effect on the environment.

Mobile Unit Makes Bridge Repair Easy

Mobile Bridge Inspection Unit (MBIU) is an electro-mechanical device mounted on a truck that makes inspection of road bridges easy.

'PATCHFILL' Repairs Potholes

PATCHFILL is a compact machine for quick, safe and economic repair of potholes using cold mix with efficiency matching that of giant machines.

Plastics to Fuel and Petrochemicals Waste to Wealth Initiative

To address the growing menace of plastic and associated waste generation in the country, a simple process for the conversion of waste plastics (polyolefins) to value added hydrocarbons e.g. gasoline, diesel and aromatics has been developed. The liquid fuel meets Euro III specifications.

Production of US Grade Gasoline and Pure Benzene Plant Commissioned

With this technology, US grade gasoline and pure benzene can be simultaneously produced from a FCC C6 heart cut stream using extractive distillation (ED) route. The RIL has set up



600,000 MTPA unit costing ₹160.00 crore. The annual gasoline production from this unit would equal prospective export monetary value of around 682 Million USD per annum with an additional profit of around 102 Million USD per annum from the sales of the recovered high purity benzene.

Dimethyl Carbonate (DMC) from Methanol and Urea

A process for the synthesis of DMC – an important intermediate – from methanol and urea has been developed. The urea route is considered better and a green alternative for DMC synthesis. At present, India does not produce DMC and all the requirement is met through imports from China and other countries.

Recovering Cobalt from Discarded Li-ion Batteries of Mobile Phones

A cost-effective process has been developed to help in reduction of e-waste and its inefficient recycling and dissolution of metals. The process has been transferred to M/s ADV Metal Combine Ltd., New Delhi.

LPG Sweetening Catalyst

Thoxcat ES, a catalyst useful for LPG sweetening has been further modified and scaled up with M/s Lona Industries to ensure a competitive edge over competing sweetening catalysts. This fine-tuned catalyst has now been shipped to ORPIC, Oman and Saudi Aramco.

Indigenous Potash Technologies

A complete technology solution for valorisation of spent wash generated in sugarcane molasses based alcohol distillery has been developed for utilisation of spent wash for production of value-added by-products viz., potash fertiliser, animal feed ingredient, etc., while achieving statutory compliance with 'zero liquid discharge' norms.

Dry Tanning (Dispersing Agent)

Game changing Tanning Technology from CSIR-CLRI, leading to cost and time savings, less quantity of tanning agent, less water requirement, fewer steps in leather processing and environmental benefits.

Facilitating "Make in India" in the Biotech Sector

- The Biotechnology Industry Research Assistance Council (BIRAC) established a "Make in India" Facilitation Cell in 2016 for disseminating information in the context of "Make in India" and attracting investments.
- BIRAC also launched the Biotechnology Innovation Equity Fund -- AcE Fund, which is a Fund of Funds to scale-up R&D and innovation in biotechnology domains. This will infuse more than 350 Crores in the Biotech Innovation Startup Ecosystem.
- BIRAC is implementing National Bio-Pharma Mission, an industry-academia collaborative mission of Department of Biotechnology (DBT) in collaboration with World Bank, with a corpus funding of 250 Mn USD for accelerating discovery research to early development of Biopharmaceuticals.
- DBT along with BIRAC has championed the cause of promoting the Start-ups Innovation ecosystem in the biotech domain. DBT endeavours to scale up the number of start-ups in the sector by nurturing approximately 300-500 new Start-ups each year to have around 2,000 start-ups by 2020.
- BIRAC has till now supported 500 start-ups and entrepreneurs. BIRAC's BIG programme has become one of the largest early stage programmes and has supported more than 250 start-ups and entrepreneurs. More than 50 BIG grantees have been able to generate follow-on funding to the tune of 125 crores from both public and private agencies.



BIRAC Initiatives for "Ease of Doing Business"

- Exemption from the service tax on services provided by BIRAC approved biotechnology incubators to incubatees with effect from April 1, 2016.
- Mandatory requirement of export/import license for biological samples removed w.e.f. August 4, 2016. Organizations to give self-certification to customs authority that they are/will follow all applicable rules, regulations and procedures for safe transfer and disposal of the biological samples.
- Definition of start-ups amended by DIPP wherein an entity shall be considered as a Biotechnology Startup for up to 10 years from the date of its incorporation/registration. For others it is 7 years.
- 100% FDI allowed under automatic route for greenfield pharmaceuticals projects. For brownfield pharmaceuticals projects, 74% FDI is permitted under the automatic route.
- For manufacturing of medical devices, the sector was opened for 100% FDI under the automatic route on January 21, 2015.
- New Biosimilar Policy known as the Guidelines on Similar Biologics announced by the Central Drugs Standard Control Organization (CDSCO) and Department of Biotechnology in 2016 addresses the regulatory pathway regarding manufacturing process and safety, efficacy and quality aspects.

DST Programmes

Aligning with **Make in India**

Advanced Manufacturing Technology (AMT) Programme

In October 2015, DST initiated a programme to promote development of advance manufacturing technologies in the country – till date 45 project proposals have been supported. During the second call 256 proposals were received with focus on design tools and process innovations, modeling & simulation platforms, Digital Manufacturing, Flexible scale manufacturing, Additive manufacturing, Smart Manufacturing, Advanced Robotics (AR) & Industrial Internet of Things (IIOT), wearable low-power electronics including energy harvesting, Sensor Networks, etc.

Technical Research Centres

The Finance Minister, during his budget speech of 2014-15, announced setting-up of five Technical Research Centres (TRCs) in existing autonomous institutions of DST. Technical Research Centres (TRCs) were established in 2015-16 in five DST institutions namely, SCTIMST, Trivandrum; ARCI, Hyderabad; JNCASR, Bengaluru; IACS, Kolkata and SNBNCBS, Kolkata.

- **Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), Trivandrum:**
4 projects on neuro-prosthetic devices, 7 projects on cardiovascular devices, 3 projects on hard tissue devices, 6 projects on biological and combinational products and 8 projects on product/material evaluation/support were initiated during the year and they recorded good progress.

- **International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI), Hyderabad:**
Activities carried out under the project were in the areas of solar energy, energy storage, energy efficiency, energy conversion, electric/hybrid vehicle systems, etc. One Indian patent was granted in 2014 and 25 Indian patent applications are filed till date; one more is in the process of getting filed. One international patent has been granted during 2014-2018.
- **Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru:** Development of 7 technologies is in progress, 15 Indian and PCT applications were filed, one start-up 'Avinir' was incubated which would deal with DNA probes having potential for various applications, including diagnostics. Another start-up, which would deal with development of anti-bacterials for use in paints and surgical instruments is under incubation.
- **Indian Association for the Cultivation of Science (IACS), Kolkata and S.N. Bose National Centre for Basic Sciences, Kolkata:** Both the institutions took steps to establish the necessary laboratory facilities for accelerating applied research.

Partnering with MHRD for Uchchatar Avishkar Yojana (UAY)

SERB is partnering with MHRD for UAY projects and funds selected projects. It is expected to enhance industry-academia interaction and encourage industry relevant R&D by using

the best human resource and infrastructure in academic institutions. The share of SERB funding will be 25%, while MHRD will contribute 50% and industry the remaining 25%. The projects funded under this scheme will be named as “UAY SERB” projects. The first batch of 39 projects is being supported with SERB share of ₹ 30 crores.

Collaboration in Impacting Research Innovation and Technology (IMPRINT) Project

DST has joined hands with MHRD to implement IMPRINT projects, which will address major societal and developmental needs such as healthcare, information and communication technology, energy, sustainable habitat, nanotechnology, water resources and river systems, advanced materials, security and defence, and environment and climate.

Twelve projects in different domain areas particularly in nanotechnology and Advanced Materials have been funded by SERB.

The second phase of IMPRINT-2 with a total budget of ₹ 970.5 crore was launched in March 2018. DST and MHRD will jointly steer this national initiative. SERB will be the nodal agency for implementing IMPRINT-2. IMPRINT-2 expands the catchment of implementing institutions by adopting a more demand-driven strategy of solution development and by incorporating specific externalities of the states of India so as to make end-user translation and technology adoption easier.

To simplify and streamline the process, attract wider participation of stakeholders including industry and sharpen the focus, a new and revised version of IMPRINT, IMPRINT Round II, has now been envisaged which will be steered jointly by MHRD and DST through SERB. Core mandate of IMPRINT II would be to:

- Develop products/processes and viable technologies for addressing the identified challenges in different domains.
- Formulate and develop focused translational projects against identified technology thrust areas.

Industry-relevant R&D

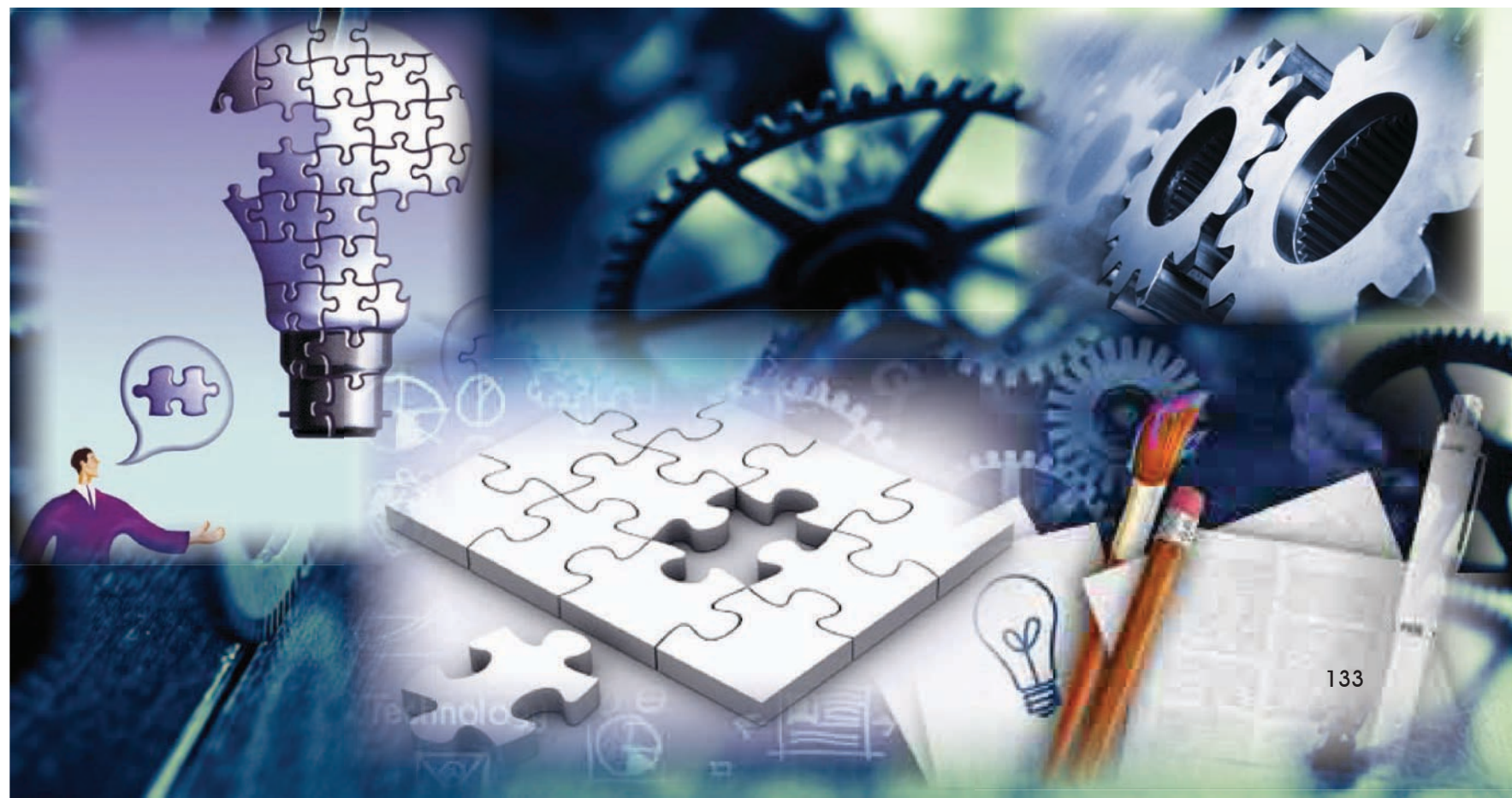
Recognizing the need to facilitate increased Public Private Partnerships, the SERB has approved a scheme that provides an opportunity for collaborative research between academic institutions and industry. Upto 50% cost to be provided by DST for the project after ascertaining the usefulness and sound scientific foundations of the project. This scheme aims to bridge the gap between public funded research and industrial R&D. The new scheme seeks to target solution-driven research to address industry-specific problems.

During the second call 256 proposals were received with focus on design tools and process innovations, modeling & simulation platforms, Digital Manufacturing, Flexible scale manufacturing, Additive manufacturing, Smart Manufacturing, Advanced Robotics (AR) & Industrial Internet of Things (IIOT), wearable low-power electronics including energy harvesting, Sensor Networks, etc.

- Evolve new technology transfer models for enabling technology diffusion to industry and stakeholders.
- Align the projects with the needs of various industry sectors and the States of India, in order to achieve end-user translation.
- Facilitate building capability and competence in identified technology thrust areas in the various HEIs and universities, in order to plug the demand-supply gap of human resources in specific areas of need.



Knowledge Generation and Discovery Research



Knowledge Generation and Discovery Research

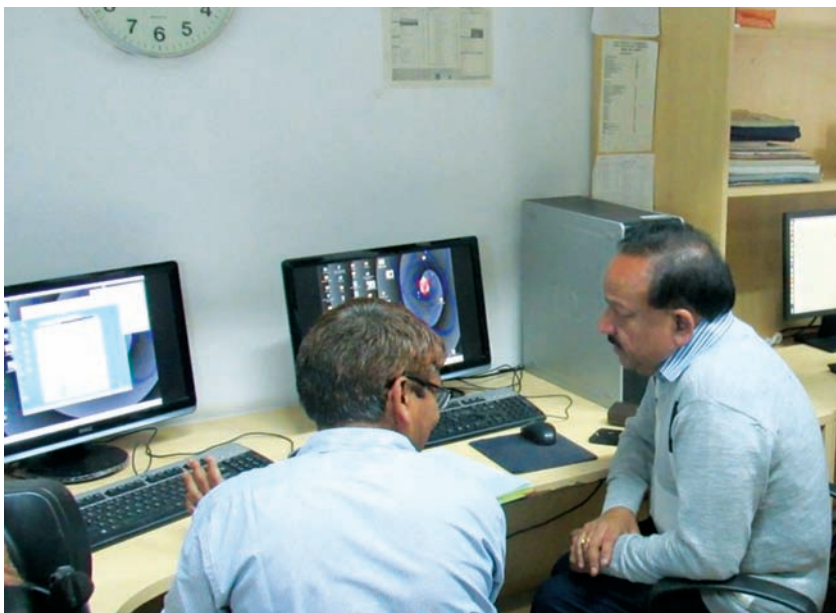
For Scientific Ideas and Innovation

THE Ministry of Science and Technology and the Ministry of Earth Sciences carry out significant research on basic science on different themes. This is aimed to improve and advance fundamental knowledge and remains as a source of new scientific ideas and innovation. Basic research is incredibly important because it lays the ground for major discoveries.

Thirty Meter Telescope

India's participation in the Thirty Meter Telescope (TMT) project was approved by the government at a total cost of ₹ 1299.8

crores in September 2014, under the joint responsibility of Department of Science & Technology and Department of Atomic Energy. The DST on behalf of the Government of India executed the TMT international observatory partnership documents becoming a full member in the project on December 2, 2014. The other countries participating in the project include the United States of America (USA), Canada, China and Japan. India will contribute in cash and kind towards the construction phase. The Indian science sector will benefit both scientifically and technologically from the participation in the project. On the technology front, design, prototyping, testing, validation and manufacturing of various in-kind items will bring in know-how for new and cutting-edge technologies. These will have long term spin-off advantages for the country.



Thirty Meter Telescope

Govt. has committed
₹ 1299.8 crores
in Sept 2014



- India's participation in Thirty Meter Telescope approved in Sept 2014 at a cost of ₹ 1299.8 Crores.
- DST on behalf of the Government executed requisite tasks in becoming a full member on TMT International Observatory.

#TransformingIndia



Department of Science Technology Govt of India 969734629779302



@Ind



Remote Technical Activation of Digital Optical Telescope located at Devasthal, India from Brussels on March 30, 2016 by the Prime Ministers of India and Belgium.



On the scientific front, after commissioning of TMT in 2022-23, India will get 25-30 assured observational nights on the TMT. This will enable Indian astronomers to study front-ranking scientific problems such as formation and evolution of stars, planets and galaxies.

India TMT Optics Fabrication Facility (ITOFF) at Centre for Research and Education in Science and Technology (CREST), Indian Institute of Astrophysics (IIA)

Devasthal Optical Telescope

A state-of-the-art world class 3.6-meter 'Devasthal' Optical Telescope was remotely activated jointly by the Hon'ble Prime Minister of India and the Prime Minister of Belgium on March 30, 2016. The telescope is installed at 'Devasthal' near Nainital. It is the largest steerable imaging telescope in Asia which is a result of scientific collaboration between the team of scientists from Aryabhata Research Institute of Observational Sciences (ARIES),

Nainital, an autonomous institution of DST, and Belgian scientists. The telescope will contribute to observations for frontline scientific research in astronomy and astrophysics.

The 'Devasthal' Optical Telescope was remotely activated jointly by the Hon'ble Prime Minister of India and Prime Minister of Belgium on March 30, 2016.

Experimental Stations at Trieste, Italy

As part of the India-Italy scientific and technological co-operation, two new experimental stations were set up at the Elettra Synchrotron Trieste Research Center, Trieste, Italy. Named Xpress and XRD2, the two beamlines were co-funded by the DST, Government of India, through Indian Institute of Science, Bengaluru, and Ministry of Foreign Affairs and International Collaboration (MAECI), Italy.

A delegation of DST, led by the Secretary, Ashutosh Sharma, and an MAECI delegation, led by the Plenipotentiary Minister, Fabrizio Nicoletti, Head of the Scientific and Technological Co-operation Unit, inaugurated the two beamlines in April 2017. The Xpress beamline uses X-ray diffraction technology to study the structure of materials

under extremely high pressure, including the synthesis of new compounds, such as ceramics or alloys, mineralogy, geophysics and the study of the properties of materials. The XRD2 beamline has been designed to determine the 3D structure of proteins and biological macromolecules and its applications covers the field of biology, medicine, pharmacology and biotechnology. The two new beamlines will be available to the Indian, Italian and international researchers, according to the scientific quality of the research projects and their impact, assessed by a peer-review system.



Inauguration of beam-lines 'XRD2' and 'XPRESS' at the Synchrotron Facility in Trieste, Italy

Basic Scientific Research Efforts at DBT are directed at conceiving and developing fundamental new ideas, approaches, and methods for addressing some of the most intriguing and challenging aspects of living organisms. DBT extends its support to investigator-initiated frontier research in life science, on the basis of scientific excellence.

New understanding of the developed TB bacterial

- Demonstrated new pathway for iron acquisition in *M. tuberculosis*
- Provided important understanding of the mechanism of bacterial survival during TB
- Demonstrated that human holo-transferrin interacts with GAPDH both *in vivo* and *in vitro* using protein chemistry, molecular biology and microscopy techniques.

Methods for making modified Morpholino-based antisense was developed and has been successfully applied in cancer cells. High-resolution X-ray crystal structures of two enzymes, *Salmonella typhimurium* 2-methylcitrate synthase (2-MCS) and acetate kinase (StAckA) has been determined. These enzymes have provided the basis for understanding the molecular basis for the specificity of the enzymes towards substrates and plausible mechanism of catalysis.

Under the SERB, a total of 2700 plus proposals would have been sanctioned till March 2018 under the Core Research Grant Scheme (EMR Scheme along with 3200 plus projects to Young Scientists/ Early Career Award Scheme. In addition, the SERB launched the National PDF Scheme in 2016 and has supported 2000 plus NPDP during the last two years.

The Ministry of Science & Technology through SERB has also supported 530 plus candidates in the Equity Scheme with almost 421 SC candidates and 108 ST candidates. This is to provide equal opportunities to candidates belonging to reserved categories. These are in addition to the candidates who have been supported under the Core Research Grant Scheme.

The tangible contributions from DST on Basic Research are given below:

- Research Papers published by DST Autonomous Institutions in refereed journals - 8755
- Scientific Books published by DST Autonomous Institutions - 128

Some details of the projects supported include the following:

Whole Genome Sequencing of Holy basil (Tulsi)

CSIR has carried out whole genome sequencing of *Ocimum sanctum*, the sacred plant of Hindu tradition which paves the way to use modern tools for scientific validation of the traditional claims in diverse medicinal usage and also opens the opportunity for *in vitro* production of the therapeutic molecules.

This is the first report of complete genome sequence of the Holy basil, using a composite next generation sequencing technology.

Ceramic Substrates for Electronics, Oxygen Sensor and Solid Oxide Fuel Cell (SOFC)

Applications

CSIR-NAL in partnership with Carborundum Universal (CUMI), has developed 100 and 250 μm thick Al_2O_3 and YSZ tapes. It has also developed tape casting grade powders and process for technologically important tape cast products like doped Al_2O_3 , GDC, ScSZ, glass sealant, etc. Among these, ScSZ is considered as the futuristic electrolyte material for SOFC which has a large market potential.

Sunlight Sensitized Long Afterglow Phosphor Powder & Paint

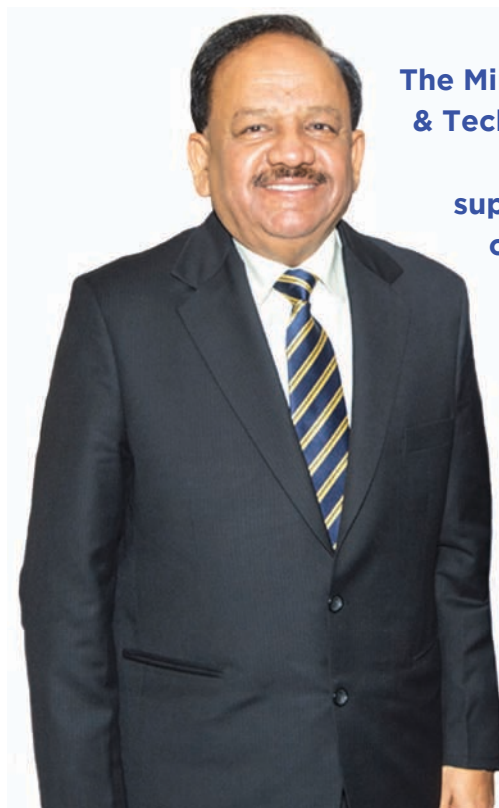
CSIR-NPL, New Delhi has developed an efficient after-glow phosphor with longer after-glow (< 6 hours) to replace existing markers like beta lights etc. Long afterglow phosphor has been of great interest globally for many strategic applications like emergency and safety marking in dark conditions. The technology has been transferred to a road marking and signage industry namely Kataline Infra Products, Nagpur.

Fatigue Life Evaluation of Welded Rail Joints

CSIR-SERC is assisting Indian Railways in assessing the quality of welded rail joints. Welded rails are being used extensively in railway tracks in India for increasing the speed of the rolling stock and better travel comfort.

Amalaki Rasayana for Management of Cognitive function in Alzheimer's disease

CSIR-CCMB has provided scientific evidence on the effect of dietary Amalaki Rasayana (AR), an Ayurvedic formulation used in Indian traditional system, in AbPP-PS1 mouse model of AD in ameliorating memory and neurometabolism which was also compared with donepezil, a standard FDA approved drug for



The Ministry of Science & Technology through SERB has also supported 530 plus candidates in the Equity Scheme with almost 421 SC candidates and 108 ST candidates. This is to provide equal opportunities to candidates belonging to reserved categories.

AD. It has been shown that Indian gooseberry, Amla improves memory function in mice genetically engineered to mimic Alzheimer's disease, a neuro-degenerative disease that has no cure.

Monsoon Mission and Improved Monsoon Predictions

Accurate prediction of monsoon rainfall is crucial as it impacts many sectors including agriculture, water resources, power generation, transport and even the economy. The Monsoon Mission was launched in 2012 with an allocation of ₹ 400.00 crore to develop the capability of dynamical model prediction system for short range of seasonal forecasts and to improve the monsoon forecasts. Under the Monsoon Mission, MoES has implemented two state-of-the-art dynamical prediction systems for short range to medium, extended range and

seasonal forecasts. All these initiatives have helped to improve the monsoon forecasts over the country. For the first time, India Meteorological Department used the Monsoon Mission dynamical model to prepare operational seasonal forecast for 2017 monsoon across the country.

After the success of the Monsoon Mission Phase I, the second phase of the mission has been launched in 2017 with the objective to develop suitable applications and improve the prediction of weather and climate extremes.

Observational Campaigns

Many observational campaigns have been undertaken in the past four years as special atmospheric observations help to understand model deficiencies and improve prediction models. To address the issues related to better measurement and understanding of small-scale processes that drive the variability, seasonality and predictability in the South Asian Monsoon, a large-scale joint India-UK observational campaign was carried out during the period June-July 2016. The campaign involved the deployment of UK's BAe-146-301 atmospheric research aircraft with sophisticated scientific instruments and India's *Sagar Nidhi* and *Sindhu Sadhna* research ships.



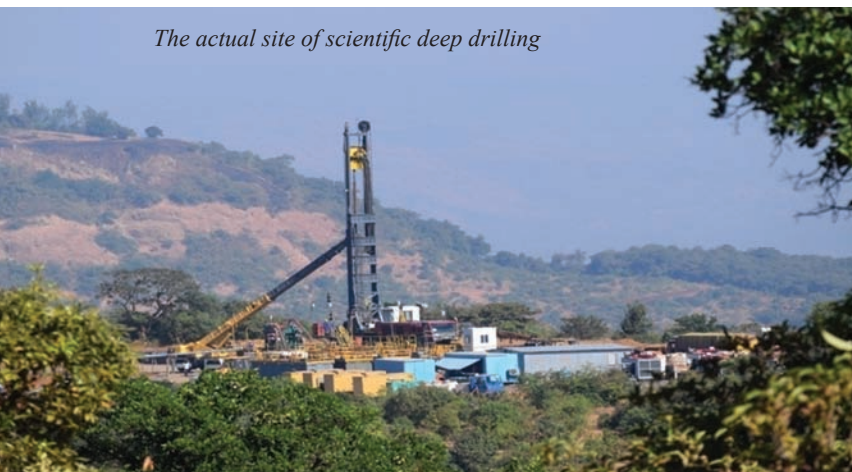
Scientific Deep Drilling

Scientific Deep Drilling in Koyana which started in 2016 is aimed at setting borehole observatory (s) at depth for directly measuring the in-situ physical properties of rocks, pore-fluid pressure, hydrological parameters, temperature and other parameters of an intra-plate, active fault zone near field of earthquakes—before, during and after their occurrence, leading to a better understanding of the mechanics of faulting, physics of reservoir triggered earthquakes and preparing a predictive model.



Hon'ble Minister of Science and Technology and Ministry of Earth Sciences, Dr. Harsh Vardhan, along with the UK & Indian scientists with the Research Aircraft

The actual site of scientific deep drilling



Borehole Geophysics Research Laboratory (BGRL), Karad has undertaken scientific deep drilling and associated investigations in the Koyna seismic zone, Maharashtra. In 2017, the pilot hole of 3 km depth was drilled with technical help from international experts. Seismological observations in the Pilot hole will now be planned for next upcoming year.

Antarctic Expedition

India is successfully co-operating two research stations, Bharati and Maitri in Antarctic to enhance the understanding of glaciology, polar atmosphere, paleo-climate and polar

Field Research Station 'HIMANSH' at Sutri Dhaka, Chandra basin, HP



biology. Annual scientific expeditions to Antarctica are undertaken with scientists from different scientific institutions. The scientific expeditions included projects on upper atmosphere, astrophysics, geophysics, meteorology, glaciology, geology, biology, environmental sciences, human physiology and medicine. Yoga was recently introduced as part of a scientific programme.

Himalayan Research Station

National Centre for Antarctic and Ocean Research (NCAOR), Goa, under the Ministry of Earth Sciences established a high-altitude research station in the Himalayas called HIMANSH (literally meaning, a slice of ice), situated above 13,500 feet (> 4000 m) at a remote region in Spiti, Himachal Pradesh (HP) in 2016. This station provides the required support to researchers and is equipped with various scientific instruments. Water Level Recorders were installed at five locations along for a stretch of 130 km along the Chandra River in Western Himalayas for hydrological balance/modelling. Glaciers were monitored for mass balance, dynamics, energy balance and hydrology. Further, the researchers would use the data as a base for undertaking surveys using Terrestrial Laser Scanners (TLS) and Unmanned Aerial Vehicles (UAV) that would digitize the glacier motion and snow cover variations with exceptional precision.

Arctic Research

MoES also continued scientific activities in the Arctic at the research station in Himadri, Ny-Ålesund, Svalbard, Norway. One of the main activities included the of Indian Arctic mooring (IndARC-II). The Ambient Noise Measurement System with a single hydrophone and a data acquisition system were deployed on IndARC-II. The IndARC-II collected more than 116 parameters and worked continuously in the Arctic waters. Glaciological field studies in Arctic are conducted essentially in two glaciers (VestreBroggerbreen and Feiringbreen) in Svalbard as a part of the Indian Arctic Expeditions.

Cloud Aerosol Interaction and Precipitation Enhancement Experiment (CAIPEEX)

CAIPEEX program has two main objectives:

- Advance the research on the aerosol-cloud and precipitation interactions
- Conduct cloud seeding experiments by using this background data for planning rain enhancement experiments for protocols of cloud seeding



The CAIPEEX project has resulted in 820 hours of airborne cloud, aerosol and rain microphysics observations over Indian region. From the airborne observations several key results have been published including new ice nucleation scheme for deposition ice nuclei, parameterization for ice water content, indirect effect of aerosol, dispersion effect, relationship between the surface and cloud base CCN under different sub-cloud aerosol conditions.

High-Altitude Cloud Physics Laboratory (HACPL)

The HACPL was set up at Mahabaleshwar with advanced measurement facilities for observing cloud, aerosol, precipitation and radiation parameters to understand aerosol-cloud-precipitation interactions. Using the observations, the indirect effect of atmospheric particulate pollution on cloud properties using HACPL observations and better understanding on role of aerosol physical and chemical properties on cloud activation is established. Long-term continuous measurements of cloud, precipitation and aerosol will provide test-bed for testing/improvement of physical processes relevant to orographic convection, cloud activation and effect of aerosol on precipitation in numerical weather prediction models.

Dynamics of Host-Pathogen Interactions in TB Infection

SysTB, a Network Program for Resolving the Intracellular Dynamics of Host-Pathogen Interactions in TB Infection was funded by the department. There is a lack of understanding on how Mycobacterium tuberculosis undergoes transition from actively dividing form to dormant form, and vice versa. The dormancy is believed to be induced by factors such as nutrient starvation, hypoxia, etc. The transcription factor Rv0081 of M. tuberculosis (Mtb) controls the hypoxic gene expression response and acts as a regulatory hub in the latent Mtb infection. The crystal structure of Rv0081 at 3.3 Å resolution was determined revealing structural basis of hypoxic gene regulation by the Rv0081 transcription factor of Mycobacterium tuberculosis.



Science & Technology Infrastructure



Science & Technology Infrastructure for Diverse Segments

THE infrastructure created with the input of Science and Technology has acquired a significant importance in recent times. Research and development activities are being carried out in diverse segments. These include power, roads (both highways and rural roads), ports, airports, railways, telecommunication and information technology and manufacturing, among others and are areas of priority towards India's overall development. The civil engineering and infrastructure markets offer significant growth prospects, due to rapid development and urbanization. Considering the current context and future scenario, CSIR is aiming for a leadership position in the next generation infrastructure engineering. It is also pursuing development of knowledge base in accordance with the global standards in the fields of electronics and mechanical engineering, particularly in the areas of microwave tubes, sensors, medical instrumentation, aviation electronics, advanced manufacturing, mechatronics and farm machinery.

Aerospace Engineering

CSIR has been playing a pivotal role in creating an enabling ecosystem for aerospace engineering and manufacturing in the country by providing advanced-technology products and solutions with a strong foundation in science. With its

growing involvement in the Indian space programme, its multidisciplinary activities and global positioning, CSIR provides necessary support to all major national aerospace programmes which include aircraft, missiles, launch vehicles, satellites, defence systems and services.

Mission on Intelligent Systems

The mission aims to develop technology for unmet needs, leveraging artificial intelligence based techniques in consonance with the advanced electronics. It would include development of technology for Intelligent Electronic Systems, Drone Applications and Brain Machine Interface, Intelligent Cyber Physical Systems, Artificial Intelligence (AI) Based Seismic Signal Analytics, AI in Healthcare, AI Techniques for Cyber Physical Security and AI Engine and Data Platform.

The research and development activities are being carried out in diverse segments. These include power, roads (both highways and rural roads), ports, airports, railways, telecommunication and information technology and manufacturing, among others and are areas of priority towards India's overall development.



Building products using Kota stone cutting and slurry waste

A technology has been developed for using Kota stone cutting and slurry waste, to make building products like paver blocks, tiles, Lightweight Cellular Foamed Concrete (CFC) blocks. It has been transferred to the Rajasthan Pollution Control Board.

Utilization of Ghazipur Site Waste to Widen NH-24 Sustainable Environmental Solutions

A study was carried out for possible use of Ghazipur landfill waste (12 million tonnes of waste spread across 70 acres) and methodology was suggested to use 65-75% of segregated waste for construction of embankment along NH-24 (Meerut Expressway).



View of Ghazipur MSW landfill



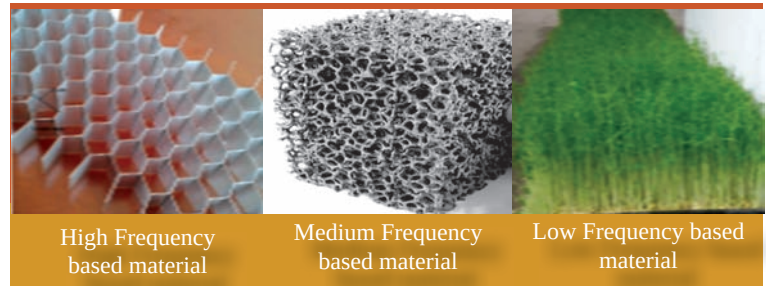
Process of segregation in the plant

Technology Demonstration

Project on Laying of Geopolymer Concrete Road Stretch at National Thermal Power Corporation (NTPC), Dadri Site



High strength fly ash based geopolymer concrete for construction of road (as per IRC specifications) at NTPC-NETRA is developed. A geopolymer concrete road stretch (50 m length and 3 m width) has been successfully laid at CSIR-CBRI using fly ash from NTPC Dadri, first of its kind in India. This road will not require water curing as required by cement concrete road and also paves the way for the utilization of bulk fly ash.



Design of Noise Barrier based on different Frequencies

Frequency based noise barriers have been developed to drastically reduce noise level (about 42 decibel) and improve the quality of life in noise affected areas.

Intelligent Dry Fog Dust Suppression System

An intelligent dry fog suppression system has been developed for effective control of dust emission from crushing plants, screening plants, loading plants and mines. The technology is being implemented in NMDC's crushing and screening plants and mining areas.



Glass Textile Reinforced Concrete Crash Barrier System

To ensure the safety of road users, a pre-fabricated Glass Textile Reinforced Concrete Crash Barrier System has been

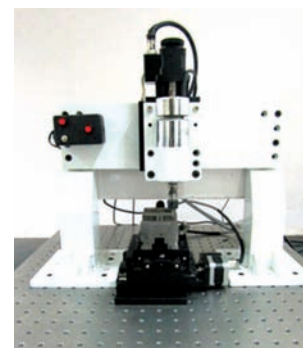


developed. The crash barriers are lighter in weight, flexible and elastic with ability to absorb the energy of the vehicle upon impact. This would provide improved safety

to the passengers in the vehicle and result in less damage to the impacting vehicles.

Indigenous 4-axis controller for multi-process micro machine

To avoid import of expensive micro-machines, indigenous micro-machine test bed has been developed at low cost. It is being used by small and medium scale micro-machining industries such as surgical tool industries, jewellery making industries etc. along with skill development. The machine has been supplied to New Horizons Institute of Technology (NHIT), Durgapur and Manbhum Pvt. Industrial Training Institute, Purulia.



Innovative Building Technology for Mass Housing Using 'EPS' Panel: Affordable Housing for Rehabilitation of Cyclone Victims

CSIR-Structural Engineering Research Centre (SERC) has conducted the analysis, designing and structural detailing of (G+1) reinforced concrete buildings using Expanded Polystyrene (EPS) Panels. The technology enables faster construction and is ideal for mass-production of affordable and disaster resistant (cyclone wind loads) houses. It has been transferred to Consortium Transmission Systems Pvt. Ltd. (CTSPL), Hyderabad for 'Hudhud' cyclone victims' rehabilitation housing programme at Srikakulam, Andhra Pradesh. About 496 dwelling units are being constructed using the technology. Development of a boring machine based on trenchless technology.

For the first time in the country, a low-cost machine for trenchless boring has been developed. The machine is affordable and requires minimal maintenance and can be used by small/middle class contractors. Techno Industrial Marketing, Uttarakhand is presently commercializing the product.



Technology for manufacturing of Austempered Ductile Iron (ADI) components for mining application

Technology for manufacturing of ADI components has been developed for mining application which would increase durability of digger tooth and reduce operational cost. The technology has been demonstrated on L&T CK -300 Excavator Machine for more than 500 hours of operation at Eastern Coal Field Limited.

MEMS Pressure Sensors

A pressure sensor for Micro Air Vehicle (MAV) application has been developed. It is fabricated for a pressure range of 0.0-1.1 bar.

Cost Effective Water Tanks using Flowable Cement Mortar

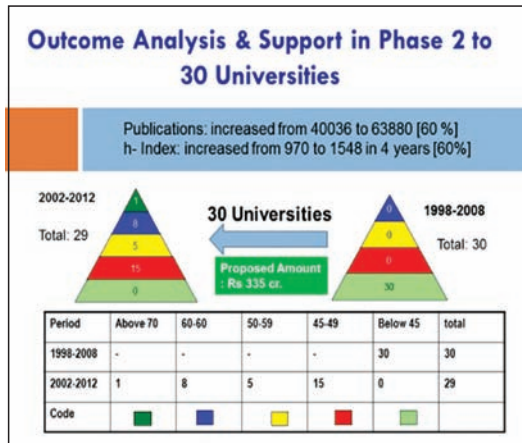
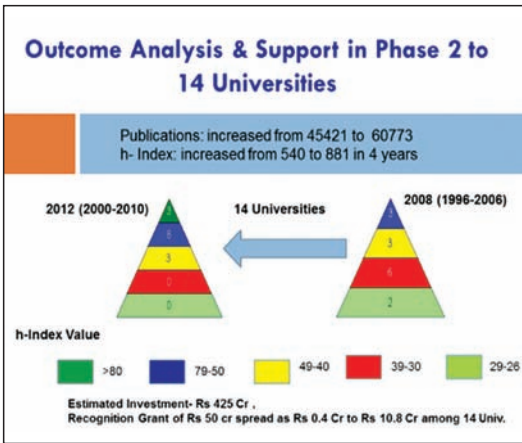
Low cost water tanks have been developed using flowable cement mortar. The water tank can be made in various sizes using the precast concrete panels and can be assembled in 30 minutes. No machinery is required for lifting the tank. Laxmi Srinivas Engineers, Hyderabad is presently commercializing the product.

cGMP Pilot Plant for Herbal Preparations: Addressing Country's Need for Validating and Standardizing Ayurvedic Medicines

The first national state-of-the-art cGMP facility for production of herbal preparations has been established in CSIR-IIIM. The facility, based on World Health Organization (WHO) and US Food and Drug Administration (USFDA) guidelines, has production capacity of 30,000 tablets and capsules per hour and 500 litres of liquid per batch. The facility has been issued license by the State Regulatory Authority (Drug & Food Control Organization). Recently, CSIR-Indian Institute of Integrative Medicine (IIIM) also received permission to manufacture and market certain AYUSH drugs using this facility.

Fund for Improvement of S & T Infrastructure in Universities and Higher Educational Institutions (FIST)

"Fund for Improvement of S&T infrastructures in Universities and Higher Educational Institutions (FIST)" program is a major infrastructure augmentation program launched by the Government in FY 2000-01. The Program facilitates support towards augmenting higher education and research largely at the university and academic sectors by augmenting basic infrastructural facilities for teaching as well as for conducting research in basic or applied science areas. The Program is currently operated in competitive mode of support at three levels i.e. Level 0, Level I and Level II covering six subject areas (Life Sciences, Physical Sciences, Chemical Sciences,



Engineering Sciences, Earth & Atmospheric Sciences, Mathematical Sciences) and PG Colleges. The quantum of support is limited to ₹ 1.50 Crore, ₹ 3.0 Crore and ₹ 10.0 Crore for Level 0, Level I and Level II respectively, depending upon the type of department or college and quality of research/teaching imparted. From the financial year 18-19, DST has introduced Level III, with a quantum of support limited to ₹ 20 Crores for 5 years duration.

During the last 4 years, a total of 692 proposals were identified and supported through the available mechanism of the FIST Program to consider financial support of varying quantum's at a total budget of about ₹ 941.48 Crores for 5 years. Besides the new proposals, grants to the ongoing projects were also supported during these years. So far, nearly 2475 S&T departments spread over 650 Academic Institutions and PG colleges (Level 0-353, Level I-1892 and Level II-230) have been supported with a total investment of ₹ 2380 Crores.

Promotion of University Research and Scientific Excellence(PURSE)

"Promotion of University Research and Scientific Excellence (PURSE)" is a proactive measure of Department of Science & Technology to build the research capacity of performing Indian Universities. The main objective of the scheme is to pro-actively support for strengthening the R&D base of the performing Universities in the country with adequate financial support and associated flexibility. It is formulated on the basis 10 years aggregate publications and h-index towards creating and nurturing the research ecosystem among performing universities in the country.

Using transparent criteria forty-four (44) performing universities whose h-index ranging from 56 to 26 have been supported ranging from ₹ 30.0 Crores to ₹ 6.0 Crores for 4 years' period based on the study report by NISTADS "Status of India in Science and Technology" as reflected in its publication output in Scopus International Database, for the three study periods

1996-2006, 1998-2008, 2000-2010. Due to this outstanding performance of the first set of 14 Universities, another round of performance linked investment under the PURSE Scheme to these 14 Universities was decided and an amount of ₹ 425 cr including an additional incentive of ₹ 50 cr based on their growth rates both in overall publications and h-index. Phase 2 support to a set of 14 Universities was released in the FY 14-15. PURSE Scheme has provided a triggering mechanism for promoting publication oriented research in the University sector deploying evidence based approaches. There has been significant increase in R&D outputs in PURSE supported Universities.

Sophisticated Analytical Instrument Facilities (SAIF)

The Department of Science & Technology has thus set up Sophisticated Analytical Instrument Facilities (SAIFs) in different parts of the country to provide services of the facilities of sophisticated analytical instruments to the researchers in general and specially from the institutions which do not have such instruments and enable them to pursue R&D activities requiring such facilities and keep pace with developments taking place globally. At present, there are 15 Sophisticated

Hon'ble Minister of S&T, Dr. Harsh Vardhan, visiting SAIF Facility at Central Drug Research Institute, Lucknow in 2015



Analytical Instrument Facility (SAIF) Centres viz. at IIT, Chennai; IIT, Mumbai; CDRI, Lucknow; Panjab University, Chandigarh; NEHU, Shillong; IISc, Bangalore; AIIMS, New Delhi; Gauhati University, Guwahati; CVM, Vallabh Vidyanagar; Sophisticated Test & Instrumentation Centre (STIC), Kochi; IIT Patna; IEST, Shibpur, Shivaji University, Kolhapur; MG University, Kottayam and Karnataka University, Dharwad, and these are being supported by the Department of Science and Technology. Five new centres have been setup in less endowed regions to facilitate the research community. A Web Portal interlinking all the Facilities for day to day transparency of the system under the SAIF program of DST has been recently developed.

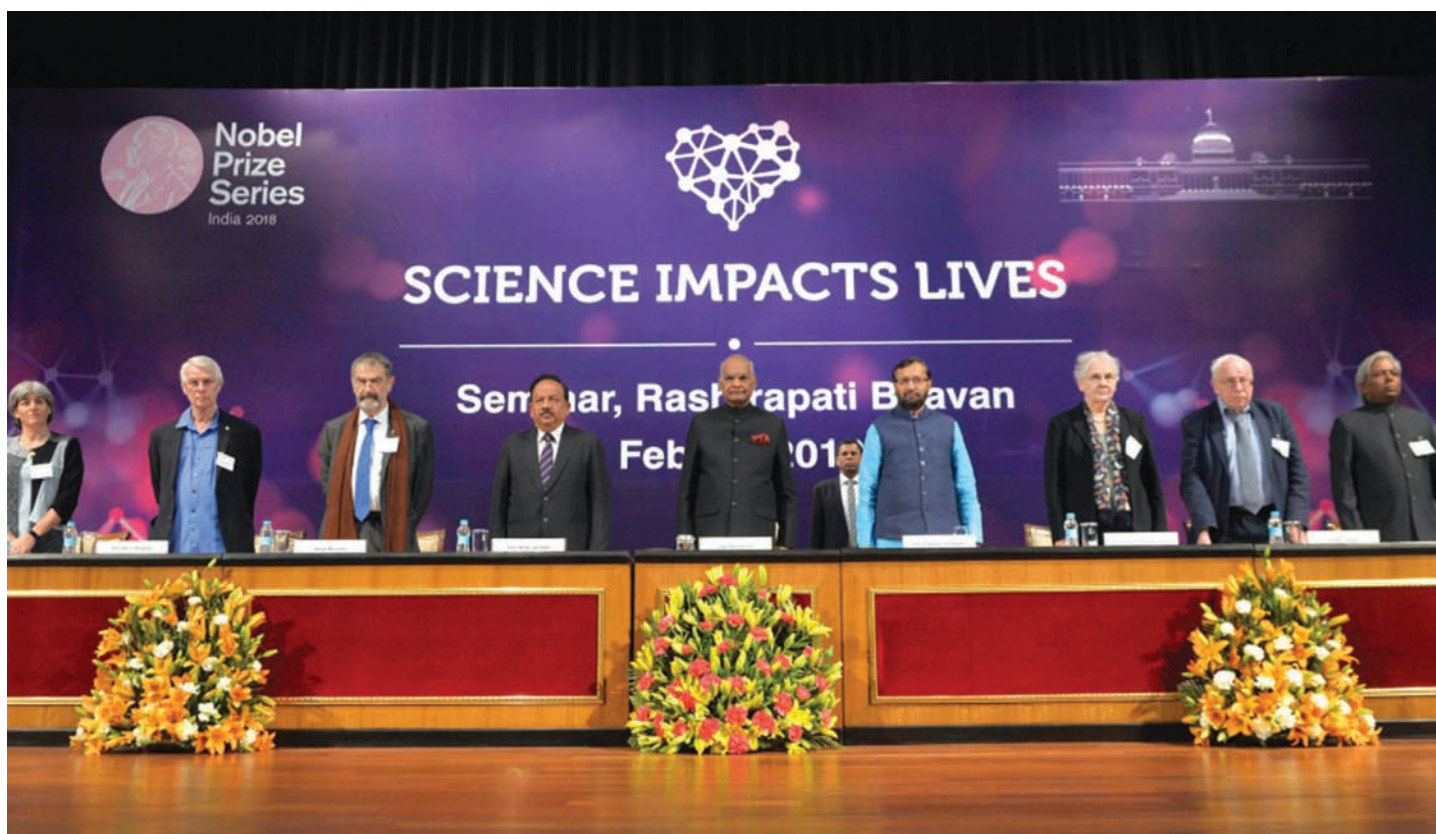
Facilities by Department of Biotechnology

- DBT launched the DBT-BUILDER (Boost to University Interdisciplinary Departments of Life Sciences for Education and Research) scheme for upgradation/reengineering/remodelling/creation of Life Science departments in central and state Universities. The scheme will boost advanced education and promotion of interdisciplinary research and technology development. Till now, 25 universities received support under this programme.
- A Beamline-14 Program Coordination Unit (DBT-BM14-PCU) at Regional Centre for Biotechnology, Faridabad has been supported by the Department for providing access to Indian scientific community to synchrotron X-ray Beam line (BM14) in Grenoble, France. An agreement has been signed between European Synchrotron Radiation Facility, Grenoble, France and Regional Centre for Biotechnology (RCB), Faridabad, India. The agreement facilitated access to six high intensity beam lines and SAXS Facility. During the year, 75 new proposals have been considered for data collection. The total number of crystals shipped is 2782 and the total number of data sets collected was 786 with deposition of 118 structures in PDB database. A total of 62 peer reviewed publications came out of this support.
- Tuberculosis Aerosol Challenge facility has been supported for maintenance at International Centre for Genetic Engineering & Biotechnology (ICGEB), New Delhi. ICGEB has also been supported for upgradation of an existing high-content screening platform as a national facility.
- A national facility for Gene Function in Health and Disease was established and operationalized at Indian Institute of Science Education and Research (IISER), Pune.



S&T Human Resource





S&T Human Resource

towards a Knowledge Super Power

HUMAN resource in Science and Technology is a major driver for India's emergence as a knowledge super power. India needs to build a critical mass of well-trained scientific and technical personnel to meet the challenges of national development and international competitiveness.

Nobel Prize Series inspires students & researchers

Two editions of the Nobel Prize Series were organised by DBT in partnership with the Nobel Foundation in Ahmedabad and Goa in 2017 and 2018 respectively. Nobel Laureates from various fields of science engaged with students, researchers, teachers and industry through a vibrant dialogue on science and innovation.

Nobel Prize Series – India 2018

Successfully completed at Goa, Mumbai and New Delhi

300+	1000+	2000+
Scientists at Rashtrapati Bhavan	Teachers at Goa	Students at Goa



The series also featured exhibitions that offered an engaging and interactive way for students to explore science. In the second edition, the department had brought together nearly 300 teachers and students from government schools across the country including Kendriya Vidyalaya (KV), Navodaya and Atal Tinkering labs. The enthusiastic participation from teachers and students representing almost all states in India revealed the eagerness for science-based learning and education in the country.

Jigyasa — Catching them Young

JIGYASA aims to inculcate the culture of inquisitiveness and scientific temper amongst the school students and their teachers. The programme aims to connect 38 laboratories with 1151 Kendriya Vidyalayas. The programme envisages to open the national scientific facilities to school children, and enable CSIR scientific knowledgebase and facilities to be utilized by school children. Nearly 24,500 students and 2000 teachers from Kendriya Vidyalayas visited CSIR Laboratories since the launch of the programme in July 2017.

The models of engagement include:

- Laboratory visit
- Select hands – on research experimentation for students and teachers
- Lectures by eminent scientists
- Visit to the state-of-art facilities
- Simple and easy scientific concepts explained with models
- Field visits
- Oral and poster presentations
- Quiz competitions
- Students as scientists programme



Signing of MoU between CSIR & KVS

Programmes implemented

- 16 CSIR laboratories participated in the Summer Camp programme implemented during June–August 2017.
- A two-day science research camp 'Jigyasa-2017' was organised during July 7-8, 2017 by CSIR-CEERI. The theme of the camp was to explore the world of electronics and allied engineering sciences to trigger and motivate young minds towards science through interaction with the scientists thereby providing an opportunity to present their ideas.
- CSIR-NPL organised Jigyasa programme on August 29, 2017. Nearly 200 students from Delhi participated in the one-day programme.
- CSIR-IITR organised "Be a Scientist" programme on Technology Day.
- CSIR-NEERI participated in the social science exhibition-cum-national integration camp organised by Kendriya Vidyalaya, Ajni. Students from seven Kendriya Vidyalayas of Vidarbha region participated.
- CSIR's Jigyasa programme will be implemented by Navodaya Vidyalaya Samiti (NVS). Based on the success of the programme, Ministry of Human Resource Development directed NVS officials to communicate with CSIR to implement Jigyasa in similar lines of KVS.
- CSIR Foundation day (September 26, 2017) was celebrated by CSIR and its laboratories by inviting students to respective laboratories. Nearly 5,000 students attended the programme from Kendriya Vidyalayas across India.



Jigyasa: CSIR Scientist's Student connect Program held at CSIR-NCL, Pune, from 30 June to 2 July 2017

CSIR's Integrated Skill Development Initiative

Following the National Skill Development Mission launched by the Hon'ble Prime Minister on July 15, 2015 on the occasion of World Youth Skills Day, CSIR launched an Integrated Skill Development Initiative on September 23, 2016 for utilization of its state-of-the-art infrastructure and human resources through specific industry oriented skill enhancement programmes.

CSIR launched 30 Skill/Training Programmes in the areas of: Leather processing; Paints and Coatings; Electroplating and Metal Finishing; Industrial Maintenance Engineering; Bioinformatics; Mechatronics; Glass Beaded Jewellery, etc. The achievements so far include:

- Skill/Training provided to more than 15000 candidates during 2016-17 and 2017-18
- Andhra Pradesh Skill Development Council, National Scheduled Castes Finance and Development Corporation (NSFDC), Punjab Skill Development Mission, Department of Industrial Policy and Promotion, NABARD have collaborated with CSIR labs for catalysing CSIR Integrated Skill Initiative.

DBT Human Resource Development: Nurturing Excellence

For a developing nation with limited financial resources, human capital is the most crucial asset. DBT has helped nourish some of the most brilliant minds who have been globally appreciated. The department is implementing an Integrated Human Resource Development Programme in multidisciplinary areas of Biotechnology, comprising of Post Graduate Teaching Programme, Star College Programme, Fellowships for different levels,

finishing school and industrial training for biotechnology students.

The Department has significantly augmented capacity for carrying out cutting-edge science and technology research in the country through fellowships and training programmes. It has attracted the best of talents in science and attracted as well as retained them in India to augment the scientific output of the country.

Skill development programme were initiated to provide high quality hands-on training (Postgraduate Diploma/Certificate) in tools and techniques in Medical Biotechnology, Agricultural Biotechnology and Computational Biology for jobs in industries, hospitals, medical colleges, Research and Development laboratories, diagnostic laboratories.

DBT's Star College Scheme Transforms Undergraduate Science Education

It is vital to attract undergraduate students to pursue higher studies in science by providing them practical exposure. In this regard, DBT is focusing on boosting its star colleges scheme which aims to improve curriculum with an emphasis on practical training to students by providing access to specialised infrastructure, and scale up the skills of teachers by organising

faculty training. Some of the highlights of the programme include:

- Support to 150 colleges
- Star status accorded to 26 colleges
- Training provided to >2600 personnel under UG, PG training courses
- Training provided to >3200 candidates in biotechnology industries under BITP

DBT Support at Different Education Levels Encouraging Biotech Education & Research

Partnerships Exposing Indians to International Biotech Facilities

- DBT-European Molecular Biology Organisation (EMBO) collaboration allows Indian scientists to submit proposals to the EMBO to hold prestigious meetings and workshops in India and compete for EMBO short-and long-term fellowships, thereby providing training and learning opportunities to students on an unprecedented scale in globally competitive high-end research.
- DBT's partnership with Heidelberg University, Germany on 'Big Data Research' is exposing Masters and Doctoral students from six Indian partner institutes, IIT Madras, IIT Kanpur, IIT Guwahati, Jawaharlal Nehru University, Allahabad University and Delhi University to short term training at Heidelberg University, Germany.

a) Fellowships for Students, Scientists & Researchers DBT – JRF

The department provides fellowships to biotechnology students to pursue doctoral research in universities/research institutions across the country. The students are selected through Biotechnology Eligibility Test (BET). Presently, around 90 students have completed the PhD program.



b) DBT-Research Associateship (DBT-RA)

The department provides fellowships for post-doctoral research in frontier areas of biotechnology and life sciences at premier institutions in India. The DBT-RA programme is being implemented by the Indian Institute of Science (IISc), Bangalore. The fellowship is initially awarded for a period of two years and the support can be extended for a period of one to two years based on review of progress. 289 students were selected for the DBT-RA for Post-Doctoral Research.

c) TATA Innovation Fellowships

DBT awards Tata Innovation Fellowship to promote innovation in science, especially in Biotechnology for path-breaking solutions to major challenges in the field. The scheme recognises and rewards scientists with excellent record in biological sciences/biotechnology and commitment to find innovative solutions in healthcare, agriculture, environment, conservation of natural resources, livestock production and manufacturing process etc.

d) National Bioscience Awards for Career Development

National Bioscience Award for Career Development (NBACD) recognises outstanding contributions of 10 young bio-scientists below the age of 45 years through a grant for research projects to facilitate their career development. It provides a monetary reward of ₹1 lakh, a citation and ₹ 3 lakhs per year as a research grant for three years.

e) National Women Bio-scientist Awards

DBT recognizes the contributions of senior and young women scientists in the country who are working in biology and biotechnology and have made exemplary contributions in research, technology and product development through two separate awards.

f) Biotech Product and Process Development and Commercialisation Awards

Every year, a maximum of five awards are presented for biotechnology products and process development and commercialisation with a monetary reward of ₹ 2 lakhs along with a citation and ₹ 5 lakhs in case of commercialised and utilized product.

g) The Innovative Young Biotechnologist Award (IYBA)

The Innovative Young Biotechnologist Award (IYBA), is a career-oriented prize to identify and nurture young scientists below 35 years with innovative ideas and desire to pursue research in biotechnology.

h) Biotechnology Entrepreneurship Student Teams (BEST)

BEST-India is a programme aimed at encouraging young postgraduates and doctoral students in developing biotechnology entrepreneurship by exposing them to issues involved in commercialisation of bio-science. It has resulted in six start-ups by the winning teams.

i) Distinguished Biotechnology Research Professorship Award Scheme

DBT, Ministry of Science and Technology initiated the scheme "Distinguished Biotechnology Research Professorship Scheme" in 2008-09 to recognise eminent scientists who have made outstanding contribution in biological sciences and have superannuated.

j) Khorana Program for Scholars

This program of scholarship is an Indo-US collaborative effort to create an effective scientific communication between the biotechnology students of India and the United States

of America (USA). The scholarship allows Indian students to undertake research internship in selected universities in USA.

k) Indo-Australian Career Boosting Gold Fellowships

The scheme is a joint initiative of DBT and the Department of Innovation, Industry, Science and Research, Government of Australia. The scheme supports collaborative research activities in cutting edge areas of science and technology. It supports training of ten Indian scientists at various institutes in Australia. Four fellows have availed the fellowship.

l) Post Graduate Teaching Programme

Postgraduate teaching programmes were initiated in multidisciplinary areas of biotechnology during 1985-86 in six universities to ensure quality teaching and to fulfil the requirement of trained personnel in the country. Since then, Post Graduate teaching programmes have been expanded to over 65 universities. Students passing out of DBT-supported teaching programmes have consistently performed well at national level competitive exams conducted by CSIR, UGC, DBT, and ICMR for doctoral fellowships.

m) DBT-British Council Ph.D. Placement Programme

The programme allows Indian students to access the best resources from UK and promotes Indo-UK research collaboration. 65 PhD students from India and 17 PhD students from UK have been awarded under this prestigious programme.

n) Women Agriculture Scientists Leadership Programme

- 23 female leaders in Crop and Agricultural Sciences from different parts of India attended the five-day workshop at University of Cambridge.
- The Female Leader in Science Course was organised by University of Cambridge and DBT under Newton-Bhabha fund.

- On-site visits to Farm Innovation Park at National Institute of Agriculture Botany (NIAB) and Botanical Garden and John Innes Centre, Norwich.

Biotechnology Career Advancement and Re-Orientation Programme (Bio-CARe)

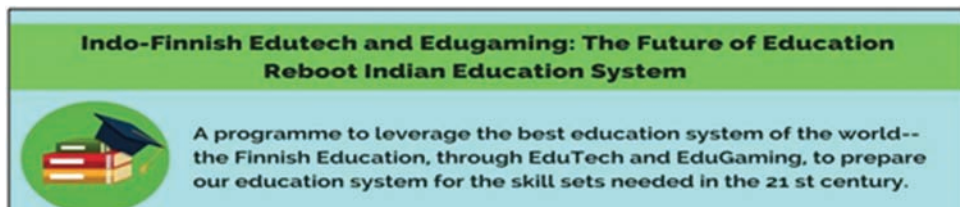
In an attempt to enhance the participation of women scientists in Biotechnology Research, DBT launched a Biotechnology Career Advancement and Re-orientation Programme (Bio-CARe) for women scientists. The programme is mainly for career development of employed/unemployed women scientists upto the age of 55 years for whom it is the first extramural research grant. The scheme is open for all areas of Life Science/Biology (including Agriculture, Veterinary Science and Medicine). The department has so far supported more than 250 young women scientists under this scheme.

Indian Biological Engineering Competition (iBEC) PRE-iGEM

The Indian Biological Engineering Competition (iBEC) was launched in 2016 to select and support best Indian student - teams to participate in the international contest iGEM (International Genetic Engineered Machine), held every year in Boston, USA. 12 teams have been selected to participate in iGEM thus far of which 10 have secured gold/silver/bronze medals.

Foldscope Access — Democratization of Science

DBT and Prakash Lab at Stanford University, USA signed an agreement in September 2015 to bring the Foldscope developed by Dr. Manu Prakash from Stanford University to India to encourage curiosity in science. Following an understanding



between DBT and Prakash Lab, Foldscopes have been distributed to several schools and college students and a series of workshops were held across India to popularise the origami paper microscope.

The team reached out to school students, teachers, scientists and citizen-scientists across India to encourage use of origami paper Foldscope to popularise curiosity based science. Low cost origami microscope was developed making the instrument accessible to colleges in remote places in India.

- 328 government colleges, 117 government schools including those in low resource areas and in the North - East were benefitted
- 445 teachers across India received training on Foldscopes in a workshop organized in Delhi
- More than 10-fold scope work shops were held across the country
- The long-term strategic objective of this project is to integrate the Finnish educational excellence and the expansive education system with Indian system of education to "Reboot education for Indian schools"
- The programme will be carried on a pilot scale and will be based on a co-creation model to reboot higher education in life sciences and conduct a pilot study for EduGaming



and EduTech for life sciences. The pilot study on life science EduGaming can be a model for future education in India.

Smart India Hackathon

Department of Biotechnology organised Smart India Hackathon 2017 Grand Finale on April 1 & 2, 2017 simultaneously at 26 different nodal centers across India. The department was a 'Premier Partner' in this initiative. Smart India Hackathon 2017 harnessed creativity & expertise of students, built funnel for 'Startup India, Standup India' campaign, crowd sourced solutions for improving governance and quality of life, and provided opportunity to citizens to provide innovative solutions to India's daunting problems.

- DBT, along with 28 other departments, participated in the 'Smart India Hackathon 2017'. About 17 problems were proposed for students to provide digital solutions
- Student teams provided web-based and mobile-based apps for manpower management, detecting impersonation in exams linked to Aadhar cards, keyword-based search to avoid duplication of projects in different funding agencies, segregation of lectures by Nobel Laureates, Padma awardees, TED talks, Biotechnology history, Marine resources and utilization, etc.



- The software prototype developed by student-teams in the hackathon were evaluated by judges from the respective ministry, industry and academic experts. The best solutions were awarded ₹ 1 lakh, ₹ 75,000 and ₹ 50,000 for the top three teams respectively. DBT selected two prototypes created by student teams in digital competition for further support.

Smart India Hackathon 2018

CSIR participated in Smart India Hackathon-2018-Software Edition and successfully organised 36-hour Grand Finale at CSIR-NCL, Pune. CSIR was a 'Premier Partner' in this initiative. The Smart India Hackathon is a non-stop digital product development competition conceptualised and organised by Government of India, where the identified problems (software and hardware challenges) are posed to engineering/technology students for developing innovative solutions.

In the grand finale organised by CSIR on March 30 and 31, 2018, 53 teams consisting of six team members and one-two mentors in each team participated to provide solutions to 10 problem statements posed by the CSIR scientists. Finally, 318 students and 75 mentors from various engineering colleges

across the country gathered to showcase their talent, while working on the problem statements.

The solutions by all the teams were rigorously reviewed by the panel of judges. After rigorous interactions with all the shortlisted teams, finally three teams received awards of Rs. one lakh), ₹ 75,000 and 2nd Runner — ₹ 50,000 respectively. Additionally, three more teams were selected for the "Persistent Inspiration Award", "KPIT Award" and "Deloitte Innovation Award".

Biotech Industrial Training Programme (BITP)

On behalf of DBT, Ministry of Science and Technology, Government of India, Biotech Consortium India Limited (BCIL) is implementing this scheme since 1993-94. The objective of this programme is to provide industry-specific training to biotechnology students for skill development and enhance their job opportunities in the biotechnology industry. This programme provides an opportunity to the biotechnology industry for training and selecting suitable personnel. The programme is announced annually and more than 5000 students have been trained under the scheme.



CSIR was a 'Premier Partner' in the Smart India Hackathon initiative. It is a non-stop digital product development competition conceptualized and organised by Government of India, where the identified problems (software and hardware challenges) are posed to engineering/technology students for developing innovative solutions.

DST Initiatives on Human Resource development

- 2686 Research Manpower Trained (other than PhDs) by DST Autonomous Institutions
- 76 PhD awarded in DST Autonomous Institutions
- 9863 Technical Manpower Trained by DST Autonomous Institutions -
- 1,50,000 students of intermediate level were provided internship in 708 Inspire Science Camps.
- 49,293 INSPIRE scholarships offered for pursuing education in various Under-graduate /Post-graduate science courses
- 4000 INSPIRE Fellowships offered for doctoral degree
- 715 young researchers provided with INSPIRE faculty positions

International Training Centre for Operational Oceanography (ITCOcean)

ITCOcean is aimed at promoting the development and optimization of scientific base, technology and information system for operational oceanography at national, regional and global scales. The facility helps in promoting excellence in integrated multidisciplinary oceanography on a global scale. It is also expected that the legacy of the training programme will endure in to the future as it will help build a future ocean system which directly serves the needs of mankind through improved marine monitoring and enhanced stewardship of the seas.

ITCOcean established under the Indian National Centre for Ocean Information Services (INCOIS), MoES has been conducting courses since 2013. 27 courses were conducted involving students, researchers, administrators, policy makers and persons involved in operational centres thus far. In total 793 students including 116 students from 36 different countries

were trained as part of the ITCOO activities. These countries include Australia, Belgium, Kenya, Nigeria, Togo, South Africa, Italy, Comoros, Madagascar, Mauritius, Bangladesh, Sri Lanka, Oman, Ghana, Tanzania, Malaysia, Romania, South Korea, Indonesia, Iran, Maldives, Morocco, Mozambique, Egypt, Saudi Arabia, Cambodia, Myanmar, Vietnam, Cameroon, Norway, France, Russia, China, Seychelles and Thailand.

The courses span from a couple of days to two weeks depending on the target audience. The courses include Ocean Data Management, Satellite Oceanography, Ocean Modeling, Fishing Zones, Ocean State Forecasting, Tsunami and Storm Surge, Remote Sensing and GIS, Ocean Colour Remote Sensing, Ocean Observation Network, Disaster Management, and Statistics for Earth Sciences.

This centre was recently conferred category two center (C2C) by UNESCO and this was approved by Government of India. The centre is now preparing for short-term courses (spanning for four months) starting this year which leads to a certification course to students in operational oceanography.

Human Resource Development & Capacity Building at MoES

Considering the need to continuously upgrade knowledge through assimilation of new ideas and application of new knowledge in the field of Earth Sciences and to address the issue of depleting scientific manpower in the field of Earth Sciences, the Ministry has taken several steps for human resource development which include funding of M.Tech, M.Sc and PhD programmes at premiere institutions in the country, establishment of MoES Chairs at IIT's and IISER, opening of Centers of Excellence at various universities with state of the art research facilities. The human resource development programmes supported by MoES include:

- Two-year M.Sc. course in Ocean & Atmospheric Sciences in University of Hyderabad.

CSIR scheme for Promoting Knowledge Sharing through Travel and Symposia Grants Scheme

Sharing of the scientific results and interacting with leading scientists in the subject at national and international conference is an important activity in the professional growth and development of a scientist/researcher. Organising symposia and attending them allows the promotion of scientific culture and growth in the country which is considered essential. Travel and Symposia Grants awarded/sanctioned during last 4 years (2014-15 to 2017-18) include:

- Travel Grants recommended to attend international conferences abroad: **1759**
- Symposium Grants recommended to organize national/international conferences: **1104**

- M.Tech/PhD program on Atmospheric-Oceanic Sciences and Technology at CAS, IIT Delhi
- M.Tech programme in Ocean Technology at IIT Madras
- MoU on co-operation in Polar Research between NCAOR and NPI which paved the way for Norway to support Indian scientists, in the form of fellowship for carrying out research in the Arctic region. The award of the proposed fellowship to an Indian student in NPI, Norway is aimed at capacity building in the field of Cryosphere

CSIR Doctoral and Postdoctoral Fellowship Scheme

CSIR doctoral Fellowships (JRF-NET/SRF-NET, JRF-GATE/SRF-GATE, SPMFS, SRF-Direct) are very popular amongst young and upcoming scientists as they provide a platform to carry

Promotion and Recognition of Excellence through CSIR Awards

The awards of CSIR have national recognition. The scientists are selected from different age groups thereby benefiting their career at each stage from the beginning to mid-career to life time achievements. These awards have served the purpose of motivating the scientist and encouraging them to contribute more. Several awardees have provided scientific leadership to the country. Awards during last 4 years (2014-15 to 2017-18) include:

- CSIR-Young Scientist Awards: **24**
- Shanti Swarup Bhatnagar Prize for Science and Technology: **42**

out research and development at university/ national lab of their choice. The postdoctoral fellowship schemes of RA, SRA and N-PDF groom the fresh doctorates to become mature scientists/independent researchers in the national laboratories and academic institutes. CSIR through its HR initiative has been contributing significantly to the generation of highly qualified science and technology manpower at the national level. Both these doctoral and postdoctoral programmes have generated high quality manpower for the scientific, technological and academic institutions for nation building. The fellowships/ schemes awarded/sanctioned during last 4 years (2014-15 to 2017-18) include:

- CSIR Junior Research Fellowship (JRF)
National Eligibility Test (NET): 10687
- Senior Research Fellowship (SRF)-Direct: 1792
- Shyama Prasad Mukherjee Fellowship (SPMF): 158
- CSIR JRF-GATE (for Engineering & Pharmaceutical Sciences): 116

- CSIR Research Associateships (RA) to pursue postdoctoral research: 525
- CSIR Senior Research Associateships (SRA): 324
- CSIR Nehru Science Postdoctoral Research Fellowship Scheme: 41

CSIR Extramural Research Scheme and Emeritus Scientist Scheme

Under the Extramural Research Scheme, research proposals from the universities and research and development institutions are funded in frontier areas of science and technology which are also in line with the research programme of CSIR laboratories. The extramural research schemes are fruitful in building the research and development capabilities which in turn have benefited the country in its scientific endeavours.

CSIR Emeritus Scientist scheme provides financial assistance to superannuated outstanding scientists from laboratories/academic institutions to pursue research in their respective fields of specialisations especially in those which are of relevance to the programmes and activities of CSIR. The experience of these scientists has proven a great help to the laboratories/academic institutions in carrying out some of the ongoing projects and mentoring the younger ones. Extramural Research Grants awarded/sanctioned during last 4 years (2014-15 to 2017-18) include:

- Research Schemes: 798
- Emeritus Schemes: 99

DBT & EMBO Fellowships

The Department of Biotechnology and EMBO and its intergovernmental funding body EMBC, have signed a Co-operation Agreement to strengthen scientific interaction and collaborative research between India and Europe. As an EMBC Associate Member state, researchers working in India

are now eligible to participate in all EMBO programmes and activities. In the year 2016, scientists have been selected under the EMBO Young Investigators scheme, 1 has been awarded EMBO Long-Term Fellowships, and 24 have been awarded the EMBO Short-Term Fellowships and 1 EMBO Young Investigator Lecture was organised. Recently, EMBO has established a new co-operation with the Wellcome Trust/DBT India Alliance under which 3 new interdisciplinary meetings in India per year will be organised.

Human Frontier Science Programme Organisation (HFSP)

India is one of the member states of HFSP. The overall objectives of the programme are to support innovative, cutting edge high risk research at the frontiers of life sciences and promoting international collaboration in the spirit of science without borders. HFSP supports investigators under four categories – Programme Grant, Long Term Fellowship, Cross Disciplinary Fellowship, and Career Development Awards.

Department of Science & Technology

Department of Science and Technology is the largest extramural R&D support agency in the country. Annually more than 10,000 scientists are supported for carrying out various R&D related activities and projects. Some of major new initiatives launched during the last four years are as following:

- Early Career Research Award – The scheme launched in 2015-16 to provide quick research support to the researchers who are in their early career for pursuing exciting and innovative research in frontier areas of science and engineering. The scheme aims to minimise the time required for the young scientist to initiate their research. 1315 young researchers already awarded.

- National Postdoctoral Fellowship (N-PDF) Scheme – In order to attract and retain young scientists and discourage brain drain immediately after Ph.D. in academic/R&D institutions, a National Postdoctoral Fellowship (N-PDF) scheme was launched in 2015 -16. 600 -700 young scientists are supported every year.
- Overseas Visiting Doctoral Fellowship – The fellowship scheme was formulated in 2015 -16 to facilitate overseas collaborative research training for Indian Ph.D. Scholars registered in Indian institutions. 350 Fellowships will be awarded for the period 2016 -19.
- SERB Distinguished Investigator Award (SERB-DIA) – This is a one-time career award to reward good performance as well as to motivate ongoing PIs to perform exceedingly well. 35 awards to be given every year.
- Visiting Advanced Joint Research (VAJRA) Faculty Scheme – The scheme will bring the best global science and scientists to India. It is also expected to enhance global ranking of our institutions. The area of research to be undertaken by the Adjunct/Visiting Faculty should be of cutting-edge and interest to India. 43 VAJRA faculty already selected.
- Teacher Associates for Research Excellence (TARE) Mobility Scheme – This scheme, launched in 2017, aims to facilitate mobility of faculty members working in a regular capacity in state universities/colleges and in private academic institutions to carry out research work in established public funded institutions such as IITs, IISc, IISERs, NITs, CSIR, ICAR, ICMR labs and other central institutions and central universities, located preferably closer to the institution where the faculty member is working. Provision of Fellowship amount of ₹ 5,000 p.m., contingency grant of ₹ 5 lakh per annum and overhead for a period of 3 years has been made. Maximum of 500 such awards would be granted per year.
- KIRAN (Knowledge Involvement in Research Advancement through Nurturing) launched in 2014. KIRAN includes women-exclusive schemes for encouraging women to

foster their career by undertaking research not only in science & engineering but also for societal benefit besides making a career through entrepreneurship and training in intellectual property management. Under the Women Scientist Scheme under KIRAN, around 1550 women scientists have been supported in the last four years.

- Augmenting Writing Skills for Articulating Research (AWSAR) schemes has been launched. 120 Doctoral/Post Doctoral scientists will be awarded for best Science popularisation articles annually under this scheme.

R&D Support by Science & Engg. Research Board (SERB)

Sl.No	Schemes	2014-18
1	Core Research Grant (R&D Projects)	2704
2	FAST Track Young Scientist Projects	2170
3	Early Career Research Awards (ECRA)	1153
4	National Post Doctoral Fellowship (NPDF)	2008
5	Ramanujan Fellowship	146
6	J C Bose Fellowship	115
7	Distinguished Fellowship	7
8	Overseas Postdoctoral Fellowship/Overseas Fellowship/Doctoral Fellowship	99
9	Year of Science Chair Pro-fessorship	4
10	ITS (International Travel Support)	5691
11	Seminar & Symposia	2613
12	WEA (Women Excellence Award)	21
13	Cell Tower Radiation	19
14	Scientists (SC)	427
15	Scientists (ST)	110





Rural and Inclusive Technology



Rural and Inclusive Technology

DURING 2014 -18, about 240 projects were supported by the Department of Science & Technology under Long-Term Core Support for Technological Advancement for Rural Areas (TARA); Scheme for Young Scientist & Technologists (SYST); and Technology Interventions for Addressing Societal

Needs (TIASN) which encompasses Technology Interventions for Disabled and Elderly (TIDE), programmes for Cold Desert Region (CODER) and Arid & Semi-Arid Region (ASAR) besides Sustainable Agriculture Rural Transformation Holistic Initiative (SARTHI) and Technology Intervention for Mountain Eco-system (TIME).

TARA: Innovating for Rural Livelihoods & Social Enterprises

SEED Division of DST has taken initiative under the Technology Advancement for Rural Area (TARA) scheme to provide location specific technological solutions on specific challenges in rural areas. These innovative technologies are developed & scaled up by Core Support Groups involving local community. (www.dsttara.in)



Line Sowing Marker for Crop Sowing in Hills
-Himalayan Environmental Studies and Conservation Organisation, Dehradun



Compact Biogas System
-Appropriate Rural Technology Institute, Pune



Multi Fibre Extraction Machine
-Centre for Technology & Development, Delhi



Technology for Testing Soil & Leaves
-Shri AMM Murugappa Chettiar Research Centre, Taramani Chennai



Design and Development of Dehusking Machine for Minor Millets
-Madhya Pradesh Vigyan Sabha, Bhopal



Egg Incubator for Marginal Farmer
-Vigyan Ashram, Pabal, Pune



Induced Breeding for Production of Fish Spawn
-Vivekananda Institute of Biotechnology, Nimpith, WB



Motorized Winch for Chinese Fishing Net
-Mitraniketan, Thiruvananthapuram



Solar Dehydration Technology
-Society for Energy Environment and Development, Hyderabad



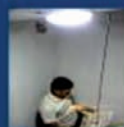
Cardamom Washing Machine
-Peermade Development Society, Idukki, Kerala



Solar Tunnel Dryer
-Sardar Patel Renewable Energy Research Institute, Vallabh Vidyanagar, Gujarat



Solar Water Heater for Mountain Area
-Himalayan Research Group, Shimla



Micro Solar Dome
-NB Institute for Rural Technology, Tripura



Fuel Efficient Wood Burning Stoves
-Technology Informatics Design Endeavour, Bangalore



Waste to Weave Technologies
-Development Alternatives, New Delhi



Pt. Deen Dayal Vigyan Gram Sankalp Pariyojana (PDDUVGSP), is a novel initiative for holistic & sustainable development. In four districts of Uttarakhand, S&T interventions targeting natural resources, skills, traditional crafts, etc. to enhance quality-of-life of people in clusters of adjacent villages were provided. Hon'ble Minister of S&T and ES along with Hon'ble Chief Minister of Uttarakhand launched the initiative from Dehradun in December 2017. The areas of interventions would be processing and value addition of milk, honey, mushroom, herbal tea, forest produce, native crops, medicinal & aromatic plants and strengthening traditional crafts, handloom, etc. Post-harvest processing of kiwi, strawberry, cherry, tulsi, ginger (adrak), black cardamom (badi elaichi) through solar drying technology, extraction of apricot oil using cold press technology would also be undertaken for enhancing their shelf life and for gainful benefits for the Farmer Producer Groups/Self Help Groups (SHGs).

Launch of Pt. Deendayal Upadhyayal Vigyan Gram Sankalp Pariyojna

Technology Advancement for Rural Areas (TARA)

25 S&T driven organisations are supported under TARA, which focuses on technology development/adaptation and delivery on specific challenges in the identified region. A compendium of technologies was brought out in 2017, which gives an overview of over 100 S&T interventions developed so far. Community was trained & empowered in use of such S&T packages. Also, after a gap of a decade, five new S&T driven organisations are being inducted under TARA to expand its presence in hitherto unexplored areas. Several novel and adaptive technologies were developed and deployed.

Technology Interventions for Addressing Societal Needs (TIASN)

37 projects were supported during the last four years through location-specific methodology in CODER & ASAR and Shivalik foothills under SARTHI. A few shining examples are:

- Prototype for manual load carrier-head harness developed and field trials conducted for farmers and labourers to reduce the stress induced on the spinal cord due to lifting of heavy weights
- Technological intervention and communication package developed for management and care of juvenile diabetes
- Green & Blue water harvesting techniques demonstrated in tribal districts of Panchmahal and Dahod in Gujarat
- Thornless seabuckthorn varieties introduced in Lahaul, Himachal Pradesh to reduce drudgery of farmers

Sustainable Agriculture Rural Transformation Holistic Initiative (SARTHI)

Rose sherbet: Women Self Half Group Sandhya is preparing rose sherbet using fresh rose petals of desi rose in clean, hygienic and scientific manner in Mali village of Kandi region, facilitated by Punjab Agriculture University, Ludhiana. The organic cultivation of rose and its processing was promoted as it clears toxins, prevents loss of heat, gives cooling effect and is a source of instant energy. Sandhya sold 7000 bottles of Rose sherbet in 2017-18, a 25 times enhancement since 2014. Sales of other products (Gulkand, mix vegetable pickle, black carrot kanji, tomato sauce, ketchup) by the SHG too enhanced by 10 times. Four more SHGs were registered in the area for promoting similar activities and livelihood creation.

Drying-cum-storage technology: An improvised drying-cum-storage technology for large cardamom has been successfully introduced and demonstrated in Ziro, Arunachal Pradesh. Flue pipe system dryer provides good colour to the capsules and perfect drying in short span of time. Cardamom farmers of Ziro are getting better economic returns as compared to traditional system.

Empowering SC and ST

Sizable part of allocations made under Scheduled Caste Sub Plan (SCSP) and Tribal Sub Plan (TSP) are used for societal programmes. Under both these sub plans, 85 projects were implemented in different parts of the country focusing on appropriate and cost-effective technology modulation and transfer, based on location-specific needs/conditions, leading to technological empowerment in related occupations of SC and ST sections of society. Due emphasis has been laid on creating sustainable livelihoods through use of locally-available resources & materials.



Bamboo Sheath Cup Making (Top) and Extraction of Palmyra Fiber



*Handicrafts making near
Thembangbapu Community
Conserved Area, Arunachal
Pradesh by TBCCA*



*Herbal tea production
near Khokhan Wildlife
Sanctuary, Himachal
Pradesh by Jagriti*



*Value addition using
bees-wax around
Parambikulam Tiger
Reserve, Kerala by RRC*

Enhancing Quality of Life of PA Communities

The Network Programme “People and Protected Areas (PPA) Conservation and Sustainable Livelihoods in Partnership with Local Communities” is a multi-locational network programme implemented as joint initiative of SEED, DST and WWF-India. It aims to coordinate and support the efforts of local and grassroots NGOs to enhance quality-of-life of communities living in and around PAs. Under the second phase (2014-2017), 15 NGOs were involved to work around 16 PAs. The programme has covered over 4000 households of 20 tribal groups including PTGs in 75 villages with technical back-stopping from nearby S&T institutions and Core Support Groups (CSGs) of SEED. For example, in Parambikulam project area, about 45% increase in income level was reported through organised production and sale of value-added products (jack fruits, honey, manjakoova, NTFPs) by women’s groups.

In Parambikulam project area, about 45% increase in income level was reported through organised production and sale of value-added products (jack fruits, honey, manjakoova, NTFPs) by women’s groups.

Enhancing Livelihoods

A Network programme for North-Western Himalaya “**Technology Interventions for Mountain Ecosystem-Livelihood Enhancement through Action research & Networking (TIME-LEARN)**” was initiated in 2017. Under this programme, 19 action research projects are being supported for S&T interventions to address local issues by engaging communities in horticulture, livestock management, post-harvest technology, utilisation of local bio-resources to develop bio-pesticides, addressing human-wildlife conflict, food and nutrition, conventional ropeway, and construction technologies for multi-hazard resistant housing in mountain areas. Some novel and adaptive technologies developed and deployed are:

- Community-owned & community-operated affordable, safe water solution powered by solar energy in Bundelkhand
- Incinerator system for disposal of waste materials
- Utilising solar energy to heat water & space in high altitude dwellings to reduce dependence on fossil fuels
- Utilising solar energy to produce value-added bars/rolls from Himalayan fruits
- Vegetable powders
- Under-utilised non-timber forest produce.

Tribal Resource Centre



A **Tribal Resource Centre (TRC)** has been established for transfer of resource based rural technologies and knowledge at Rikhad Village, Chakrata, District Dehradun. This Centre will also help the villager's immediate surroundings of six villages for technological intervention in their daily needs. The whole village has been served with toilets, bathrooms, dustbins, soak pits and improved drainage bringing complete sanitation in the village. Processing and production facility centre has been developed with community participation for utilising local agri-horti produce.



CSIR has in place an ambitious, socially relevant programme named CSIR 800. This programme aims at developing and providing innovative R&D based products and processes which would be affordable by the common masses.

CSIR 800 – S&T Interventions for People at the Base of the Economic Pyramid

CSIR has in place an ambitious, socially relevant programme named CSIR 800. This programme aims at developing and providing innovative R&D based products and processes which would be affordable by the common masses. These have not only removed drudgery but also brought about economic upliftment of the Indian rural populace by successfully launching small scale enterprises.

Apple cultivation in new areas

Proof of concept has been established for the apple trees to flower and bear fruit in the Eastern Ghats region. About 3000 apple grafts of promising varieties of low chilled apple were distributed in the hilly tracks of Eastern Ghats. About 150 apple grafts were planted at Regional Agricultural Research Station (ANG Ranga Agriculture University in Andhra Pradesh). CSIR-CCMB also reduced the flowering/fruiting time of apple using the bahar treatment practice. The ripe fruit has long shelf life

and is at par with other varieties in terms of flavour and taste. Apple cultivation by tribals in Andhra Pradesh, Odisha and Telangana will lead to increased incomes (through sale of the fruit) and enhanced nutritional status (through consumption of fruit).

Water for Rural Areas

- CSIR-IICT successfully commissioned and demonstrated 12 defluoridation plants of capacity 50-150 L/h capacity in schools and village hamlets in fluoride affected villages in Nalgonda District, besides model units at CSIR-IICT hostels, Zaheer School and guest houses. So far three lakh liters of free drinking water have been served to the community, which corresponds to a population of six lakh people.
- CSIR-CMERI installed about 100 units of water filters for removing arsenic from ground water and gainful disposal of arsenic waste benefitting about 500 people with a yearly benefit of 16.06 lakhs. 100 de-fluoridation units were also deployed by CSIR-CMERI for 500 beneficiaries.
- A new cost-effective material has been developed by CSIR-CGCRI for bisphenol detection in water. Commissioned a plant at Ramchandrapur, Maldia district to produce water of 8m³/hour. Installed about 50 improved Iron Removal Plants (IIRP) in and around Bankura district, West Bengal, approximately 3000 families benefitted.
- CSIR-IICT designed, installed and commissioned a 1000 L/h capacity RO based mineral water plant in Vattipally village located in Marriguda Mandal, Nalgonda, the worst fluoride affected region with a high fluoride content of 5.5 ppm which is reduced to < 0.5 ppm and TDS from initial 1130 ppm to final 65 ppm.
- CSIR-NCL developed Ultrafiltration-membrane based water purification units for Indian rural/tribal community. 50 such community units of 500 liter per hour water filtration units deployed in various areas of Maharashtra including tribal belt of Palghar district and in public places and government run schools in Pune.

Succor to distressed banana farmers

CSIR-CFTRI's model called FRIG (Farmers, R&D, Industry and Govt.) helps distressed banana farmers by creating a robust food value chain, which would be beneficial to the banana processing industry. The move was driven by the need to mitigate hardships of farmers in Karnataka, who were forced to sell plantains for a meagre ₹ 2 per kg in December 2015. The institute has a range of technologies for making banana-based products which include banana nectar, ready-to-serve (RTS) beverages, banana bar and so on. For demonstration of the model, around 2 tonne of fresh banana was procured from farmers of Chamarajanagar district and processed at the institute's pilot plant, packed and stored in cold storage. Buyers were brought into the loop for purchase of banana pulp. Samples were sent to pulp exporters for evaluation of products. Farmer groups, buyers and export houses along with officials from women & child development department were involved in formulating a sustainable framework. Women & child development department agreed to buy banana bars for distribution as a food supplement to Anganwadi children – 25 g/day of the bar can provide approximately 90 kcal energy along with other micronutrients for a price of ₹4.

Cultivation of Medicinal and Aromatic Plants (MAPs)

- CSIR-CIMAP organised about 60 Farmers' training-cum-demonstration/awareness programmes on cultivation and processing of medicinal and aromatic plants (MAPs) and trained about 9,500 farmers. Organised 14 entrepreneurial training programmes for women for making incense sticks using floral bio-resource and trained 515 women. It also organised Kisan Mela (Farmers' Fair) in Lucknow which was attended by about 12,000 farmers. Further 21800 farmers visited CSIR-CIMAP for gaining knowledge on cultivation and processing of MAPs.

- CSIR-CIMAP's efforts brought 3500 acre additional area under cultivation of MAPs (Menthol mint, Vetiver, Palmarosa, Lemongrass, Kalmegh and Satavar). Farmers earned in the range of ₹ 25,000- ₹ 75,000/- per ha per year through cultivation of MAPs. Employment opportunities to the tune of more than 2,75,000 man days generated. 5 distillation units were also set up at farmers' fields. And 35 demonstration of Early Mint Technology (EMT) were organised on the farmers' fields benefitting 1565 farmers. Extension Literature/Publicity folders/Brochures have been published in English and Hindi language and distributed to farmers.
- Demonstration of lemongrass, vetiver, palmarosa, menthol mint and ashwagandha were made on farmer's field covering an area of 1140 acres in different parts of the country including Bundelkhand, Vidarbha and Kutch region. From these demonstrations crop produce worth ₹ 482.50 lakhs (essential and ashwagandha roots) was obtained. A total employment of 1.53 lakh mandays was created from the cultivation of these plants.

Processing of Agri Produce in Mizoram: CSIR-CMERI conducted training cum skill development programmes on processing and preservation of local agri-produce in association with the Women Technology Park (WTP) at Tuirial, Mizoram and worked for the creation of 2 Self Help Groups comprising 20 women each for providing sustainable income throughout the year. A production facility for value-added products from Assam Lemon (*Citrus longilimon*) was also established. Efforts are on for creation of 10 more Self Help Groups comprising 20 women each for providing them sustainable income throughout the year.

Terracotta Products: CSIR-CGCRI trained 27 artisans from Duttapukur (24 Parganas, West Bengal) on Terracotta processing with emphasis on slip casting technique.

Improving the quality and yield of solar salt: Scientific intervention for small scale salt manufacturers of Didwana/ Nawa, Sambhar Lake Area improved the salt quality helping small scale salt producers earn additional revenue in the range ₹ 0.50 to 1.0 lakh based on 10 acre area of salt production. Small scale manufacturers have been educated in value addition in solar salts. Manufacturers have been educated to recover potassium and magnesium salts from the bittern. Total estimated salt production with improved technologies is in the range of 25,000 MT per annum, creating additional profit of ₹ 100 PMT of salt, with total monetary benefit amounting to ₹ 25 lakhs per annum.

Bamboo cultivation: CSIR-IHBT has been promoting cultivation and utilisation of bamboo in rural areas. During the past year the Institute supplied 17,015 saplings of different bamboo species to Himachal Pradesh, Punjab and Jammu & Kashmir. Around 600 plants of *Bambusa bambos* and 400 plants of *Phyllostachys pubescens* were planted through the active participation of the AcSIR students and the Panchayat Pradhan at Rakh village, situated at a very high altitude. The villagers were trained in different aspects of bamboo cultivation and plantation management.

Improved Biomass Chullha: The average thermal efficiency of CSIR-IIP improved biomass Chullha is ~26% which is nearly 10% more than the conventional biomass stoves available in rural areas. Improved Chullha without chimney also lowers indoor air pollution level (Particulate matters) by 10.5%. Of simple design and low cost, material required for its construction is readily available in the rural market – overall cost of this chullha is ₹ 250-300 which is affordable for poor sections of our society.

100 improved cook stove prototypes of "NEERDHUR" were distributed to 70 households. MNRE approved NEERDHUR based on performance testing conducted by Improved Cook-

Steps like rural bio-resource complexes, skill and entrepreneurship development of rural communities led to empowerment and improvement of socio-economic condition of villagers.

stove Test Centers to meet the newly developed cook-stove emission standards by Bureau of Indian Standards (BIS 2013). NEERDHUR shows a thermal efficiency of 33.33% with emission levels as CO: 3.78 g/MJd, TPM: 340.10 mg/MJd at a power output of 1.70 KW.

Fourpan jaggery making plant: An improved four pan jaggery making plant has been installed at village Sunderpur, Distt. Saharanpur U.P. 23% extra jaggery can be prepared in the improved plant with 12% saving of fuel. The improved design has also resulted in better combustion of bagasse in the furnace as the CO₂% and Smoke number is comparatively better than that of conventional plants. Nearly 37 improved jaggery units have been installed in rural areas of U.P. and Uttarakhand which are running successfully while providing employment to hundreds of locals and additional income in lakhs of rupees annually.

DBT Societal Development

The Societal programme of the Department has effectively used biotechnological processes and tools for the benefit of the disadvantaged sections of the society comprising women, rural population, SC/ST and weaker section over the last four years. Steps like rural bio-resource complexes, skill and entrepreneurship development of rural communities led to empowerment and improvement of socio-economic condition of villagers. The programme seeks to create a platform for self-employment generation among the target populations and diffusion of proven and field-tested technologies through demonstration, training and extension activities.

DBT Boosting Rural Livelihood Generation and Skill Development

1240 rural women and men benefitted from dissemination of technology development of bio-agent and mycorrhiza colonised seedlings of horticultural crops by rural women, 550 benefitted from distribution of tissue culture raised plantlets along with bio-fertiliser kits and protocol details on plant production and protection techniques & 269 farmers have been benefitted through cultivation of extinct banana

The Societal Development programme seeks to create a platform for self-employment generation among the target populations and diffusion of proven and field-tested technologies through demonstration, training and extension activities.

Rural Bio-resource Complexes Empowering Villagers

- Five bio-resource complexes consisting of clusters of 3-5 villages have been established in State Agriculture Universities at Bangalore, Bhubaneshwar, Hissar, Pant Nagar and Parbhani.
- Women and rural SC/ST population were economically and technologically empowered through selected biotech packages like cultivation of aromatic and medicinal plants, mushrooms, Spirulina and seaweeds, biological control of plant pests and diseases, vermicomposting, bio-fertilisers, aquaculture, floriculture, poultry farming and animal husbandry.



Health in Rural India

Awareness created about preventable causes of mental retardation, namely, congenital hypothyroidism, biotinidase deficiency and galactosemia and to establish the newborn screening program as a multi-institutional project by SGPGI, Lucknow, eleven thousand three hundred and fifty samples from newborns have been collected and all samples were tested for 3 disorders. Ten babies were diagnosed to have congenital hypothyroidism.

Rural Bio-Resources Management Uplifting Socio-economic Status of Villagers

Farmers, predominantly females and entrepreneurs, were provided hands-on training and demonstration at 3 Common Facility Centres (CFCs) established at Gayatri Suman Farm (Bulandshahr), Krishi Vigyan Kenda, Muradnagar (Ghaziabad) and Krishi Vigyan Kendra, Dadri (Gautam Budha Nagar), beneficiaries were trained on post-harvest management of fruits and vegetables, bio-control of crop diseases and pests including root-knot nematode, planting of nutritious grass spp. and cultivation of *Azolla pinnata* as green animal feed. These benefitted 4145 farmers, 580 farm women/SHGs, 770 rural youths and 275 extension functionaries visited the centre.

Women Empowered through Biotechnology Based Programmes

- Ornamental Fish Culture for empowerment of rural women
- Poultry Farming for sustainable livelihood generation for rural women
- Health and Hygiene for well-being of women: UTI, Breast Cancer screening

Pisciculture

Production in fish hatchery and rearing was taken up as a livelihood option for rural youths and farmers in three blocks of Bhagalpur District in Bihar.



Special Initiatives for North East India



THE North-East Region (NER) of India is a biological treasure trove that has not been fully explored. There are, for example, around 800 medicinal plants and herbs in remote areas of Sikkim, their properties known only to a fast vanishing population of local shamans, and their active ingredients largely uncharacterised. In fact, NER constitutes one of the richest hotspots of biodiversity of the country, and most of it remains to be characterised for its medicinal, aromatic, edibility, ecological and ornamental values.

Biotechnological research and development work in NER holds promise for yielding highly profitable patents on endemic species. The rich genetic resources spread across diverse ecosystems and nurtured by indigenous communities provide ample opportunities for promoting economic development of the region. Thus, NER offers unique potential for biotechnology-based interventions for overall development of the region.

- **North-Eastern Region-Biotechnology Programme**

Management Cell (NER-BPMC) established for conceptualisation, implementation and monitoring of biotechnology programmes in NER and also to evolve and implement various new programmes in the area of biotechnology for the benefit of NER states.

- **Twinning Programme** has catalysed collaborations between institutions from NER and the rest of India, evolved NER-specific projects for implementation across all eight states of the region. More than 480 Twinning projects have been implemented, addressing issues in Healthcare (Medical biotechnology), Agriculture (Agri-biotechnology), Livestock & Fisheries (Animal and Aquaculture Biotechnology), and in the areas of Environment, Medicinal and Aromatic Plants (MAP) with specific relevance to developmental needs of the region; nearly 250 research papers have been published in peer-reviewed journals and more than 1000 young scientists of NER have been trained in advanced biotechnology.



- **Development of Molecular Diagnostic Laboratories in 11 Medical Colleges of NER.** The programme is operational in all four states of the region, namely Assam, Nagaland, Tripura and Manipur.
- The department has provided critical support to establish sophisticated infrastructure for improved diagnostic services in pathology, haematology and genetics departments at the North Eastern Indira Gandhi Regional Institute of Health and Medical Sciences (NEIGRIHMS), Shillong (Meghalaya). The facilities will specifically help to establish viral etiology of nasopharyngeal carcinoma (EBV), and oral squamous cell carcinoma (HPV); in unravelling pattern of neoplastic renal diseases and haematolymphoid neoplasma, and



in molecular typing of minor blood group antigens in NER. Around 1000 diagnostic tests for cancer have been conducted by this lab so far.

- **Technology Business Incubation Centre** established in the campus of the Institute of Bioresources and Sustainable Development (IBSD), Imphal, Manipur to increase the income of farmers, as well as generate jobs for socio-economic development of the North-Eastern region. This initiative will help unemployed youth and farmers of the North-East region to survive and grow their businesses through the early stages of development and also would nurture new and small biotechnology-based enterprises.
- **Centre of Excellence (COE)** under the Agri-Biotechnology area established at the Assam Agriculture University, Jorhat (Assam) with focus on research in Gene Technology, Allele Mining, Molecular Breeding and Microbial Gene prospecting. It is engaged in developing skilled/trained human resource. Biofertilisers and biopesticides are also being distributed to the farmers. Nine PhD students enrolled in Agri-biotechnology at Assam Agricultural University were awarded with fellowships.
- **Value Chain Development in Citrus** programme aims at using modern technologies for mass production of



citrus plants and value-added citrus products. Under the programme, more than 2000 seedlings of rough lemon were raised, Khasi mandarin and sweet orange were successfully grafted, and processing of citrus juice has been standardised and polyhouse for multiplication of citrus root stock was constructed. The implementing partners are ICAR-RC, Nagaland, ICAR RC for NEH region, Shillong Meghalaya, NRC for Citrus (ICAR) Nagpur, IIT Kharagpur, West Bengal.

Value Addition of Agro Produce



- Nagaland State Science & Technology, Kohima has taken initiatives to improve income of farmers through value addition for their produce. The major issues faced by farmers

include dehydration of the agricultural produce and its preservation. Preservation of fruits and vegetables for prolonged periods is a major problem for rural economy. But if dehydration and preservation process is done in a cost-effective manner, it increases the shelf-life and also reduces the weight for transportation. A low-cost biomass fired dryer which is efficient and based on fuel wood has been developed and tested by NASTEC, Kohima, which has found very good response in the remote villages where there is no electricity particularly during the rainy season. It could be used in conjunction with the solar air heater based dryers.



Biomass Fired Dryer



*Solar Air Heaters developed at HPL-IITB
integrated with drying duct for preliminary testing*

- A project on "NER-Scented Rice" was implemented during 2016 -17 to make the aromatic rice of the northeast more resilient and sustainable. Another project in consortium mode on 'NER-Banana' was also initiated during the year to address the need to conserve, characterise and expand the germplasm stock.
- A multi-centric programme on value addition in jackfruit and commercialisation of its processed products aims at identification of superior genotypes of jackfruit, their molecular characterisation, and validation and commercialisation of technologies for value added products from jackfruit. The programme has identified more

than 40 elite jackfruit genotypes from Karnataka, Assam and Tripura for culinary or table purposes, organised training workshops for existing jackfruit technologies for farmers, and produced value-added products.

- Multi Utility Heat Pump to maintain a vegetable cold store between 10 to 15°C and simultaneously enabling drying of spices, fruits and vegetables was designed, developed, integrated and commissioned in Heat Pump Laboratory, Indian Institute of Technology, Mumbai (IITB) for preliminary testing before dispatch to Nagaland. Preliminary tests have been done and result indicates satisfactory operation.

Chemical Ecology of NER

A network research programme on 'Chemical Ecology of North Eastern Region' focuses on identification of the origin and composition of plants, insects and vertebrate pheromones and semio-chemicals; analysis and (re)engineering of chemical communication mechanisms; molecular and structural mechanisms; behavioural and neural mechanisms; biochemical, genetic and physiological mechanisms, governing interactions between flora and fauna of NER.

high value crops (HVCs) of NER, mass multiplication of required bio-inputs and evaluation of their efficacy providing training to nearly 1400 farmers in the use of bio inputs in organic farming of 9 target crops (5 spices, 2 fruits and 2 vegetable crops).

Impact of Jhum Cultivation

DBT has supported a multi-centric programme on assessment of impact of Jhum cultivation on soil microbiota and on restoration of diverse agro-ecosystem in NER.

Eco-friendly Agriculture

A multi-centric network programme has been implemented for promoting eco-friendly agriculture practices in 14 districts across all 8 NE states, with emphasis upon the application of bio-inputs (biopesticides, biofertilizers) for organic farming of key

Advanced Diagnostics

In the area of Animal Biotechnology, DBT has recently launched an ambitious programme on Advanced Diagnostics and Services in Animal Health and Disease for surveillance and control of trans-boundary, exotic and zoonotic pathogens.

Cultivation of Mushroom for Generating Livelihoods

CSIR-NEIST developed and introduced organised mushroom cultivation in NER. As a result, mushroom cultivation has increased in Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Tripura and Nagaland. A mushroom germplasm bank has also been established in CSIR-NEIST premises. The technology has been disseminated through awareness camps and training. Presently,



there are 30,000 beneficiaries including 20 entrepreneurs/NGOs and employment to over 5000 people has been generated. The income to the beneficiaries ranged from ₹ 10,000 per month to ₹ 1,50,000 per month from cultivation of mushroom from October to March.



Gold fish fertilised egg



Training workshop

Joint Venture on Pisciculture

MASTEC-ICAR joint venture project on pisciculture and its allied activities has been established for socio-economic development in Manipur, at Manipur Science & Technology Council. The project was supported by Department of Science & Technology for rearing and production of spawn, fish brooders of Indian major carps – *Catla catla*, *Labeo rohita*, *Cirrhinus mrigala*, and other exotic carps such as Grass carp (*Ctenopharyngodon idella*), Silver carp (*Hypophthalmichthys molitrix*), Common carp (*Cyprinus carpio*). To impart basic knowledge about scientific farming of food and ornamental fish, a two-day training programme on Pisciculture was organised during June 19-20, 2014 at Manipur Science Aquarium, Imphal. Altogether 30 participants including 11 beneficiaries of food fish and 4 beneficiaries of ornamental fish attended the training programme. In addition, the breeding of fan tail Gold fish (*Arassius auratus*) was tried with the available facilities at Manipur Science Aquarium. Survival rate of the fry was 50%.

Augmenting Clean Pork Production

A DBT-supported programme on Augmenting Clean Pork Production and Value Addition, being implemented at the National Research Centre for Pig, Guwahati, Assam, is designed to develop shelf stable pork products (namely nuggets and bites, sausages, patties, kebabs, samosa, momo, slices etc) and to refine and standardise the technologies for producing a wide range of value added pork products to provide variety to the pork consumers. Production of pork sausages has already been initiated.

Strengthening Fisheries

For strengthening the Fisheries and Aquaculture Biotechnology (FAB) related research and development activity in the NER region, DBT has established a FAB-Centre of Excellence (FAB-COE) at College of Fisheries, Central Agricultural University, Lembucherra, Tripura.



Capacity Building & Human Resource Development

The Department of Biotechnology has made intensive efforts in capacity building and human resource development (HRD) for the benefit of entire North-Eastern Region of India, as follows:



- Sophisticated biotechnology infrastructural facilities have been created at National Research Centre on Mithun at Jharnapani, Medziphema (Nagaland) and National Research Centre on Yak at Dirang (Arunachal Pradesh), for strengthening research dynamics for desirable gains in Mithun husbandry, Yak husbandry, improving research activities on genomics and conservation.
- In the area of Animal Biotechnology, DBT has launched an ambitious programme on Advanced Diagnostics and Services in Animal Health and Disease for surveillance and control of trans-boundary, exotic and zoonotic pathogens.



The programme envisages establishment of three core laboratories across the NER for carrying out research and training activities in trans-boundary and endemic animal diseases. It also aims to impart training to the state veterinary personnel in disease reporting, sample collection techniques and fostering public-public partnership module for effectively handling the animal-man-environment continuum chain.

The Department of Biotechnology has initiated establishment of a state-of-the-art, Regional Animal House Facility at Regional Medical Research Centre (RMRC), Dibrugarh.

- Established a network of 126 Biotech Hubs across NER, providing necessary infrastructure in universities/colleges/institutions and training in sophisticated technologies to support and promote biotechnology education and research. 6 State-Level and 120 national with more than 600 training programmes and supported more than 500 PG and PhD students.





Department of Biotechnology has established “X-Ray Crystallography Facility” at IIT Guwahati. This facility is fully functional and available to all NER researchers for their experimental use.

- An Overseas Associateship scheme for NER scientists aims to promote capacity building in cutting edge areas of biotechnology and life sciences. 205 scientists have been awarded the associateship thus far.
- DBT has initiated a scheme for establishing “Biotechnology Labs in Senior Secondary schools (BLISS)” across all 8 states of NER. Around 100 such labs under BLISS are under pipeline for establishment.
- DBT has initiated a “**Visiting Research Professorship (VRP)**” Scheme to utilise the expertise of outstanding biotechnology professionals for bringing advancement in Biotechnology and Life Science related activities in various institutions of research and higher learning in the NER States of India.



Students of school of Meghalaya being explained the functioning of different equipment

- Established a Centre for empowerment of human resources at NEHU, for conducting trainings/workshops for faculty/research students of the region in niche areas of biotechnology for undertaking research and development activities. Distinguished faculty with national/international credentials are invited to impart advanced training to the participants.



Kalyani, to provide comprehensive training to scientists, research students and clinicians belonging to the NER, who are engaged in "Biomedical Research", to better equip them to undertake focused research leading to understanding the molecular basis of diseases prevalent in NER of India. So far 60 researchers from NER (2 batches) have been trained in workshops held at Assam University Silchar, and Tezpur University, Tezpur.



- 29 bioinformatics centers have been established in all the 8 states of the NER and are networked as the North-Eastern Bioinformatics Network (NEBINet). These Bioinformatics centres are provided with the latest IT equipment to support the research activities of the host institutions in NER. Two

new bioinformatics centres were established during the last year, at College of Fisheries, Central Agricultural University, Lembucherra, Tripura and National Research Centre on Mithun (ICAR), Nagaland.

- Established a "DBT Biotechnology/Bioinformatics training centre for teachers and research scholars from the North-Eastern Region of India" at ACTREC, Mumbai. This centre will provide high-end hands-on training to NER researchers on cancer biology. Presently, 15 researchers from NER are being trained at ACTRECT.
- DBT has initiated a training programme through NIBMG,

Writing Skills and Effective Management of Intellectual Property Rights (IPR) in Biotechnology. DBT has organised a series of three-day capacity-building workshops on effective grant writing skills and basics of Intellectual Property Rights (IPR) for the research institutions and universities of the North-East Region.

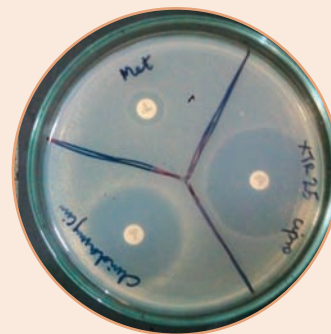
- **Training of NER researchers at ICAR-NIHSAD, Bhopal:** NER has a long International border which poses problems in dealing with the inevitable inflow of transboundary pathogens which, if left uncontrolled, may be potentially lethal, zoonotic or exotic. To address this, NER researchers are trained in pathogen handling and biosafety issues. 40 researchers have been trained at ICAR- National Institute of High Security Animal Diseases (ICAR-NIHSAD earlier HSADL), Bhopal.
- DBT has established a "Technology Incubation Centre for Entrepreneurship Development in Mushroom Culture and Farming" at Department of Biotechnology, Bodoland University. A number of farmers have been trained on value added products including Mushroom soup, Mushroom Cake, Mushroom Custard and Mushroom Pakora. The unit has also produced mushroom spawn of *Pleurotus florida*, *Pleurotus flabellatus*, *Volvariella volvaceae* etc.

Characterisation of Hotspring

The project "Microbiological characterisation documentation, sociological insight, physicochemical analysis of hot springs (Tatopani) of Sikkim" at Sikkim University, aims at microbiological characterisation documentation, sociological insight, physicochemical analysis of hot springs (Tatopani) of Sikkim. More than 200 bacterial isolates have been isolated and among these isolates, 46 isolates were found to be positive for amylase production and 6 for protease production. One isolate was found to be resistant to Clindamycin, one to Penicillin, one to Gentamycin and 38 isolates were found to be resistant to Methicillin. DNA isolation of more than 30 isolates has been done and among them 16 S rDNA sequencing of 15 isolates has been done and is still in progress. Initial sequencing results suggest that most of them belong to genus *Geobacillus anoxybacillus*, and *Bacillus* sp.



*Newly found
Hot Spring in
Yumesamdung,
North Sikkim*



*Gram Staining of
Geobacillus Toebii
isolated from Yumthang
Hot Spring*

Technology Demonstration in North East

An indigenous technology on improving traditional water mills for income generation to enhance the livelihood of tribals in Arunachal Pradesh was demonstrated at two places Rikpu Ronya and Mukyom-Kojak village, West Siang District, Arunachal Pradesh by Arunachal Pradesh State Council for Science & Technology, Itanagar.



*Traditional water mill demonstration in
Arunachal Pradesh*

2*100 kW Micro hydel plant at Thangu, North Sikkim

A 2*100 kW Micro hydel plant has been commissioned at a height of 13000 feet in Thangu North Sikkim based on cross flow turbine technology by Department of Science & Technology.



Department of Science & Technology



- **North Eastern Centre for Ethno Medical Research established in Manipur:**

Ethno Medicinal Research Centre (EMRC) in the remote region of Manipur was established with budgetary support of approx. Rs. 6.00 crores in 2017. This Centre aims

to undertake ethno phyto-

chemical research of wild herbs available in the NE region that have unique medicinal and aromatic properties, particularly in our traditional systems. This one-of-its-kind initiative will not only provide scientific validation of traditional herbs but also aims to improve quality of life and economic status of the local community through product development and better livelihood.

- Improved drying-cum-storage technology for large Cardamom has been successfully introduced and demonstrated in Ziro, Arunachal Pradesh. Flue pipe system dryer provides good colour to the capsules and perfect drying in short span of time. Now, Cardamom farmers of Ziro are getting better economic returns through the introduction of this improved drying technology as compared to traditional system.

North East Centre for Technology Application and Reach (NECTAR)

NECTAR works with domain experts and with Central and State Government funded laboratories to identify techno-economic gaps and technologies to induct them in the North East. It provides last mile guidance and support to States to ensure that such technologies reach ultimate beneficiaries in the North Eastern States.



Some major accomplishments of NECTAR are:

- To promote the unique traditional art of concrete hive beekeeping, which is vanishing with time, a project was supported to revive the scientific method of beekeeping. More than 500 underground concrete hives were constructed along with water reservoirs.
- Under the beekeeping project, 170 beekeepers were supported and 1700 bee boxes were distributed among the farmers in the villages of Tuensang district of Nagaland viz. Chendang, Konya, Longtang, Chingmei, Kiding and Yangli. This intervention was aimed at empowering the local village people to the subsidiary occupation of beekeeping to generate supplementary income. Further, this intervention would increase the output of honey production in the state.
- NECTAR has extended capital support to North East Network (NEN) - Chizami Weavers – the project has engaged 300 back-strap loom weavers from 11 locations under Phek district to produce home furnishings (cushion cover, table runner), garments (shawls and mekheles) and accessories (bags) that cater to both rural and urban consumers. NECTAR also linked the weavers with designers, thereby facilitating the weavers to enhance their skill and understand the knowhow of market trends.

Popularising and Communicating Science





Popularising and Communicating Science

THE Ministry of Science & Technology is mandated to communicate science & technology (S&T) to the masses, stimulate scientific and technological temper, and coordinate and orchestrate such efforts throughout the country. The programmes of the Ministry aim to build capacity for informed decision making at the community level and promote scientific thinking. It is devoted towards societal upliftment through the dissemination of scientific knowledge in an informed manner through the media to ensure percolation of the message to every corner.

The National Council of Science & Technology Communication (NCSTC) focuses on outreach activities; training in S&T communication; development, production & dissemination of S&T software; incentive programmes; field based science communication projects; research in S&T communication; international co-operation, motivating students and teachers; environment awareness, and gender focused programmes. Some of the important successful initiatives over the years include campaigns like 'Year of Scientific Awareness', 'Year of Physics', 'Year of Astronomy', 'Year of Mathematics', observation of the 'National Science Day' and 'National Mathematics Day', the 'National Children's Science

Congress', 'National Teacher's Science Congress, and 'Science Express', amongst others. A multi-pronged effort has been developed by the NCSTC including communicating science using folk media; use of mass & digital media for science communication and popularisation, and use of social media in S&T popularisation.

CSIR-National Institute of Science Communication and Information Resources (CSIR-NISCAIR), an institution belonging to the Council of Scientific & Industrial Research (CSIR), has been making a substantial contribution to the communication of scientific information in the country for the past more than sixty-two years. The Institute is the only organisation in the country that disseminates R&D information through 20 scholarly peer-reviewed journals. CSIR-NISCAIR is also taking science to the masses through its three highly-circulated popular science

magazines in English (*Science Reporter*), Hindi (*Vigyan Pragati*) and Urdu (*Science ki Duniya*). The Institute has also made a foray into science communication through multimedia channels and social media. Besides, CSIR-NISCAIR has also been organising training workshops in science communication and science writing for scientists, researchers, students, teachers, etc.

Vigyan Prasara (VP) is an autonomous organisation under the Department of Science & Technology (DST) to serve India's science popularisation agenda. This is achieved through several strategically important two-way stakeholder specific approaches to communicate principles and practices of S&T. This also includes implications for development and quality of life. VP serves as a resource & facilitation centre for S&T communications.

India S&T Portal

- Objective to provide a one-stop information centre for school students, scientists and the common public on various schemes and programmes/activities and major achievements in S&T.
- Portal is part of the larger, National Government Services Portal (NGSP), which provides a single-window access to the various services provided by the Indian Government.
- Provides information pertaining to scientific education and scientific research & development, including details of policies, schemes, documents and programmes for scientists, researchers, scholars and students.
- Documents and reports, like e-books and citizen charters, application forms, S&T related schemes like the 'Digital Literacy Mission' and 'Multiplier Grants Scheme', as well as open data from national databases, such as the district rainfall normal, expenditure on research and development can all be accessed from a single window on the S&T Portal.



The banner for the India S&T Portal features a central orange circle with the text 'India S&T Portal' and the national emblem. To the left, it states: 'Development of a one stop information centre for school students, scientists and the society at large on various schemes and programmes, activities and major achievements in S&T.' To the right, it states: 'This would be a 360-degree view and connect to all the stakeholders and activities of S&T in India. An internet-TV channel on S&T is also in the advanced stages of planning and execution.' The banner includes social media handles for @IndiaDST on Facebook and Twitter. At the bottom, there are four small images: a computer monitor, a laboratory flask, a beaker, and a person using a laptop.

Science Express – Climate Action Special

- Most popular, mega outreach and flagship programme of NCSTC.
- Innovative mobile science exhibition mounted on a specially designed 16-coach AC train, traveling across India since October 2007.
- Completed nine tours of the country, covering 1,61,000 km and exhibiting at 529 locations spread across the length & breadth of country. Reached out to over 18.1 million visitors – the largest, the longest running and the most visited mobile science exhibition.
- Has 12 entries in the *Limca Book of Records* including six new ones in the 2017 edition.
- *Science Express* (Phase I-IV) showcased cutting-edge research in S&T being carried out worldwide in collaboration with Max Planck Society and Federal Republic of Germany.
- *Science Express Biodiversity Special (SEBS)* (Phase V-VII) displayed rich biodiversity of India and conservation measures with Ministry of Environment and Forest as partner.
- *Climate Action Special (SECAS)* (Phase VIII and IX) highlighted global challenges of climate change.
- Detailed information is available on website www.scienceexpress.in.

Science Express (SE) Milestones (30 October 2007— 08 September 2017)

- Total Visitors ~ 1.81 crore
- Number of Schools/Colleges that visited SE ~ 45,052
- Number of Students who visited SE ~ 40.67 lakh
- Number of Teachers who visited SE ~ 2.2 lakh
- Number of General Visitors including children ~ 1.21 crore
- Students participating in on-board Lab ~ 4.9 lakh and Kids Zone ~ 2.5 lakh



- Students participating in Platform Activity ~ 7.4 lakh and Outreach Activity ~ 1.7 lakh
- Number of participants in on-board Teachers Orientation Program ~ 9,500
- Distance travelled ~ 1.60 lakh kilometers
- Total number of Halts ~ 529
- Number of exhibition days ~ 1,812
- Entries in *Limca Book of records* ~ 12
- Over 270 trained Science Communicators
- Extensive Media Coverage

Hands-on STEM & Innovation Demonstrations

- Science, Technology, Engineering and Mathematics (STEM) and innovation demonstration activities through science fairs, expositions, mobile science exhibitions, lecture-demonstrations, visits to S&T establishments and labs, hands-on-STEM activities, and so on.
- Include hands-on activities, science based toys, games, and quizzes.
- 261 science fairs, melas, visits to S&T establishments like labs and industry organised.
- Attended by close to 10 million people.
- Participation by 1 million students during 2014-17.
- Six mobile science exhibitions and lecture-demonstrations organised attended by more than 35 lakh students.

National Awards for S&T Communication and Popularisation

NCSTC instituted National awards for 'Outstanding Efforts in Science & Technology Communication' in 1987 to stimulate, encourage and recognise efforts in science popularisation and communication. Presently, there are six categories awards:

1. General
2. Print media including books and magazines
3. For children
4. Translation of popular S&T literature in languages mentioned in the Constitution of India and in English
5. For innovative and traditional methods
6. For electronic media.

A total of 26 individual and 7 institutions were awarded during the period 2014-17.

Initiative for Research & Innovation in Science (IRIS)

- IRIS is a public-private partnership between DST (NCSTC), Intel and Indo-US Science and Technology Forum for empowering next generation of innovators.
- Aims to inspire budding scientists in India.
- IRIS enables outstanding projects to represent India at global science competitions like Intel International Science and Engineering Fair (Intel-ISEF).
- During 2014-17, team-India while competing with more than 5000 participants from 78 countries, bagged more than 40 honours including 25 Grand and 6 of them had minor planets named after them.

Mission Eco Next

(Previously, Eco Next & Eco Media Initiatives, Eco & WaSH Futures)

- The programme aims to inspire and nurture the 'Eco Intelligent Youth Young Change Makers'.
- 'Mission Eco NEXT' initiatives focus upon promoting real-time responsiveness for building regenerative ecological futures which are leveraged by eco-media, eco-design, eco-innovation for promoting integrated efforts for conservation of natural resources, specifically aimed at developing models in public guidance systems based on science communication.
- These include location-specific initiatives for actionable learning and building field capacity for adopting scientific best practices in knowledge critical domains.
- S&T communication trainings and support are provided to youth for leadership and improvement of quality-of-life of specific target groups, based on scientific approaches of 'being-on-their-own' and 'collective response' to challenges and location-specific issues.
- During 2014-17, over 50 training and capacity building programmes were conducted.

India Innovation Initiative — I³

- Aims to promote innovation amongst citizens in age group 18 and above.
- Participants engage in creating innovative solutions to real-life societal problems and bring out a working prototype.
- Innovations in advanced stages of commercialisation are supported by linking them to the ecosystem, so that the process-to-market could be accelerated.
- Incentivises innovators with exclusive and special training on business idea development, business plan creation and financing to help them commercialise their innovations.

- Best of the innovations are provided incubation support, mentorship, investor and industry connect.
- Also aims to build capacity of innovators for launching start-up enterprises and doing business by equipping them with necessary knowledge in the areas of defining a business problem, carving a solution, conducting market research and creating a business plan so that they are better prepared to seek incubation and funding.
- Since 2014, about 40 projects are selected each year from hundreds of entries received at regional level, for recognition and rewards at the national level fair. Most of the innovative ideas/projects get incubation support, venture funding and/or seed capital.

India International Science Festival

As a new initiative, the India International Science Festival is being organised every year with the objective of sharing achievements of S&T with the public; building strategy to instil scientific temper among the masses; showcase India's contributions in the field of S&T; provide platforms to young scientists for knowledge and idea exchange; and support flagship programmes like Make in India, Digital India, Start-ups, Smart Villages and Smart Cities.

- **IISF 2015** organised in IIT, Delhi from 4th to 8th December 2015. About 10,000 delegates from all over the country participated in Young Scientists Conference, Techno-industrial Expo, Science Film Festival, Exhibition and Competition showcasing innovative models under the INSPIRE programme, Industry Academia Conclave, Largest Practical Science Laboratory Demonstration.



(From Left) Dr. Harsh Vardhan, Minister of Science & Technology and Earth Sciences; Shri Y.S. Chowdhary, Minister of State for Science & Technology and Earth Sciences; largest practical science session with 2000 students organised on 7th December 2015, which found its way into the Guinness Book of World Records.

- **IISF 2016** organised at CSIR-National Physical Laboratory (NPL) Campus, New Delhi during 7-11 December 2016. The event was inaugurated by the Honourable Home Minister, Shri Rajnath Singh. The 6th National Level Exhibition & Project Competition (NLEPC) under the INSPIRE Award Scheme was organised by Department of Science & Technology during the IISF. About 560 selected awardees from all over the country participated in the event. The top 60 innovative projects were felicitated by Dr. Harsh Vardhan, Hon'ble Minister for Science & Technology and Earth Sciences.



Honourable Home Minister, Shri Rajnath Singh inaugurating the IISF 2016 (left); Dr. Harsh Vardhan, Minister of Science & Technology and Earth Sciences giving away awards

- **IISF 2017** was held in Chennai during 13-16 October 2017 at various venues which include Anna University, Central Leather Research Institute (CLRI), Structural Engineering Research Centre (SERC), National Institute of Ocean Technology (NIOT) and IIT-Madras. Fifteen major events were held as a part of the IISF-2017.



A new Guinness World Record was created for the largest biology lesson – 1049 students participated in the record breaking session.



Dr. Harsh Vardhan, Minister of Science & Technology and Earth Sciences inaugurating the IISF 2017

S&T Communication through Community Radio

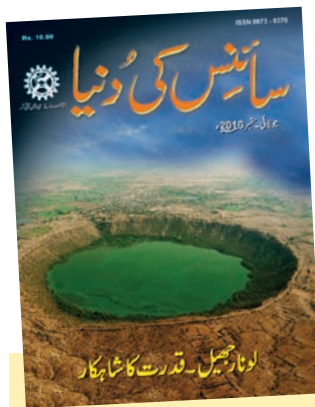
- NCSTC has launched initiatives in conceiving, designing, preparing and delivering radio programmes to ensure reach of information and messaging to all remote areas.
- In recent times, the focus has been on achieving gender equity and alignment with the national priority of Beti Bachao, Beti Padhao, well leveraged by community radios (CRs) across the India.
- NCSTC has so far supported 68 CRs under its Science for Women's Health and Nutrition (SWHN) initiative besides 'Radio Mathematics' aimed at inculcating basic math skills, amongst even the illiterate. The programmes prepared using local expertise in the subject area and in vernacular, are aired twice a day and the time of broadcast is decided by the community to ensure maximum mileage.

Children Science Congress (CSC)

- Flagship programme of DST to initiate young students (10-17 years) into the arena of science through hands-on, minds-on approach.
- Encourages child scientists to identify societal problems and motivates them to arrive at a possible solution through research.
- Focal themes of CSC in 2016 and 2017 were 'Science, Technology and Innovation for Sustainable Development with special emphasis on accessibility for Persons with Disabilities'. It covered almost all the districts in India, with participation of over 500,000 students annually. Promising ideas and projects were shortlisted for presentations at the state level and further scrutiny led to about 650 projects getting shortlisted for a presentation at the national level.
- Grand finale of CSC, popularly known as National Children Science Congress (NCSC) is held during 27-31 December each year.
- Child scientists with the best projects of NCSC also participated in the Rashtriya Kishore Vigyanik Sammelan organised as a part of Indian Science Congress. Over the years, children from neighbouring countries, SAARC nations and even ASEAN have participated in this.

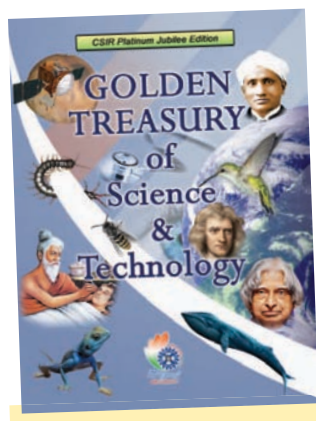
Publications to Popularise Science and Scientists

- **Popular science magazines of CSIR-NISCAIR:** CSIR-NISCAIR has been disseminating information to the masses through its three widely circulated popular science magazines. The three magazines are *Science Reporter* (English monthly), *Vigyan Pragati* (Hindi monthly) and *Science ki Duniya* (Urdu quarterly).



- **Golden Treasury of Science & Technology:**

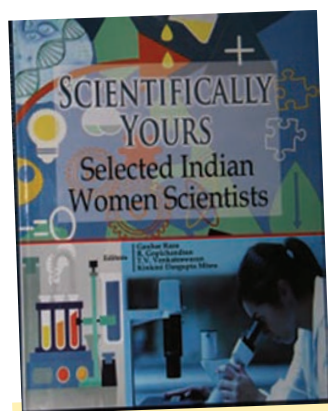
As part of the Diamond Jubilee celebrations of CSIR, CSIR-NISCAIR brought out the Diamond Jubilee edition of the *Golden Treasury of Science & Technology*. This extremely popular encyclopaedia contains S&T terms and terminologies that are in the public domain. Explanations to these terms have been provided in an easy-to-understand language.



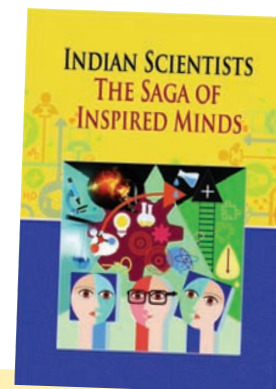
- **Moments of Eureka:** This book brought out by CSIR-NISCAIR in collaboration with Vigyan Prasar and RSTV is based on interviews of some of the most eminent scientists in the country – these interviews were telecast on Rajya Sabha TV (RSTV).



- **Scientifically Yours:** This book brought out by CSIR-NISCAIR in collaboration with Vigyan Prasar and RSTV covers the lives and times of some eminent women scientists in the country.



- **Indian Scientists – The Saga of Inspired Minds:** To develop scientific temper in the society, especially young students, interesting aspects about the inspiration that guided 54 Indian stalwarts in S&T were presented through a publication *Indian Scientists: The Saga of Inspired Minds*, published by Vigyan Prasar, and with a message from Hon'ble Prime Minister.



Science Channel

A dedicated one-hour slot "DD-Science" on Doordarshan National channel was initiated to highlight the value of science and technology in our daily life. This was also an attempt to demystify science and make it accessible to all. "Science is everywhere and for everyone" has been used as the guiding principle to ensure high quality, educative and entertaining programmes, to enable people to understand issues and to address these through a participatory process. The aim is to evolve the one hour show "DD – Science" into a 24x7 science channel.

New Multidisciplinary Digest Science Diplomacy

Dr. Harsh Vardhan, Union Minister for Science & Technology, Earth Sciences and Forest, Environment & Climate Change,





Dr. Harsh Vardhan, Minister of Science & Technology and Earth Sciences releasing the first issue of Science Diplomacy

released the first issue of *Science Diplomacy* brought out by CSIR-NISCAIR. The publication was released during the inaugural ceremony of the India International Science Festival (IISF) 2017 at the Anna University, Chennai on 13 October 2017. *Science Diplomacy* is among the first endeavours to bring highlights of Indian scientific achievements in foreign languages. Currently the publication has been brought out in English and Japanese. More foreign languages would be added in the future.

Workshop for “Training Journalists in S&T Reporting”

CSIR-NISCAIR and NCSTC organised a Workshop for “Training Journalists in S&T Reporting” during 1-3 September 2015. The Workshop, which was attended by 18 journalists, facilitated interaction of journalists with some of the most eminent scientists and scientist administrators of the country. It also exposed them to prominent scientific projects and imparted to them reporting skills which would be helpful in effective communication of scientific developments in the country. Hon’ble Minister of S&T and Earth Sciences, Dr. Harsh Vardhan, was the chief guest at the Valedictory Function, which was also attended by Dr. Girish Sahni, DG-CSIR and Mr Rajendra Prabhu, Chairman, NUJ (I) School of Journalism & Communication.

Catalysing Debates on Science Communication

Panel Discussion on Scientific Temper: CSIR-NISCAIR in collaboration with Rajya Sabha TV and Vigyan Prasar organised a panel discussion on *Scientific Temper: A Prerequisite for Knowledge-based Society* on 10 January 2016. Inaugurating the event, Vice President of India, Shri Hamid Ansari emphasised that scientific temper is a pre-requisite for innovation and research. The panel discussion was attended by Nobel Laureate Dr. Venkataraman Ramakrishnan, Prof. Raghavendra Gadagkar, and Dr. Anil Kakodkar.



Vice President of India, Shri Hamid Ansari delivering his address



Dr. Harsh Vardhan, Minister of Science & Technology and Earth Sciences at the concluding function of the Workshop; Dr. Girish Sahni, DG-CSIR on his left and Mr Rajendra Prabhu, Chairman, NUJ (I) School of Journalism & Communication on his right

Fifth Media Chaupal: The fifth Media Chaupal was held in Haridwar, Uttarakhand during 22-23 October 2016 in which CSIR-NISCAIR collaborated with organisations such as 'Spandan', Dev Sanskriti Vishwavidyalaya, Divya Prem Sewa Mission, India Water Portal, and the Atal Bihari Vajpayee Hindi University. Around 350 journalists, scholars, scientists, philosophers, academicians and students from all around the country participated in the fifth chaupal whose theme was "Science, Development & Media".

Former Chief Minister of Uttarakhand Dr. Ramesh Pokhriyal delivering the opening address



"Round Table Meet on Mass Communication":

A "Round Table Meet on Mass Communication" was organised during the Third India International Science Festival (IISF) in October 2017 at the Anna University in Chennai, Tamil Nadu by CSIR-NISCAIR in collaboration with the National Institute of Ocean Technology (NIOT), Chennai. The Round Table Meet was inaugurated by Dr. Narender K. Sehgal, Former Adviser, Govt. of India and winner of the prestigious Kalinga Prize. Dr. V.K. Saraswat, Member, NITI Ayog chaired the Valedictory Session.



(From right) Dr. V.K. Saraswat, Member, NITI Aayog, Dr. Jayant Sahasrabudhe, ViBHA, and Dr. Manoj Kumar Patrairiya, Director, CSIR-NISCAIR at the Summing-up Session of the Round Table Meet on Mass Communication at Chennai

"Regional Workshop on "Sustainable Development Goals: Communication Strategies":

CSIR-NISCAIR organised a Regional Workshop on "Sustainable Development Goals: Communication Strategies" during 16-18 November 2017 at the NASC Complex, New Delhi in collaboration with the Association of Academies and Societies of Sciences in Asia (AASSA) and the Indian National Science Academy (INSA). The Workshop brought together scientists, communicators and policy makers from South Asian countries like Japan, South Korea, Indonesia, Georgia, Iran, Afghanistan and India.

From Right: Dr. P. Goswami, Director, CSIR-NISTADS; Dr. Manoj Kumar Patrairiya, Director, CSIR-NISCAIR; Prof. Yoo Hang Kim, President, AASSA; Dr. Narender K. Sehgal, Former Adviser, Govt. of India; Prof. A.K. Sood, President, INSA; Prof. Krishan Lal, former President, INSA; Mr S.P. Mishra, Deputy Executive Director, INSA



17th Indian Science Communication Congress: CSIR-NISCAIR and the Indian Institute of Mass Communication (IIMC) organised the 17th Indian Science Communication Congress during 21-22 December 2017. Scholarly societies and bodies involved in science communication including the Indian Science Writers' Association (ISWA), Society for Information Science (SIS), Indian Science Communication Society (ISCOS) and Vigyan Bharati (VIBHA) also collaborated. Some 200 delegates including science communicators, scientists, researchers, science fiction writers, science enthusiasts, science journalists and students participated in the congress held under the theme "Communicating India's Scientific Wisdom: Changing Paradigms".



From left: Prof. K.G. Suresh, Director-General, Indian Institute of Mass Communication; Prof. R.K. Bhandari, former director CSIR-CBRI; Dr. R.S. Sangwan, Director, Academy of Scientific and Innovative Research (AcSIR); Dr. Narender K. Sehgal, UNESCO Kalinga Prize Winner for Science Popularization, Mr. Kamal Kishore, Member, National Disaster Management Authority and Prof. Manoj Kumar Patariya, Director, CSIR-NISCAIRs

"National Workshop on "Science, Technology & Innovation Policy: Optimising Communication & Information Research": In view of the need for optimising communication and encompassing information research when crafting science, technology and information policies, CSIR-NISCAIR organised a national workshop on "Science, Technology & Innovation Policy: Optimising Communication & Information Research" during 23-25 January 2018 at the NASC Complex, New Delhi in collaboration with the Department of Science & Technology, Government of India. About 100 participants including scholars, researchers, scientists, practitioners, policy makers and students from all parts of the country participated in the workshop.



Dr. Manoj Kumar Patariya, Director, CSIR-NISCAIR addressing the gathering. On the dais (from right) Dr. H. Purushotham, Chairman and Managing Director, National Research Development Corporation (NRDC); Prof. K.K. Dwivedi, Vice Chancellor, ITM University, Gwalior; Dr. R.S. Sangwan, Director, Academy of Scientific and Innovative Research (AcSIR); Dr. Neeraj Sharma, Head and Advisor, Policy Research, DST; Dr. Akhilesh Mishra, Senior Scientist, Policy Research, DST

Global Connect Promoting International Cooperation





International Science and Technology Cooperation and Collaborations

THE Ministry of Science and Technology has the mandated responsibility of negotiating, concluding and implementing science and technology (S&T) agreements between India and other countries; and providing interventions on S&T aspects in international forums. This responsibility is carried out by the Ministry of External Affairs (MEA), Indian missions abroad, S&T counsellors at Germany, Japan, Russia and USA, stakeholders in

scientific, technological and academic institutions, concerned governmental agencies and various industry associations in India.

International Science & Technology Cooperation is realised at two levels, that of bilateral cooperation with developed and developing countries, and multilateral and regional cooperation. Presently, India has bilateral S&T cooperation agreements with 83 countries with active cooperation with 44 countries. In recent years, the cooperation has with Australia, Canada, EU, France, Germany, Israel, Japan, Russia, UK and USA has been strengthened significantly. Cooperation with African countries has also been strengthened through the India Africa S&T Initiative. The soft prowess of S&T has been leveraged to engage with several countries under India's Act East policy and with some neighbouring countries.

The DST currently supports three bi-national S&T centres which are independent entities established under inter-governmental bilateral agreements with France, USA and Germany. These are:

- Indo-French Centre for Promotion of Advanced Research (IFCPAR / CEFIPRA)
- Indo-US Science & Technology Forum (IUSSTF)
- Indo-German Science & Technology Centre (IGSTC)

The collaborations are in selected areas of mutual interest with different countries/organisations, and are materialised through various modes of cooperation such as contact building through joint workshops/seminars/frontiers symposia/exhibitions, visitation, fellowships & internships, exploratory visits providing support for joint R&D projects of mutual interest, participation in mega-science projects, joint R&D clusters, promoting commercial R&D and innovation and many such endeavours.

In order to enhance international S&T cooperation, about 500 bilateral R&D projects with nearly 44 countries and over 100 joint workshops/seminars were supported by DST. More than 2100 exchange visits took place under various bilateral programs. 27 projects were funded under the U.S.-India Endowment Fund for innovation, while 12 technologies have been commercialised in the broad areas covering healthy citizens and empowered citizens. More than 200 students were exposed to international peer interactions with Nobel Laureates and eminent scientists through the Lindau, Hope, Asian Science camp and Sakura programs to enhance professional opportunities in fundamental scientific research and to make research careers more appealing. More than 300 African researchers have availed the CV Raman Fellowship to undertake R&D work in India. Under the India Science and Research Fellowship program, more than 80 scientists from neighboring countries have availed fully paid fellowship to undertake R&D work in India.



1 India-Israel Partnership

India and Israel have agreed to significantly step up scientific and technological collaboration through the establishment of India-Israel Industrial R&D and Technological Innovation Fund (I4F) worth US \$ 40 million. The joint Fund is aimed at facilitating and supporting industrial R&D projects leading to co-development and commercialisation of innovative technologies benefiting both countries in sectors covering agriculture, energy, ICT, health and water challenges.



2 BRICS Science, Technology and Innovation Cooperation

BRICS countries signed an MoU on Science, Technology and Innovation Cooperation in March 2015 to promote research and innovation with the broad objectives of addressing global and regional socio-economic challenges, utilising shared experiences and complementarities in STI and to co-generate new knowledge, innovative products, services and process in BRICS member countries supported by appropriate funding and investment instruments.

A. Arrangement of BRICS STI Framework Programme and the Implementation Plan

Eight funding agencies from BRICS countries signed an "Arrangement of BRICS STI Framework Programme" and the "Implementation Plan" and agreed to co-invest together US \$10 million to support multidisciplinary R&D projects under BRICS STI. Pursuant to this, 26 BRICS R&D projects were supported, out of which India is a partner for 22 projects. The second call was announced in 2017 for which 291 eligible proposals were received.



B. BRICS Young Scientist Forum

Coordinated by India, the BRICS Young Scientist Forum/ Conclave is becoming an effective platform for networking of young creative talent. More than 50 young scientists from BRICS countries participated in these conclaves covering the areas of Biotechnology, Renewable Energy and Nanotechnology and Materials. India hosted the first conclave and deputed a team of 25 young Indian scientist in the second BRICS Young Scientists Conclave held at Hangzhou, China during 11-15 July 2017. These young researchers got a unique opportunity to discuss pressing problems, such as affordable energy solutions, affordable health and their solutions through scientific exploration and technological innovations. Two editions of BRICS Young Scientist Conclaves have been organised.

C. BRICS Science, Technology, Innovation and Entrepreneurship (BRICS-STIEP)

The Action Plan for BRICS Innovation Cooperation (2017-2020) was prepared in India's leadership, which was endorsed by the fifth BRICS Science and Technology Ministerial Meeting in China on 18th July 2017 and signed on 5th September 2017 at the IX BRICS Summit in Xiamen, China. The plan holds the initial focus on creation of networks of science parks, technology business incubators and SMEs, and to create talent pools for converting ideas into solutions to address societal challenges. The Department of Science and Technology, Government of India from India, and the counterpart Ministries/ Departments from other BRICS countries shall be the implementing agencies of the plan.



S&T Minister Dr. Harsh Vardhan with the Prime Minister of Portugal in Lisbon

3 India-Portugal Partnership

The R&D collaboration between India and Portugal will be significantly strengthened with the announcement of a 4 million Euro fund to support collaborative activities in marine science & technology, new materials research and tissue engineering.



Hon'ble Minister for S&T and ES inaugurating the India centric beam-line at PETRA III, DESY in Hamburg, Germany in September 2016

between academia and industry, focused on advanced manufacturing, energy technologies, bio-medical devises, ICT and others. A India centric beamline was also launched at the synchrotron facility at DESY, Hamburg, Germany.

4 Indo-German Bilateral Projects

Considering the relevance of digital economy and society, DST and Max Plank agreed to support the new phase of the Indo-German Centre on Computer Sciences. The new phase of the Indo German Centre for Sustainability will undertake research on impacts of climate change on the coastal infrastructure and the adaptation strategies. The funding to the bilateral Indo German Science and Technology Centre (IGSTC) was doubled from two million to four million euros from each side to further strengthen industrial R&D cooperation

5 Newton Bhabha Fund

The Newton Bhabha Fund aims to bring together the UK and Indian scientific research and innovation sectors to find joint solutions to the challenges India is facing in economic development and social welfare. The scheme is part of the UK's £ 375 million Newton Fund to support science and innovation partnerships between the UK and emerging powers. Under the Newton Bhabha programme between DST and the Research Council, UK, the neutron and muon source facility



at the Rutherford Appleton Lab in Oxfordshire, UK will be accessible to Indian researchers. This will enable Indian scientists to work in the frontier areas of nano-science and technology through access to the portfolio of high-end instruments.



6 India-Canada Technology Summit

The DST-CII India-Canada Technology Summit was held on the 14th and 15th of November 2017. It is aimed at providing a high profile and wide-ranging platform to industries, institutions and government agencies from India and Canada and to forge knowledge-business partnerships to boost investments and trade. The focus areas of the summit were smart ideas, defence and aerospace, smart machines, smart transport, smart women, smart people, clean energy and smart care.



7 Global Research Council Meeting

SERB jointly hosted the Fifth Annual Meeting of Global Research Council (GRC)-2016 from 25th to 27th of May 2016 with the Research Councils UK (RCUK). The Global Research Council (GRC) is a virtual organisation comprising the Heads of Research Councils from around the world, dedicated to promoting the sharing of data and best practice for high-quality collaboration among research funding agencies globally. Heads of Research Councils from 44 countries were among more than 100 delegates who attended the event to share the best practices and discuss policy issues in the field of Research Funding. A Statement on 'Principles of Interdisciplinarity' and 'Actions towards Equality and Status of Women in Research' was discussed and endorsed by participants representing the global research community.

to include smart grid and grid storage critical importance of expanding clean energy research, development, manufacturing, and deployment, which increases energy access and reduces greenhouse gas emissions. A Funding Opportunity Announcement (FoA) was made in July 2016 to support multi-institutional network projects using public-private partnership model of funding. An award will be made to a consortium with the knowledge and experience to undertake high-quality collaborative research programs. Seven applications have been jointly submitted by the US and Indian researchers who would be members of the Consortia based on their mutual interests, priorities and strengths.

8 Joint Clean Energy Research and Development Centre on Smart Grids and Energy Storage

India and the United States expanded collaboration under the Partnership to Advance Clean Energy-Research (PACE-R)

9 MoUs signed during the India-Africa Forum Summit

Under the India-Africa Forum Summit, DST in partnership with MEA is implementing the CV Raman Fellowships which enables researchers from African nations to undertake research in Indian R&D and academic institutions under a fully paid fellowship. This has established the S&T footprint of India across 38 African nations. From

2017, the number of fellowships was increased from 100 to 200 every year. Capacity building and training through twinning model have been extended to Benin, Ethiopia and Tunisia. Under the Africa Initiative Technology Transfer, programs with Ethiopia, Rwanda and S. Africa have been launched.

10 India-Japan Joint Research Laboratory Programme

Japan relationships with India were substantially strengthened by establishing Indo-Japan Joint laboratories in Internet-of-Things, big data analysis, and Artificial Intelligence (AI). The Phase II of the Indian Beamline at the synchrotron facility at KEK in Tsukuba, Japan was launched in November 2016 for conducting studies on nano-material characterisation for energy storage and generation.

11 IC-IMPACTS Program with Canada

An innovative model of R&D cooperation through the India-Canada Centre for Innovative Multidisciplinary Partnership to Accelerate Community Transformation and Sustainability (IC-IMPACTS) programme supported to promote research partnerships aimed at social transformation by providing solutions through application of science and technology in identified areas of safe and sustainable civil infrastructure and integrated water management.

12 India-Australia Strategic Research Fund (AISRF)

New projects in the areas covering advanced manufacturing, smart cities and infrastructure technologies, lifestyle and emerging disease control; and bio-medical technologies will be launched with Australia under the India-Australia Strategic Research Fund (AISRF). The program, which is in its tenth year, has announced ten projects selected for funding on 10 April 2017. Phase II of the Australia-India Strategic Research Fund (AISRF) was launched for providing technological solutions to grand challenges in areas of human health science and agriculture biotechnology.

13 ASEAN-Indian Science and Technology Development Fund (AISTDF)

The ASEAN-Indian Science and Technology Development Fund (AISTDF), with an equivalent amount of 5 million USD, has been created to support collaborative R&D projects, research & training fellowships and ASEAN-India Innovation Platform which includes social innovation, research innovation and product innovation. The call for proposals under R&D collaborative projects and research training fellowships have been launched. Ten R&D projects in the areas of Material Science, Biofuels, Chemical Engineering, Biotechnology and Electronics and IT have already been sanctioned for a period of 3 years. The ASEAN-India Innovation Platform concept document has also been finalised and the activities under the Innovation Platform are being launched soon.

14 India-EU Cooperation in Research and Innovation

The India-European Union (EU) Science and Technology Agreement was renewed in 2015 for another five years. In the last four years, 17 multi-countries projects were supported in the areas of new energy materials and smart grid, diagnostic for chronic non-communicable diseases, bio-economy and waste to energy.

15 India-EU Collaboration in Water

India and European Union agreed to collaborate in the water sector at the 11th India-EU Joint Steering Committee meeting held in Brussels on 6th June 2017. Pursuant to this decision, a joint India-EU Water Call was launched on November 7, 2017 seeking joint research proposals focused on wastewater treatment technology including bioremediation, drinking water purification and real time water quality monitoring. Both sides together will jointly invest € 30 million to address these water challenges faced by India.

16 DST- ICTP Cooperation for ICTP Ramanujan Prize in Mathematics

The 'Ramanujan Prize', named after the illustrious mathematician from India, for outstanding contributions by young mathematicians from developing countries is being

awarded annually since 2005. As per the MoU between ICTP and IMU, DST agreed to fund the annual 'Ramanujan Prize for Young Mathematicians from developing countries' for a period of five years following 2014. Dr. Amalendu Krishna, mathematician from the Tata Institute of Fundamental Research (TIFR), Mumbai, India, was awarded the '2015 Ramanujan Prize' in recognition of 'his outstanding contributions in the area of algebraic K-theory, algebraic cycles and the theory of motives.' The award carries a citation and a prize money of USD 15,000.

17 Indo-US Fulbright-Kalam Fellowships in Climate Change

The Fulbright-Kalam Climate Fellowship has been launched in pursuance of the Joint Statement of the Government of USA and the Government of India. The United States-India Educational Foundation (USIEF) has been given the responsibility to administer the Fulbright-Kalam Climate Fellowship on behalf of both the governments. The first batch of six fellows has been selected.

18 Program with Centre National de la Recherche Scientifique (CNRS)

Initiated co-operative program with the Centre National de la Recherche Scientifique (CNRS) of France to further accelerate scientific cooperation in frontier areas of mutual interest through thematic networked Centres.

19 India-Italy Partnership

A new chapter of cooperation with Italy was enabled through the

Industrial R&D program focused on industry led research which would enable development of new process or products in sectoral areas covering Advanced Materials, Smart Manufacturing, Technologies for Cultural Heritage and Water Technologies. Two new Indian beamlines were also established at the synchrotron facility at Elettra and access to more than 150 Indian researchers to this facility was also provided.

20 India-Russia Partnership

A new programme was launched with the Russian

Ministry of Education and Sciences (RMES) to support joint research projects in the areas of Applied Sciences. DST and the Foundation for Assistance to Small Innovative Enterprise (FASIE) of the Russian Federation concluded a new MoU to further the objectives of supporting enterprises in both countries for technology development through industrial research and innovation.

21 India-South Africa Partnership

A novel program on grass-root innovation was launched with

South Africa for sharing of open source technologies and IP protection of traditional knowledge systems. This program is designed for co-development of products, validation

through deployment and market ready technology transfer to meet the unmet needs of common people.

A multi-institutional project on HIV Vaccine Research has been also initiated to develop preventive HIV vaccine that will also lead to identification of biomarkers and development of novel techniques for diagnosis and management of tuberculosis.

22 India-South Korea Partnership

The South Korea virtually-networked R&D Centres on

'Robotics' and 'Computational Materials' have been established. These Centres are aimed at leveraging complimentary R&D strengths of both countries through convergence of competencies in design, simulation and development of advanced manufacturing techniques.

23 India-US Partnership

A new priority R&D area on Smart Grids and Energy Storage

was supported through joint consortia-based project to enhance the cooperation with USA under the Partnership to Advance Clean Energy Research (PACE-R). India also became a partner in the LIGO project for gravitational wave detection with agreement to set-up the detector station in India.



The call announcement of the India Science and Research Fellowship (ISRF) 2017-18 launched in the 2017 India International Science Festival, Chennai

24

Partnership with neighbouring countries

India Science and Research Fellowships were extended for seven neighbouring country scientists for undertaking research work in India. These include fellowships for Afghanistan, Bhutan, Bangladesh, Maldives, Myanmar, Nepal and Sri Lanka. S&T Ministers Conclave was also organised as a part of the 2017 India International Science Festival held in Chennai. Ministers from Afghanistan and Bangladesh participated in the event. On the occasion, Hon'ble Minister announced 200 travel slots for researchers and scientists to avail various training opportunities in India.

Activities/Achievements of CSIR International S&T in Cooperation & Collaborations

Process flow sheet for beneficiation of low grade Iron ore sample from Shire-Mentebteb, Ethiopia

CSIR-NML has developed a process flow-sheet for beneficiation of the low-grade iron ore (as saying 33.17% Fe) of Ethiopia to produce concentrate with 51% Fe. About 500 million tonnes of iron ore resources are located in Shire-Mentebteb region of Ethiopia. The deposit is a lean grade goethitic ore and it is to be concentrated to a level suitable for utilization through blending with high grade concentrate for iron and steel making.



CSIR's Twinning Programme with the Metal Industries Development Institute (MIDI), Ethiopia

CSIR is not only helping Indian industries with its knowledge base and expertise but is also foraying in developing and under developed counties to enhance their competitiveness. One such example is CSIR's agreement with the Metal Industries Development Institute (MIDI), Ethiopia. CSIR will enhance the capacity and capability of MIDI under the twinning arrangement and thereby enable it to contribute more efficiently towards the development of Metals and Engineering sectors in Ethiopia.

Working programme between CSIR and Vietnam National University

In furtherance to the MoU signed between CSIR and Vietnam National University (VNU), a "Working Programme" was initiated between the two organisations during 2014 -16 for S&T collaboration in the areas of chemical science & technology and geosciences, oceanography and climate change.

MoU signed with Stiftelsen SINTEF

CSIR and the Stiftelsen SINTEF headquartered in Norway entered into a MoU towards developing Scientific & Technical cooperation at Oslo, Norway during the visit of the Hon'ble President of India to Norway.

DBT International Collaboration

As India is emerging as a major biotechnology hub in the Asian region, there is a need for scientific capacity building to match the global standard and for facing new challenges. The Department has strategically developed strong international collaborations with numerous countries and non-governmental organisations over the last decade. DBT has also initiated the process of constant dialogue with the scientific communities across the globe for generation of new ideas and concepts in all areas of biotechnology and life sciences. More than 400 R&D projects were supported with nearly 20 countries. Few recent developments in international collaboration are summarised below:

Australia

Agreement has been signed for collaboration in important areas of biotechnology like aquaculture and marine biotechnology, vaccines, bioenergy and biofuel, stem cell, transgenic breeding, food technology with the Australian Department of Education, Science and Training. Proposals were invited in the area of immunomodular, immunotherapeutics, biotechnological intervention for improved agricultural productivity and vaccines. The Indian and Australian Governments have set up the Australia India Strategic Research Fund where competitive funding is awarded under two components covering a range of science and research priority areas-Indo-Australian Science and Technology Fund, Indo-Australian Biotechnology Fund for providing support for collaborative research projects with an Indian and an Australian applicant

Canada

The department has ramped up its collaboration with different Canadian agencies. A major initiative was announced during the visit of Hon'ble Prime Minister of India to Canada in April 2015. In it, five health innovations in India are being funded by Department and Grand Challenges, Canada and the Government of Canada. Department in collaboration with IC IMPACTS (the India-Canada Centre for Innovative Multidisciplinary Partnerships to Accelerate Community Transformation and Sustainability), Canada under the ongoing programme "Water for Health" have funded several projects. In order to further collaboration with IC-IMPACTS, a joint call in the area of "Portable Diagnostics and Analysers" was announced. There will be increased focus on the development and evaluation of new diagnostics and analysers for infectious diseases, maternal and infant health, nutritional deficiency and interdisciplinary approaches and platform technologies.

Denmark

Department in collaboration with Innovation Fund Denmark (previously Danish Council for Strategic Research) invited

proposals for Strategic Research Projects within Human Health Biotechnology. Under the call one project was jointly recommended for funding.

Finland

Department in partnership with TEKES, Finland (a funding agency for technology, innovation and industry collaboration) invited proposals in the area of "Innovative health and well-being solutions for all" through joint call.

France

Department has signed a MoU with the University Pierre ET Marie Curie (UPMC) and The Centre National de la Recherche Scientifique (CNRS) for the establishment of a National Institute of Marine Biology and Biotechnology in India. The MoU was signed by Secretary, DBT, in the presence of Hon'ble Prime Minister of India and the Hon'ble President of France during the Prime Minister's visit to France in April 2015.

Germany

In collaboration with German Federal Ministry, Science Research and Technology (BMBF), the Department has agreed to participate in inviting proposals focusing on Biotechnology for reuse of biodegradable urban solid waste and Biotechnology for reuse of biogenic raw materials in agriculture.

Netherlands

The Department and its subsidiary company the Bharat Immunologicals and Biologicals Ltd (BIBCOL) has signed a MoU with the Institute for Translational Vaccinology (Intravacc) of the Kingdom of Netherlands on "Development of Vaccines". The MoU was signed during the visit of the Prime Minister of Netherlands to India on 5th June 2015. Intravacc and BIBCOL have agreed to partner with the aim of setting up of a measles-rubella vaccine plant for BIBCOL.

Russia

Five joint proposals in area of nano-biotechnology, affordable diagnostics and devices in human health and bioenergy have

been supported under the 'Programme of Co-operation' (PoC) with the Russian Ministry of Education and Science, Russian Federation in the area of Biotechnology.

Spain

DBT has collaborated with CDTI, Spain (The Centre for Industrial Technological Development) an enterprise of Ministry of Economy and Competitiveness, Spain for technological development and innovation of Spanish companies.

Switzerland

A new collaborative network project titled "Improvement of pigeon pea for plant type, pod borer resistance and moisture stress tolerance" was initiated with Indian investigators from National Research Centre on Plant Biotechnology (NRCPB), Indian Agricultural Research Institute (IARI) and National Bureau of Plant Genetic Resources (NBPGR), New Delhi; and Swiss investigators from Swiss Federal Institute of Technology (ETH), Zurich, and School of Agricultural, Forest and Food Sciences (HAFL), Zollikofen with the objective to develop pigeon pea varieties with improved productivity and resistance to pod borer, which can be marketed, processed and priced in line with cereals and competing crops.

Sweden

Swedish Governmental Agency for Innovation Systems (VINNOVA) is partnering with the Department with three joint calls for proposals successfully accomplished. In the current year, a call for proposals partnering DBT, India and VINNOVA, Swedish Research Council was announced in the area of Biotechnology.

Tunisia

Under the Joint Programme of Cooperation, a project entitled "Assessment of the protective effect against Tuberculosis, of a new vaccine composition" has been sanctioned at ICGEB. A major focus of the project is on development of a novel method of vaccination against tuberculosis (TB), based on enhancement of BCG-mediated apoptosis through FOXO3

activation. The aim of the study is to use a novel vaccine composition made of the classical BCG mixed to FOXO3 activators (Commercially available chemicals and/or drugs capable to strongly activate FOXO3). Such composition would induce higher apoptosis of infected cells than the classical BCG alone and may confer a higher protection against TB.

U.K.

The Department in collaboration with U.K. partners (BBSRC, NERC, MRC, AMS, British council, DFID, Newton fund, INNOVATE) has launched programmes which touch upon an array of global challenges which are relevant in local Indian context. Flagship programmes initiated in partnership with U.K. are directed to address key issues of health, environment (atmospheric pollution), climate change and agriculture, antimicrobial resistance, vaccine development and tackling loss of farm produce. Programmes also address the need for improving upon quality of research through bilateral student exchange programmes.

USA

One of the major success of DBT's collaboration with USA is the low-cost rotavirus vaccine. DBT also spread access to the low-cost origami microscope in collaboration with Prakash Lab, Stanford University. The statement of intent for this initiative was signed by Secretary, DBT in the presence of Hon'ble Prime Minister of India on his visit to USA during the India-US STARTUP Konnect event. According to their agreement DBT and Prakash Lab are using Foldscope as an educational and training tool to understand physics, chemistry, biology and instrumentation. Workshops and training programmes are being run by Prakash lab in collaboration with Indian laboratories.

Japan

DAILAB (a collaborative laboratory called DBT-AIST International Laboratory for Advanced Biomedicine) at the Biomedical Research Institute (BMRI), Tsukuba campus of the National Institute of Advanced Industrial Science & Technology (AIST)



in Japan is the first international laboratory in Life Sciences & Biotechnology. It emerged as a step up from bilateral MoU and is aimed at promoting close and effective research collaboration and networking. The DAILAB-TENJI (Training for Technology Exhibit & Networking to Jump for Innovation and Industrialisation) has been participating in industrial trade fairs held in India and Japan to skill technology exhibiting and networking for innovation and industrialisation.

EU

DBT is partnering in the fourth joint transnational call in the area of 'Human infectious disease research' under Infect-EraNet. Under an ongoing initiative with geographical era-net INNO INDIGO, the Department has funded five proposals in area of "Clean Water and Health" under the project "Integrating Bio-treated Wastewater Reuse with Enhanced Water Use Efficiency to Support the Green Economy in EU and India (India side)".

MoES international cooperation

MoES extensively engages with the best institutes overseas in the field of earth system sciences to solve some of the key challenges in weather and climate related to the Indian region.

Cooperation with NOAA, USA

Under an MoU between MoES and the National Ocean and Atmospheric Administration (NOAA), ten joint research and development activities have been undertaken in the field of monsoon, ocean observations, tropical cyclone, tsunami, INSAT 3D, predictive capabilities on marine fisheries and harmful algal blooms, development of an ocean wave modeling and assimilation system for the Indian ocean region to enhance the capability to generate a skillful global wave model systems especially for monsoon conditions. Significant achievements have been made in joint research between MoES and NOAA



during last four years.

India expressed readiness to enhance cooperation on Arctic science and research. This was conveyed to the first ever White House Arctic Science Ministerial meeting in Washington DC where the Minister of Science & Technology and Earth Sciences, Dr. Harsh Vardhan signed a statement for the purpose. The Minister emphasised the significance of environment and climate change in the Arctic region and its impact on Indian monsoon.

Cooperation with UK Met Office (UKMO)

In 2016, MoES signed a Consortium Agreement with the U.K. Met Office (UKMO), Korea Meteorological Administration (KMA), the Commonwealth of Australia through its Bureau of Meteorology and the Commonwealth Scientific Industrial and Research Organisation (CSIRO) and National Institute of Water and Atmospheric Research Limited, New Zealand for Core

partnership on Unified Model (UM) for weather and climate forecast. This MoU enables robust collaborative partnership on joint developmental programs among all the international partners of the UM system (UK, Korea, Australia, India) under a common governance structure.

Cooperation with NERC, UK

Under this MoU, three implementing agreements (IA) have been signed with NERC UK.

1. Predicting the variability of the South Asian monsoon
2. Atmospheric pollution and human health in an Indian megacity
3. Sustaining water resources for food, energy & ecosystem services in India



India-UK Virtual Joint Centre on Water Security (IUKWC)

MoES and the NERC, UK are working together to support research in the area of “Sustaining Water Resources” and has set up a “India-UK Virtual Joint Centre on Water Security” (IUKWC) at IITM, Pune. The centre will provide a platform for joint hydrological research and greater dialogue, engagement and knowledge transfer between researchers, policymakers and business. The centre will fund and co-ordinate a diverse programme of workshops and exchange visit.

Cooperation with Belmont Forum Countries

An MoU was signed between MoES and the Belmont forum countries to support Indian scientists for international collaborative research through joint calls in societally relevant global environmental change challenges. MoES is participating in 4 Collaborative Research Areas (CRA), namely those on coastal vulnerability, food security, biodiversity and climate predictability and inter-regional linkages.

Cooperation with International Seabed Authority (ISA)

The Council of the International Seabed Authority (ISA) on 10th August 2017 approved the extension of contract between Ministry of Earth Sciences (MoES), Government of India and the

ISA (an Institution set up under the Convention on Law of the Sea to which India is a Party) for exploration of Polymetallic Nodules (PMN) for a further period of 5 years (2017-22). By extending the contract, India’s exclusive rights for exploration of PMN in the allotted area of 75,000 sq km in the Central Indian Ocean Basin (CIOB) will continue and open up new opportunities for resources of commercial and strategic value in area beyond national jurisdiction.

Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES)

RIMES is an international and intergovernmental institution owned and managed by its 33 member and collaborating states for building capacities in the generation and application of user-relevant early warning information. Currently, the Government of India serves as the Council Chair. The 9th RIMES Council Meeting and the 3rd RIMES Ministerial conference was held at Port Moresby, Papua New Guinea during 23-25 August 2017. It focused on discussion issues relating to enhancement of multi-hazard early warning capacities and to the broadening of the RIMES institutional development process. Afghanistan, Djibouti, Mozambique, Tonga, and Yemen joined as the new RIMES Member States. INCOIS started providing OSF (Ocean State Forecasts) services to various countries including Comoros, Mozambique and Madagascar.



Way Forward



Way Forward

DURING the last four years there has been a special focus on convergence and bringing science to society. Keeping with the call of our Prime Minister of Sankalp se Siddhi – Making of a New India 2022, the Ministry of Science & Technology and the Ministry Earth Sciences will strive to ensure that science and technology continue to impact society. We will deepen our engagement with society and continued efforts will be made towards quality education, encouraging youth and attracting them to Science.

Cutting edge new applications of science for global competitiveness; science for national missions; bringing more socio-economic benefits from Earth System Science services; encouraging startups and entrepreneurs, and promoting indigenous, affordable and accessible products under Make in India will be the endeavour of the ministries.

Our Motto is

Vigyan Se Vikas – Science Impacting Society.

The future road map of the Ministries is given below.

Department of Science and Technology (DST)

DST will focus on bringing together the science of the future and the social scientific needs of this huge country. Capacity building of scientists, teachers, researchers and students will continue to be high on priority and given added impetus.

- **Securing our Future:** DST to launch a comprehensive Rs 3600 Crore National Mission on Cyber-Physical-Systems (mentioned in the Budget Speech of the FM 2018), which includes Artificial Intelligence, Machine Learning, Deep Learning, etc. and the synthesis of these elements for applications in Agriculture, Health, Manufacturing, Robotics, Sensor Networks, Education, etc. The Missions will cover the entire value chain from R&D to technology development to innovation/startups to commercialization of technology.
- **Impacting Research Innovation and Technology (IMPRINT-2):** The second phase of IMPRINT-2 with a total budget of ₹ 970.5 crore has been launched in March 2018. DST and MHRD will jointly steer this national initiative. SERB will be the nodal agency for implementing IMPRINT-2. IMPRINT-2 is proposed to be undertaken in a more inclusive manner by expanding the catchment of implementing institutions, by adopting a more demand-driven strategy of solution development and by incorporating the specific externalities of the states of India so as to make end-user translation and technology adoption easier.
- **Teacher Associates for Research Excellence (TARE)** will continue to facilitate mobility of faculty members working in regular capacity in state universities/colleges and in private academic institutions to carry out research work in an established public funded institution such as IITs, IISc, IISERs, NITs, CSIR, ICAR, ICMR labs and other central institutions and central universities, located preferably closer to the institution where the faculty

member is working. Provision of fellowship amount of ₹ 5,000 p.m., contingency grant of ₹ 5 lakh per annum and overhead for a period of 3 years has been made. Maximum of 500 such awards would be granted per year.

- **Augmenting Writing Skills for Articulating Research (AWSAR):** DST has been in the forefront in devising and implementing several initiatives to communicate Science and Technology (S&T) to the society and to inculcate scientific temper among all as enshrined in the Constitution of India. In order to encourage science communication as an alternate career choice and to tap latent talent to popularize & communicate science and inculcate scientific temperament in the society, each year 100 best entries from PhD Scholars and 20 from Post-Doctoral Fellows will be awarded ₹ 10,000/- each with a Certificate of Appreciation. In addition, Cash prizes of ₹1,00,000/-, ₹50,000/- and ₹ 25,000/- respectively would be given to 3 leading stories.

Department of Biotechnology (DBT)

India's biotechnology industry has been built on four core beliefs – entrepreneurship, innovation, developing local talent, and demonstrating high quality value based care. The country is amongst the top 12 biotech destinations in the world and ranks third in the Asia-Pacific region. The industry includes 500 companies, records the second highest number of USFDA-approved plants (only after the United States). Continued support to the biotech industry to reach the target USD 100 Billion by 2025 will be the endeavour.

- Development of a translational ecosystem connecting Industry-Academia-Research to take advanced leads from our research labs to commercialization especially in the health, agriculture and energy sector.

- Mission on application of big data and computational biology and biotechnology.
- Building and strengthening partnerships with national and international stakeholders. Will collaborate across ministries, state governments and build robust biotech capacity across the country
- International Bioconnect offices will be established to leverage International strengths for national impact. Vibrant translational ecosystems for cutting edge science for maximum social development.

Council of Scientific and Industrial Research (CSIR)

CSIR is repositioning itself towards technology and intellectual property development, translation and commercialization with a major focus on enhancing industrial competitiveness and entrepreneurship. CSIR today is focused in a major way on "Technology Innovation and Translational Research and Commercialization" to achieve the national goal of socio economic development. To achieve results, CSIR will focus on outcomes through a thematic approach to harness multidisciplinary talent and infrastructure.

- CSIR has forged close ties with stakeholders across government and private sectors around specific missions of relevance to economy including MSME, and the strategic sector.
- CSIR is focusing on solving the problems faced by the common people, through desired scientific and technological interventions such as affordable health care, malnutrition, enhancing potability of water, hygiene and sanitation, affordable housing, to name a few.
- On the societal front, other mandates include large-scale skill development and employment generation.

- Eight Thematic Directorates have been formed in CSIR and these cover specific sectors: (i) Aerospace, Electronics, and Instrumentation & Strategic Sectors; (ii) Civil Infrastructure & Engineering; (iii) Ecology, Environment, Earth & Ocean Sciences and Water; (iv) Mining, Minerals, Metals and Materials; (v) Chemicals (including Leather) and Petrochemicals; (vi) Energy (conventional and non-conventional) and Energy devices; (vii) Agri, Nutrition & Biotech; and (viii) Healthcare.
- The Theme Directorates are envisaged to provide for greater alignment to and for enhancing industrial/ stakeholder focus of CSIR R&D activities. The roadmap and activities of each theme would focus on substantial contributions towards each of the parameters – public good, private good, strategic good and societal good.

Ministry of Earth Sciences (MoES)

MoES provides weather, climate, ocean, coasts and seismology. MoES will spread its impact from land to deep oceans. The development of Multi-hazard Early Warning Systems for Disaster Risk Management will continue to be on a high priority.

- MoES will augment the Agromet Advisory Service (AAS) network to sub-district level by setting up of District Agro-Met Units (DAMUs) in 530 districts, thus creating a network of 660 units by the end of March 2020 for providing sub-district (block) level agromet services to farmers in the country. Currently, about 24 million farmers are receiving crop specific agro-meteorological advisories in vernacular languages. It is planned to reach about 40 million farmers by the end of July 2018. This initiative will help farmers to reduce crop losses due to weather vagaries.
 - MOES will be installing six more desalination plants in Lakshadweep islands, each with a capacity to produce 1.5 lakh litres of water per day, with the help of Lakshadweep administration. Two plants will be commissioned by December 2018. These six plants are in addition to the three plants already installed by MoES. This will ease drinking water problems in the islands.
 - MoES will further strengthen the weather and climate services and establish a state of the art multi-hazard early warning system for severe weather like tropical cyclones, floods, droughts, thunderstorms/dust storms, etc. The ultimate goal will be to make India “Weather Ready and Climate Smart”.
 - MoES will further strengthen the ocean and coastal services by improving Tsunami warning system for predicting inundation due to Tsunamis, establishing Marine Coastal Pollution Monitoring and Prediction system, and assessment of Marine Litter around the Indian seas.
 - Oceans cover 72% of the Earth and provide a substantial portion of the global population with food and livelihood. The blue economy encompasses sustainable use of ocean resources for economic growth, improved livelihoods and job and health of ocean ecosystem. MoES is in the process of formulating multiagency programmes on the Deep Ocean Mission encompassing various aspects of oceans in an integrated framework with involvement of other national departments, viz. CSIR, DBT, ICAR, Department of Space, etc. It consists of appropriate programmes for sustainable harnessing of ocean resources (water, minerals and energy) and development of suitable technology like manned submersibles, deep sea mining system, autonomous underwater vehicles (AUV), etc.
- 