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Department of Science and Technology
Ministry of Science and Technology
Technology Bhawan, New Mehrauli Road
New Delhi, India-110016

Department of Science & Technology
Annual Report 2011-2012

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Government of India
Department of Science & Technology
Ministry of Science & Technology
New Delhi

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OVERVIEW

The year 2011-12 is a land mark year for the Department of Science and Technology. It earmarked the completion of 40 years of service by the Department to the S&T sector since its establishment. It is also the last year of Eleventh five year plan. Therefore, the overview of various programmes and activities of the Department of Science and Technology presents outcomes of the current year and collectively of the 11th five year plan in various schemes being implemented by the Department.

Contributions to Support and Strengthening Human and Institutional capacity in Basic Research

The report of the Steering Committee constituted for the preparation of the Eleventh plan for the Science sector proposed the establishment of new mechanisms for supporting basic research in the country. Accordingly, Department of Science and Technology established **Science and Engineering Research Board (SERB)** through an Act of Parliament during the Eleventh plan period. The Board has now become functional and evolved mechanisms and tools for supporting basic research. Science and Engineering **Research Council (SERC)** which emerged as a flagship programme of the Department of Science and Technology and the most important Extra Mural Funding Programme in the country for more than three decades has now been merged with National SERB. Whereas SERC supported research through a competitive grant model for selecting projects, the board has evolved tools for supporting the research of individuals and groups based on proven track record in addition to the SERC evolved models of R&D funding. The Board with a fund of Rs. 200 crore has commenced its activities in the financial year 2011-12.

Since the establishment of SERB, the existing SERC has been operating as a window of the board. During the year, SERC provided R&D grants to total of 207 JC Bose Fellows, 155 Ramanujan fellows, 45 Swarnajayanthi fellows, 1500 young scientists, and about 2500 project grantees. There has been a four-fold increase in the quantum of funds deployed under Research and Development support during the Eleventh plan compared to Tenth plan. There have been increases of about 250% in the number of project investigators supported through SERC. During the Eleventh plan, there have been some incremental improvements in the gender parity among the principal investigators supported through Extra Mural Research support in the country. Male: Female ratio among the principal investigators supported under Extra Mural Research projects has improved from 81:19 to 67:33 during the Eleventh plan period.

During the year, a **National Centre for Combustion Research (NCCR)** has been established with two nodesat at a cost of Rs. 93 crores. One node of the centre is sited at Indian Institute of Technology, Chennai and the other is at Indian Institute of Science, Bangalaru. NCCR will create advanced and state of art capacities in combustion research and will involve all the 55 known experts in the area in the country. It will serve also to increase the density of scientists and engineers in combustion research.

Fund for Infrastructure Strengthening of Science and Technology (FIST) is another successful ongoing scheme of the Department of Science & Technology. Since its inception the Department has supported more than 1500 departments and about 150 colleges in the country for strengthening S&T

infrastructure. Synergies have been established during the last year with Ministry of Human Resource Development through University Grants Commission for extending support for civil and building infrastructure for departments and academic institutions receiving support through FIST. During the Eleventh plan period a total of 715 departments have been supported through a fund of Rs. 782.63 crore. Of these, 118 new departments and 52 colleges have been added during the year 2011-12. The metrics for evaluation of the output of this scheme have been scientific publications, number of PhDs / post graduates trained and number of faculty members supported under FIST grants scheme. The scheme has led to significant increases in the quantum of S&T outputs in engineering research areas.

For supporting research and development in less endowed regions like North East, Jammu and Kashmir and Bihar etc., special packages have been designed and delivered by the department. These packages have been proactively designed in consultation with universities in the region. Total of 92 colleges and 18 universities have been supported in the North East Region and Jammu and Kashmir during the last three years. Under these packages, 450 fellowships have been offered for academics from the regions to undertake research in collaboration with other regions of the country. Review of the programmes has shown that the special packages have made tangible impact on the S&T systems of the regions.

Contributions to Rejuvenation of Research in University Sector

Promotion of University Research and Scientific Excellence (PURSE) is a programme under Research & Development head of the Department of Science and Technology introduced in 2008. Under this programme, universities contributing to publications in a major impact making manner are provided research incentive grant with flexibility for the universities to invest into R&D programmes. Based on the publications outputs during 1996-2006 as assessed by a third party review in 2008, total of 14 universities were recognized for grants under PURSE programme. A study in 2010 revealed that 30 new universities had qualified for support under the same criteria, namely the number of publications and h-indices derived from citations. Accordingly, 30 universities were added to the list of **PURSE** awardees during the year 2011-12 making the total number of such awardees to 44. The national share of universities in scientific publications in the year 2010 has been estimated at 31%, which had been earlier assessed at 15% in 2003.

Besides, **Consolidation of University Research, Innovation and Excellence (CURIE)** for women only universities designed and delivered proactively by the Department of Science and Technology has benefited all the six women only universities in the country in strengthening their R&D infrastructure. Each university has also been provided a mentor support for deciding investment priorities.

Technology Development and Deployment and Convergent Solution Designs for Social Challenges

Technology Development Programmes (TDP) implemented by the Department of Science and Technology aim at several and diverse objectives. Therefore, several sub-schemes have been designed to serve differing objectives. **National science and Technology Management Information Systems (NSTMIS)** is an information management system which gathers R&D statistics on India and brings out data on annual basis. The data management system has now been updated to 2010-11. National model for measurement of innovation indices has also been developed during 2011-12.

Natural Resource Data Management System (NRDMS) serves to collect Resource elated data and supports Extra Mural Research and capacity building in niche areas, while, Geo spatial technology related R&D is supported through NRDMS. Likewise, **National Spatial Data Infrastructure (NSDI)**

serves as a data sharing platform for data generating agencies of the Government of India. This unit has also motivated several states to established State Spatial Data Infrastructure (SSDI) during the last few years. The Department has developed National Data Sharing and Access Policy (NDSAP) and developed policy framework for promoting the access of data generated with public funds to civil society during the year 2011-12. Under the directives of the Government, the Department has also developed during 2011-12, a law for Vetting Imageries and Geo Spatial Information for Licensing (VIGIL) for national security considerations.

Technology Development and Demonstration (TDD) Unit of the Department embarked upon new approaches during the year 2011-12. Convergent solutions to energy problems of rural India were accorded high priority. An off-grid 250 kw hybrid power plant based on solar and biomass energy has been supported to solve energy problems of a village population of 4000 in Maharashtra. The demonstration plant is expected to offer inputs for scientific assessment of policy formulations in promoting renewable energy programmes. Similarly, a Pan-IIT Solar Energy Research Initiative has been supported during 2011-12.

Under a Technology Mission on **Winning Augmentation and Renovation (WAR)** for water, convergent solutions for 17 different types of water challenges in 12 clusters have been supported during 2011-12. More than 60 technology demonstrations have been supported in different locations in the country.

National Mission for Sustaining Himalayan Ecosystem **(NMSHE)** and National Mission of Strategic Knowledge for Climate Change (**NMSKCC)** have been mounted by the department. Total of 6 Knowledge networks have been created and several lead projects have been mounted. So far, total of 105 knowledge resource persons with expertise in the area have been networked.

Science and Technology Advisory Council (STAC) is a mechanism to link technology inputs to socio-economic Sector through respective ministries. Active linkages have been established by Department of Science and Technology with Ministry of Steel, Ministry of Mines and many others. Co funding of 5 research projects with socio-economic ministries has been made during 2011-12. A live technology portal to provide information on technology assets available with institutions and organizations under the central sector has been established during 2011-12. State-Centre Technology partnerships have been promoted with two states.

Science and Technology for Socio Economic Goods

For technology action in the field, **Science for Equity, Empowerment and Development (SEED)** programme of the department supported a large number of technology demonstration projects during 2011-12 to deploy scientific tools for improved livelihoods of weaker sections of the society especially scheduled caste and tribal population including women and elderly. Through its flagship scheme Technology Advancement for Rural Areas (TARA), long term core support was extended to select band of 20 S&T based voluntary organizations to nurture and sustain scientific manpower for taking challenges to work on technology innovations, incubation and delivery related issues for tackling emerging livelihood problems in Rural India. A Council for Science and Technology for Rural India (CSRTI) has been constituted and two nodal centres established during 2010 at IIT Madras, Chennai and NEIST, Johrat have developed specific intervention projects for increasing the social incomes in select villages through S&T outputs. Under this initiative, a new model for leveraging technology interventions for increasing the remunerative income in village clusters has been developed.

National Council for Science communication and popularization (NCSTC) has enlarged its network during 2011-12. Plans have been made to forge synergy with Ministry of Environment and Forests for Science express carrying exhibits on Biodiversity and Climate Change related topics during the next round in 2012. In commemoration of 60th Anniversary of UNESCO-Kalinga Prize for science popularization, an international event was designed and organized at Bhubaneswar during 4th-7th January 2012. A Children Science congress, Teachers Science congress, Women Science congress and Science communicators Science congress were concurrently organised along with the Indian Science Congress at Bhubneshwar from 3-7th January,2012.

On 3rd March, 2011 India gained the full adherent status in the working group on **Good Laboratory Practice (GLP)** of the OECD. This put India in the group of 34 developed countries and the 4 other non member adherent countries. India became the 3rd Non member country to get this recognition. This full adherent status to Mutual acceptance of data (MAD) would imply that safety data for pharmaceuticals, agrochemicals, industrial chemicals, food and feed additives and cosmetics generated in GLP certified labs of the country would now be acceptable in all OECD member and adherent countries. This is a result of sustained effort to establish GLP norms and prove capability for compliance in Indian testing facilities. Gaining member status offers the scope to build a national network of GLP certified testing laboratories in the country. With rigorous testing norms posing as barriers to global trade, national GLP compliance monitoring gains paramount importance. DST proposes to develop a robust GLP ecosystem in the country with both rigorous monitoring and capacity building.

National Entrepreneurship Board (NEB) enlarged the base of Science and Technology Parks (STEP), Technology Business Incubation (TBI) centres and supported more than 100 Entrepreneurship development training programmes. Connecting TBI's and STEP's has been one of the focussed initiatives of the Department. In collaboration with an Indian Media partner and Indian Institute of Management, Ahmedabad, DST mounted a programme called "Power of Ideas". A National call for the "Entrepreneurship based ideas" received more than 16250 responses from which more than 250 have been selected for mentoring and Entrepreneurship support. The overwhelming response to the call reveals an untapped opportunity to link innovation with Entrepreneurship. A small sized Innovation fund has been created under PPP model and innovation clusters have been supported in specific sectors.

Fostering International Multi-lateral and Bilateral S&T Cooperation of India

International S&T cooperation has been enlarged and deepened during the Eleventh plan. For efficient arrangement, International S&T cooperation Division is now grouped as International Multilateral & Regional Cooperation Division and International Bilateral Cooperation Division.

Indo-EU S&T cooperation has been expanded and water related R&D has been selected as the joint theme for promotion of collaboration for 2011-12. For this purpose, fund of 10 million Euro has been earmarked by both European Commission and India each. Several on going projects under EU-India collaboration programme in the areas of Computational Materials Sciences and Solar Energy Materials have started to yield important results. Brazil, Russia, India, China and South Africa (BRICS) working group meeting India made some key recommendations. Under Indo Brazil and South Africa (IBSA) framework workshops were held. Under SAARC arrangement one workshops was organized.

A bilateral Indo-German Centre for Research and Development has now been established in National Capital Region. This centre is designed to promote academy-industry collaboration under Indo-German

S&T cooperation agenda. Industrial Research and Development will be fostered through Indo-German S&T cooperation. A fund of 20 million Euros has been created with 1:1 Share between India and Germany for a period of five years. Indo-Russian Centre for Research and Development has now been established for promotion of technology partnerships with academic institutions and industries in both partnering countries. Indo-US Endowment Board has been created with a fund of 30 million US dollar for supporting collaborations between entities in both countries on innovations. The Endowment board has already met and some landmark decisions taken for fostering Indo-US collaboration in Innovation sector. A meeting with science ministers of African states is being organized in Delhi under Indo-African Initiative on 1-2 March 2012.

Facilitating India's participation in Mega Science Programmes

India's access to Synchrotron facilities has been improved significantly by building a dedicated Indian beam line in a facility in Japan. Indian beam - line in Synchrotron in Japan has become operational this year. This would increase the access to materials scientists of India to modern R&D infrastructure significantly. India has joined a major partner in establishing Facility for Anti-proton and Ion Research (FAIR). Under this partnership, India will invest up to 36 million Euro in the construction of the accelerator against which 27 million Euro worth of components would be sourced from India. This facility is expected to enhance both technical capability for building devices like accelerator components and enable access to advanced global R&D infrastructures. A Thirty Meter Telescope is being designed and built through a consortium of five countries namely China, Canada, India, Japan, India and USA in a site in Hawaii. India has joined the consortium as an observer before making decisions on partnering.

Attraction of Talent to Science Sector and to Careers in Research

Innovation in Science Pursuit for Inspired Research (INSPIRE) is national programme launched by the Hon'ble Prime Minister of India on 13th December 2008 and implemented by the Department of Science and Technology. Under the scheme, more than 5 lakhs INSPIRE Awards for children in the age group of 10-15, more than 0.75 lakh INSPIRE Internships for youth in the age group of 16-17, 7600 Scholarships for youth in age group of 17-22 for Bachelor and Masters' level education in basic sciences and 1200 for people in the age group of 22-27 have been supported until March 2011. During 2011-12 more than 1.2 lakh INSPIRE Awards, 43,000 INSPIRE Internships, about 5,000 Scholarships for higher Education, 650 INSPIRE Fellowships and 48 INSPIRE Faculty Awards have been made. A national level competition for 688 children in the age group of 10-15 selected from 2.1 lakh children was conducted in Delhi with highly successful impact.

Mission Mode Actions in Nano Science and Technology

Nano Mission made a significant impact in the country during 2011-12. More than 250 scientists, 12 Thematic Centres, 8 Units and 8 centres of Excellence have been supported under Nano mission. So far more than 670 Ph.Ds have resulted from the nano mission. During the year 2011-12, India emerged as sixth major player in scientific publications in nano science and technology field. Annual growth rate of scientific publications from India during 2011-12 is estimated at 9.7 % marginally lower than that of China at 10.1% and has registered the second highest growth rate in the world. Some important technology leads in the nano technology areas have been gained and a healthy growth trend in registration of patents in the area has been observed. Some technology leads from nano mission have been commercialized such as

silver coating of textile anti microbial property and ceramics filter for water purification, and thin film coating for solar energy harvesting etc.

Promoting Research in Drug and Pharmaceutical Sector under PPP model

Drug and Pharmaceutical Research Programme (DPRP) has entered into a phase of favorable results during the last two years. Two grants-in-aid projects were funded for conducting clinical trials in neglected diseases such as Malaria and Kala Azar. Some products have also been commercialized. They are **Alquit** (A herbal product for the control of animal ectoparasites) by M/s Natural Remedies Pvt. Ltd., Bengaluru; **Bonista** (Parathyroid Hormone as injectable for Ostepoprosis) by M/s Virchow Biotech Pvt. Ltd., Hyderabad; **Receptol** (A colostrums based protein for the management of HIV/AIDS) by M/s Biomix Networks Ltd., Mumbai; **Rhoclone** (Anti-Rho-D immunoglobulin Injection (Monoclonal) 300 mcg developed for hemolytic disease of the new born) by M/s Bharat Serums & Vaccines Ltd., Mumbai; **Leucet** (for allergic rhinitis and asthma) and **Zemet** – for diabetes by M/s Indigene Pharmaceuticals Ltd., Hyderabad. Nine new molecules are under different stages of trials. The 3 new molecules under Phase-I trials are RBx 7644 (Antibiotic by Ranbaxy, Gurgaon), LL-4858 (Anti-tubercular by Lupin Ltd., Pune), CT1 (Anti-hyperglycemic agent by CDRI, Lucknow), TRC4186 (Diabetes and aging related Vascular complications by M/s Torrent Pharmaceuticals Ltd. 4 new molecules under the Phase-II clinical trial are LL-4218 (Anti-Psoriasis by Lupin Ltd.), RBx 11160 (Anti-malarial by Ranbaxy, Gurgaon), DRF7295 (Anti-Cancer by Dabur Research Foundation), Mw+ Chemotherapy (Cancer by Cadila Pharmaceuticals Ltd.). Similarly, 2 new molecules permitted for Phase-III Clinical Trial are 80/574 (Hypolipidemic Agent by CDRI, Lucknow) and LL-2011 (Migraine – Lupin Ltd.). So far 22 product patents and 13 process patents have been obtained and the programme has enabled the training of young scholars in handling sophisticated instruments.

Geospatial Technology and Mapping Services

Survey of India (SoI) and National Atlas and **Thematic Organization (NATMO)** have undergone major internal changes. SoI has launched an initiative to undertake digital mapping of India and prepare 1:10,000 maps within the next three years. A pilot experiment to prove the technical viability of 1:10,000 maps through digital mapping has been completed during 2011-12.

Nurturing Research in Frontier and Cutting Edge S&T Areas through Grant-in Aid Support

The number of autonomous institutions receiving Grant in Aid from DST increased during 2011-12. National Innovation Foundation has been adopted as an autonomous Grant-in-Aid institution of DST. During the year 2011-12, the autonomous institutions engaged in basic research and development reported many important discoveries leading to scientific publications. Average citations per paper of publications from the institutions supported by DST exceed the national average of 3.4. JNCASR led the list of top 50 institutions with respect to average citations per paper with a value of 7.5 for the citation period 2005-09. JNCASR and IACS are among the top ten institutions of India with respect to Average citations per paper for the period 2005-09. S&T output indicators from DST nurtured autonomous institutions during 2011-12 are 2270 papers, 258 patents and 167 Ph.Ds, During the year 2011-12, Dr Balasubramanian Sundaram working in Jawaharlal Nehru Centre for Advanced Scientific Research, (JNCASR) Bengaluru was awarded the prestigious Bhatnagar prize, 6 were elected to Indian science academies and one was elected to The World Academy of Sciences (TWAS) as a fellow. ARIES reported

some key first observations from the new 1.3 meter telescope, while, ARCI has reported the commercialization of technologies for silver nano coating on textiles and ceramic water filters.

Positive Signs and Impacts

Positive impacts of several schemes implemented by DST on the Indian science sector have been recognized during the year 2011-12. India's publication growth rates for the last four years have remained in the range of 12-15% per year. During the year 2011, the publication rate seems to have exceeded 20%. Relative ranking of India with respect to the number of scientific publications has improved to 9th or 10th depending upon the type of data base employed. In chemistry, India ranked 5th and in nano science its ranking was 6th during 2010. Support of DST could be linked to more than 42% of scientific publication outputs of the country during 2011. INSPIRE Scheme reached out more than 7 lakhs people and there is evidence for increasing trends in the attraction of talented youth to study of science. In 2011, there are also indications of rejuvenation of research in the university sector. International S&T cooperation of India with other partners has enlarged in both in content and quantum. Technology solutions in some critical areas like potash based fertilizers, hybrid energy plants for rural applications, technology solutions for water related challenges and security technologies have been designed, developed and demonstrated. Positive impact of DPRP scheme is already recognized through commercialization of several leads and nine drugs being under clinical trials.

Preparing for Twelfth Plan and Future

Preparation of Twelfth plan programmes has been completed by the department. The Department of Science and Technology has been assigned the task of establishing a super computer facility which will place the country among the top five Nations with respect to technology capability in Supercomputing area. DST has proposed a plan to establish a policy development cell and propose at least 16 policy resolutions during the Twelfth plan. India has committed to spear head the development and enunciation of Science, Technology and Innovation Policy 2012. Programmes have been developed to connect the science sector to about 3 million people in India and strengthen institutional capacities in at least 100 universities and R&D institutions and establish at least 5 national centres in advanced research. Department has proposed to demonstrate planned technology interventions in at least 10 districts with beneficial outcomes on per-capita incomes. On the whole, DST enjoyed a productive phase during the eleventh plan and the beneficial outcomes of the efforts of the Department have started to become visible during the year 2011-12. There are evidences through S&T output indicators that India will rise as an important power in science during the next ten years. This seed has been sown during the last five years. There is hope for a balanced growth of the science, technology and innovation sector in the country. DST hopes to nurture the hope of the country in science, technology and innovation space.

Way forward: Changing Role of Department of Science and Technology

The Department of Science and Technology has enlarged its role during the Eleventh plan; both as a policy body and as a research funding and promotional agency. Indian science sector is poised for a planned development and emerging as a global leader. Policies, Strategies and Structural reforms would become necessary inputs for meeting the aspirations of the country to emerge as a global power. While such roles should be continued to be played by DST, it is relevant that various policy functions and other promotional roles are also accorded equal priorities by the Department. DST hopes to serve the nation

even better through promotion of science sector in the years to come. Some roles of DST for promotion of Indian science sector in wake of changing context of the country have been mapped and summarized thus:

- Policy formulation for science sector with a stronger focus on enlarging the role of private sector into Research and Development.
- Strengthening of Human Capacity with a vision to broaden the R&D base of the country while promoting excellence in science education and research.
- Strengthening of institutional capacity with a focus on rejuvenation of research in the university sector and multiplying the number of centres of excellence.
- Establishment of Technology Platforms with a special emphasis on convergent technology solutions in key areas of national importance like water, home-land security, fertilizers, solar and clean energy.
- Promotion of new mechanisms and structures for national S&T partnerships among academia, research and industry for technology development, developing and strengthening bilateral, multi-lateral and regional S&T cooperation of India with other countries for technology diplomacy, technology synergy and technology acquisitions and Public-Public-, Public-Private- and Public-People- partnerships for innovations and technology deployment.
- Serving and servicing social contract of Science and Technology for increasing living choices to people and
- Coordinate the establishment of large R&D facilities in cooperation with other agencies in the country.

CHAPTER 1

STRENGTHENING OF HUMAN CAPACITY IN RESEARCH

The Department of Science and Technology has established the **Science and Engineering Research Board (SERB)** through an Act of Parliament during the Eleventh plan period. The Board has now become functional and has evolved mechanisms and tools for supporting basic research. Science and Engineering Research Council (SERC) which has been a flagship programme of the Department of Science and Technology and the most important Extra Mural Funding Programme in the country for more than three decades has been merged with National SERB. The **Science & Engineering Research Council (SERC)** in Indian S&T system has enhanced the Indian capability and global visibility in research and has driven level of funding support system per scientist to critical levels. It has created and nurtured competency in frontier areas of global standards especially in areas like Plasma Physics; Structural Biology, Neuroscience, Organic Synthesis; Robotics & Manufacturing, Biomedical Engineering etc. SERC has emerged as a national model for a transparent & rigorous peer review mechanism. The output and outcome indicators from SERC supported research are also very encouraging. The R&D promotional activities are further intensified through innovative programmes such as Intensification of Research in High Priority Areas (IRHPA), Fund for Improvement of S&T Infrastructure in Universities and Higher Educational Institutions (FIST), FAST Track Young Scientist's R&D programme and Prestigious Fellowships like J.C Bose, Ramanujan and Ramanna. The focus of the programmes under the Research & Development Support has been restructured after the Science and Engineering Research Board (SERB) takes over the basic research projects and programmes undertaken by the Science and Engineering Research Council scheme. The SERB is expected to play an important role in national development and will improve upon the best global practices in the area of promotion and funding of basic research.

ATMOSPHERIC SCIENCES

Studies in atmospheric science encompass a wide range of disciplines; include the physical, chemical, biological and dynamical aspects of the atmosphere (lower, middle and upper atmosphere), the monsoons, coupled land-ocean-atmospheric system, geosphere-biosphere interactions and development of atmospheric technology. During the period under report organized two meetings of the 'Program Advisory Committee on Atmospheric Sciences'. A group monitoring workshop was organized in which 21 ongoing projects were monitored. The salient achievements under the above program are as follows:

Atmospheric Dynamics and Modeling

A micrometeorological tower is being established at Silchar, Assam to understand the atmospheric features in the region. Studies of the atmospheric energetics during different epochs of the southwest monsoon season, and inter comparison of model simulations with different resolutions, predictability studies of the atmosphere using error growth in the mesoscale and global models, numerical simulation of western disturbance and associated extreme weather using a mesoscale model, Monsoon Rainfall forecasting using Neural Networks and establishment of a coupled climate and carbon cycle modeling activity and climate variability over India using Regional Climate model are under progress.

Space Weather Physics and Dynamics

Observational studies on 'Schumann Resonance Phenomena in the Earth-Ionosphere cavity' at Agra have been initiated. Investigations on the structure and dynamics of ionospheric irregularities through radio beacon scintillations, very low frequency wave propagation and exploration of magnetospheric plasma, variations of the total electron content and ionospheric perturbations due to earthquakes, characteristics of low latitude magnetic pulsations over two Solar cycles, remote sensing of low latitude ionosphere and magnetosphere using whistler technique and application of global positioning system for monitoring the Earth's atmosphere, study of nonlinear processes in Sun Earth connection, investigation of atmospheric effects on future ground based augmentation for GPS system and electro-dynamical control over the ionization processes near the northern crest of equatorial ionization anomaly and beyond are in progress.

Atmospheric Technology Development

The 'Design and development of multi-channel hand-held Sun Photometer' and its validation has been completed. A mini-profiler with ~200 MHz frequency band was developed, tested at Hyderabad towards establishment of a 'Stratosphere-Troposphere (ST) Radar facility at Nainital'. Initiated new projects on 'Studies on the Troposphere features and Stratosphere Troposphere coupling processes over the Monsoon region using Stratosphere Troposphere (ST) Radar at Cochin' and 'Development of ST Radar facilities for Atmospheric studies in the Geophysically sensitive Tropical to Sub-Tropical transition region' under IRPHA Scheme**.** Also identified Visakhapatnam as another scientifically important location towards the establishment of ST Radar and further discussions are in progress. Development of multi wave length LIDAR for cloud microphysical studies is in progress.

Aerosols and Air Quality

Observational and modeling studies on source apportionment of atmospheric dust fraction in the Raipur region were initiated. Studies on the 'Role of Polycyclic Aromatic Hydrocarbons (PAH), Volatile Organic Compounds (VOC) and Ammonia in aqueous phase atmospheric autoxidation of Sulfur dioxide', 'Ambient air pollution and its sources in the background sites of different hill spots in the northwestern Himalaya, Himachal Pradesh', 'Characterization, toxicity and health risk assessment of polycyclic aromatic hydrocarbons in particulate matter and emissions from different combustion fuels', 'Spatial and temporal dynamics of urban heat island in Delhi and its implication for the air quality of Delhi', `Behaviour of Ozone and its precursors under different industrial environment around Udaipur' and `Physical and optical properties of Aerosols over an urban location- Jaipur' are in progress.

Agrometeorology

Lysimetric studies to develop 'Crop coefficients' for enhancing water productivity of crops in Meghalaya and quantification of 'Green House Gas' emission in rainfed cropping systems have been initiated. Studies on 'Carbon sequestration potential of reduced tillage system under rainfed conditions', 'Crop-weather Pest interaction studies in Rapeseed Mustard in Assam', 'Integration of crop growth and yield response of cotton to multiple environmental stresses, soil and genotypes in space and time by dynamic simulation' are in progress.

Human Resource Development

The SERC School on 'Seismo Electromagnetics' was organized at Agra and the School on 'Radar Probing the Atmosphere' at Nainital.

Thrust Areas for Support during 12th Plan Period

The following thrust areas were identified during the 12th Plan period.

1. Weather and Climate Processes
2. Land-Ocean-Atmosphere Interactions
3. Crop-Weather Interactions
4. Science of Climate Change
5. Air Quality and its impact on Society
6. Middle Atmosphere: Observations and Modelling
7. Ionosphere and Space Weather Research
8. Navigation and Telecommunication
9. Planetary Atmospheres
10. Human Resources and Infrastructure

EARTH SCIENCES

Grants-in- aid is provided to carry out research in challenging areas of Earth Sciences, through extramural funding, facility creation and manpower development. Support for organizing national seminars as well as for attending seminars / symposia is also provided to young and deserving scientists. The scope of the programme includes study of Earth and Earth System Processes – it's coupling with the atmosphere & oceans. In this programme, individual R&D proposals attempting to carryout research in forefront areas of earth sciences are supported through peer review mechanism. Co-ordinated programmes are evolved wherever an integrated approach to understand a problem / phenomena is felt. Every year around 100 research projects are supported under the scheme. As part of manpower development several contact programmes and Summer / Winter schools are organized in areas of national / global interest. The Earth Sciences Programme is implemented through SERC Division of DST and is guided by a Galaxy of experts viz. the Programme Advisory Committee on Earth Sciences. The Programme Advisory Committee on Earth Sciences, in addition to recommending projects to be funded also shoulders responsibility to scout for talent to take up specific research problems, identifies gaps in research, information and advises DST on improving the research environment in the country through manpower training, Brainstorming sessions or facility creation. Several national facilities related to ICP-MS, ICP-AES, EPMA, Fission track dating etc have been supported to different Universities/ Institutions under IRHPA programme. Necessary efforts are also being made to create manpower around these facilities.

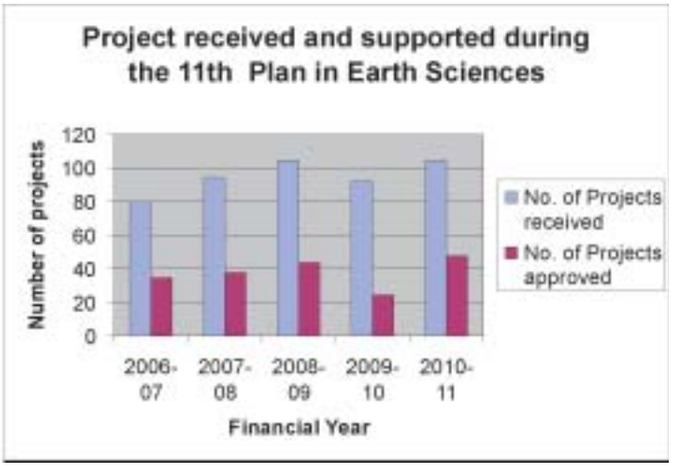


Fig. 1.1

There has been a substantial increase in funding of earth science projects during the l1th five year plan period (fig 1). A good

number of PhDs and research publications have been brought out during the 11th Plan period. There is an increase in earth science publications in SCI journals by 12%.

I. PAC-Earth Sciences Programme

Earth Science has emerged as a multi-disciplinary science dealing with a variety of products and a gamut of complex processes, and over the years research on these has substantially increased the knowledge of the past and recent geological features, and of the natural resources. This development has led to the identification of a range of new questions and to the initiation of new lines of research. A major contemporary emphasis has been to understand and quantify the earth's endogenic and exogenic processes which control its internal dynamics and shape its surface, contributing to global change.

Earth Sciences research in India has undergone major changes over the years. With the creation of modern research facilities and availability of state-of-the-art equipments, the traditional qualitative approach of exploration, description and data generation has changed to more quantitative methods of data collection, processing and interpretation. This change of approach has been necessitated not only by the fact that ESS complexities and new emerging questions needed in-puts from multiple branches of science for solution and interpretation, but also by the recognition that such knowledge is crucial for planning for sustainable development of the natural resources and assessment of natural hazard scenarios, the two most important aspects of societal concern.

A document is being prepared by extracting relevant conclusions and major highlights of DST-sponsored Earth Science research carried out during 1990-2010 from 240 final project reports made available from DST project files. These reports have been classified and categorized into 17 major themes. In order to achieve coherence in the description of the highlights each theme has been differentiated into several sub-themes. It has been found that a substantial work has been carried out in earth sciences field during the last one decade and we need to march ahead with the help of new analytical techniques by adopting multidisciplinary approach.

II. Science of Shallow Subsurface Programme

During the last five years there has been a renewed interest and recognition of the social relevance of Earth System Science. This is exemplified by the studies carried out under Science of Shallow Subsurface (SSS) Program of DST. It was felt that we need to study and understood the shallow subsurface (up to about 100 m depth) for all its properties and processes, under different geographical and geological terrains, so that land management is possible and life on land can be sustained.

Recognizing the essentiality of our knowledge of the shallow subsurface, the DST supported this research initiative as a thrust area of research for the last five years.

The SSS study is multidisciplinary and includes aspects and people from various disciplines like geology, geophysics, geochemistry, hydrology, pedology, agriculture, ecology and microbiology. The study is India centric with its unique climate, geology, biology, history and is very relevant to our ecosystem. It was also recognized that there is a need to study the areas of floodplains and deltas. This is because these areas have seen maximum land use density for a long period and could provide valuable information on the Quaternary climate and geological history of the region.

Studies in the Gujarat corridor have been carried out in three windows (a) Baroda window, (b) Kachchh window and (c) Narmada window. A total of 18 projects were funded in these windows and a significant number of publications have been brought out from this window. (Fig. 2)

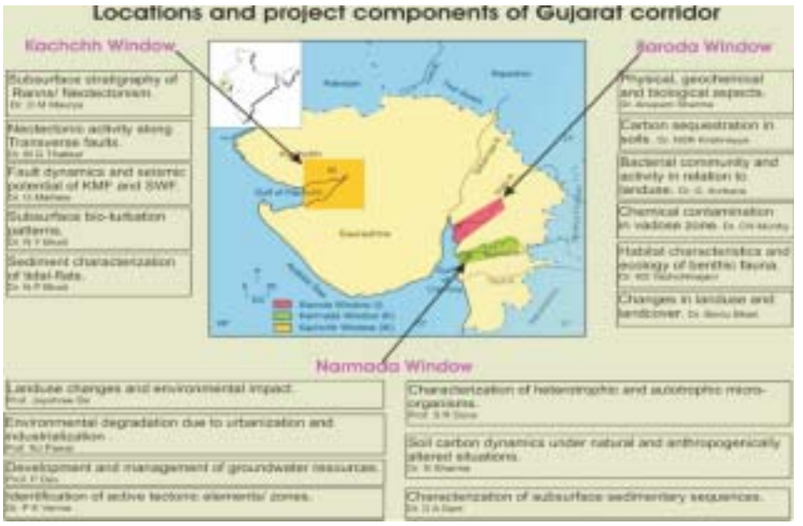


Fig-1.2: Projects supported in Gujarat Corridor under SSS programme

The subsurface sediments (down to a depth of 40 m) dating back to 125 Ka of Baroda window show significant physical, chemical and biological changes. A transition in climate conditions, land-sea marginal setup and having marine-fluvial-aeolian sediments of late Pleistocene to recent age all along the river course, provide an opportunity to address issues like provenance, palaeoclimate, depositional environment coupled with diagenetic changes.

The Ganga plains are of great significance from an academic standpoint, as they hold important clues regarding the tectonic and climate factors that governed the interaction between the Himalayan orogen and the Foreland. Understanding the landforms of the Ganga Plains – their origin, development and dynamic imprints – is therefore of critical significance to plan effectively for sustainable development of the region. It was observed that the climate played a dominant role in the sedimentary architecture and the Interfluve region includes large buried valleys-high groundwater potential. Project undertaken are shown in Fig. 3.

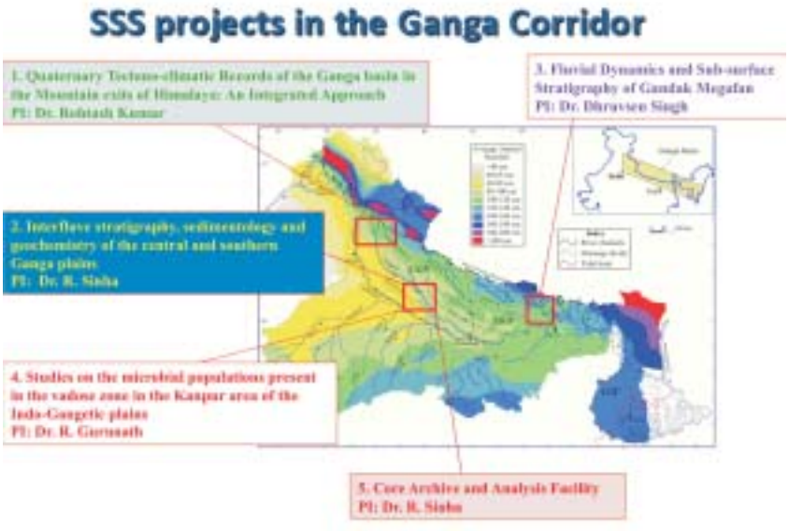


Fig-1.3: Projects supported in Ganga Corridor under SSS programme

For the first time an integrated multidisciplinary study on the sediments from the Cauvery Delta region has been carried out and has yielded significant results towards the goal of understanding the stratigraphic record and its response to source area variability, climate and sea level changes and their impact on the delta building process in this region. Integration of outcrop data, drill cores, geophysical data, clay mineralogy, geochemistry, pollen analysis and isotopic studies i.e. multi-proxy approach have provided valuable information.

Large scale (1:50000) geomorphological and lithological maps have been generated for the eastern segment of North Brahmaputra Plain (NBP) through visual interpretation of high resolution satellite data (IRS LISS III FCC and Cartosat 1) followed by ground verification along selected traverses under the above programme.

III. Deep Continental Studies (DCS) Programme

The Deep Continental Studies programme was launched in 1986 with a view to probe deep earth's interior by multi-disciplinary geophysical and investigations with multi-institutional participation. The programme's principal objective is to identify the geotectonic corridor in the Indian subcontinent and initiate investigations to delineate the subsurface geological structures and to elucidate their geological, geochemical and geophysical characters. Several geotectonic corridors were launched under the programme with integrated geological and geophysical components. Some of the corridors like the Central Indian transect, NW Indian transect, NW Himalayan transect, Southern Granulite Terrain (Phase-I & Phase-II) were completed and a few publications have been brought out for the dissemination of knowledge among scientific community. The other corridors viz., NE Himalayan syntaxes, Barren Islands, Sikkim corridor, Indian Dykeks, Paleomagnetism and Magnetostratigraphy are near completion.

Vision for 12th Plan Strengthening Basic Research and Expanding R&D base-Human Capacity in Earth Sciences

The new concerns of Earth Sciences have opened up new vistas and challenges in addition to those that existed in the traditional areas of groundwater exploration and management, surface water resources, mineral exploration and energy resources. Rapid strides have taken place via new technologies and sophisticated instruments for the acquisition of the synoptic data sets using remote sensing techniques. This has provided entirely new perspective in the areas of geodynamics, particularly seismology and neo-tectonics; monitoring of natural phenomena over short temporal scales, and hazard management. There is a strong need to initiate multidisciplinary studies in few important areas like palaeoclimate studies, structural deformation and experimental modeling, metallogeny , tectonic geomorphology etc.

Under the DCS programme of the DST, a very meaningful campaign has been launched by the DST, through a multidisciplinary and multi-institutional endeavor to obtain a glimpse of the natural process in the formation of Indian sub-continental mass. It is felt very necessary to get the picture of this evolution of the crustal mass of India in better detail and precision, using the new techniques and technologies as well as expertise that are available in different institutions and centres of scientific research. DST had initiated the DCS programme, which in its first leg of such an endeavor has been a noteworthy achievement and which has been lauded by various science organizations, both within the country and abroad.

LIFE SCIENCES

ANIMAL SCIENCES

During the year two new initiatives were launched and new projects were sanctioned apart from funding ongoing projects. The new initiatives launched during the year are, (i) 'Intensification of basic research in bird biology', and (ii) 'Strengthening of faunal research in North East India'. Capacity building activities focusing on research in chronobilogy, neurobiology, and herpetology were also undertaken during the year.

New Initiatives

a) Initiatives for intensifying research in bird biology

Activities for intensifying basic research in bird biology were initiated during the previous years.In this direction a 2007 a 'brainstorming session in ornithological science in India' was held at Gurukula Kangri University, Haridwar in 2007, to take stock of the state of ornithological studies in India followed by a four day 'thematic workshop on avian biology' in 2008. During the current year, 106 concept proposals were received in response to the advertisement. These proposals were discussed in detail by an expert committee. Eighteen proposals were found to be suitable for submission with minor modifications. Thirty five proposals qualified for next level of intervention and the investigators were invited for interaction meeting with experts. The objectives and methodologies were discussed in detail and inputs were provided to improve the scope of each proposal. The participants were also requested to submit reformulated proposals in the light of the discussions. The revised proposals are being processed through peer review mechanism for consideration of funding.

b) Initiatives to strengthen faunal research in North East India

A programme has been initiated to sensitize and strengthen basic research in animal science, particularly wild life in North Eastern India, one of the hot-spots of bio-diversity in the world. A series of activities were initiated for the past couple of years including brainstorming sessions followed by thematic workshops. In response to these initiatives 72 concept proposals were received. These were screened by a group of experts. Thirty five proposals qualified for the next level of intervention. All these PIs were given a chance to attend the interaction meeting so that they could develop a viable research proposal. In the interaction meeting the science component of these concept proposals were discussed threadbare and inputs were given to improve the general scope of each project by focusing on objectives and methodologies in sufficient detail. The participants were advised to submit reformulated proposal in the light of the interaction meeting and the reformulated proposals are being considered for funding.

Ongoing capacity building activities

During the past five years, workshops, interaction meetings and a few series of national schools focusing on research in sub-areas of animal sciences, such as herpetology, neurobiology and chronobiology were implemented. These activities involved faculty members from different parts of the country and abroad.

The heterogeneous participants were selected from different parts of the country by the respective planning committees. The schools were for a period of fifteen days each.

Herpetology schools were initiated during 2007 and the 1st school was held in North Orissa University, Baripada. The 2nd was held at Wild Life Institute of India, Dehradun, followed by 3rd at Arya Vidya Peeth, Gauhati and the 4th at Salim Ali Centre for Ornithology & Natural History, Coimbatore. The 5th school is scheduled at North Orissa University during 24th February to 10th March, 2012. More than 100 researchers have been trained in herpetology and most of them are active researchers and are associated with institutions, universities and conservation NGOs.

Schools focused on neuroscience research for a 5-year annual cycle was first started in 2007 to impart quality training to young and promising investigators. The first school was held at Nagpur University, followed by the 2nd at Indian Institute of Science, Bangalore and National Centre for Biological Sciences, Bangalore. The third was conducted at IISER, Pune and the fourth at National Brain Research Centre, Manesar. The 5th school is scheduled during February 16-29, 2012 at NIMHANS, Bangalore. 25 participants were trained in each school and several of them are pursuing successful careers in neurosciences.

Schools on chronobiology were first started under animal sciences programme in 2001 to impart intense training in theory and some hands on exercises for nationally selected group of young researchers in the field of chronobiology. The second series of 3-year annual schools were again initiated in 2007 and were conducted at Lucknow University , NEHU Shillong and JNCASR, Bangalore. The third series of 5-year annual schools in chronobiology was launched in 2010 and the first in this series was held in Delhi University, Delhi, followed by CCS University Meerut and the third school is scheduled at North-Eastern Hill University, Shillong during 20th June to 3rd July, 2012. Chronobiology has become a part of M.Sc. Zoology curriculum in several Universities. The number of active researchers in the area has increased.

Biochemistry Biophysics, Microbiology and Molecular Biology

The Department continued to promote modern biology by providing grants for research in the sub-areas of biochemistry, biophysics, molecular biology and microbiology. This intervention has been successful in enhancing of Indian researchers competence in the field of modern biology, by enabling capacity building in emerging areas, strengthening the required infrastructure and publication of research papers. Through these efforts, about 15 research projects were sanctioned and funded by December 2011. Another about 15-20 projects are in the pipeline. More than fifty percent research projects have been sanctioned to the academic institutions.

Achievements of the programme under the sub-areas were as follows:

Some of the research projects funded in the sub-area were as follows:

- "Binding, conformational and molecular dynamic simulation studies of different phytomedicines with human serum albumin
- Mechanism of antioxidant as well as DNA damage prevention activities of different natural occurring flavonoids and their synthetic derivatives

- Identification and functional characterization of transcriptional regulators involved in tropane alkaloid biosynthesis in Datura metel
- Dietary polyphenols as modulators of energy sensing network: evaluation under insulin resistant conditions

Research from some of the ongoing and completed projects in the sub-area revealed the following:

- A novel cutinase have been identified, cloned, expressed, purified and characterized. They are shown to be thermostable, stable in organic solvents, and surfactants and have broad substrate specificity and temperature, pH dependence. This could have the potential for replacement of lipase for transesterification process and other applications in various industries.
- Structural Biology and Biophysics

  Some of the research projects funded in the sub-area were as follows:
- Structural studies of serine protease from Mycobacterium tuberculosis
- Role of five terminal residue in folding and stability of yeast iso-1-cytochrome-c.
- Folding and stability of naturally truncated photosynthetic pigment, C-phycoerythrin from cyanobacteria Phormidium tenue
- Understanding the mechanism of inter-cell communication in Staphylococcus aureus.
- Effect of Macromolecular and Osmolytic Crowders on Protein Structure and Folding
- Characterization of folding intermediates of Chymopapain

Research from some of the ongoing and completed projects in the sub-area revealed the following;

- A detailed investigation on two large members, namely, BGLI and BGL II of family 3 of the glycosylhydolase families has been made in the study using both CD and florescent spectroscopy. Complete sequence of BGL1 encoding BGL1 was determined and the protein successfully expressed in the extracellular Pichia pastoris. Glycosynthase BGLI was also synthesized which has been effectively used for synthesis of sugars with 45% conversion efficiency.
- The function of Zymomonas mobilis putative endoglucanase enzyme was predicted using In-silico analysis and expression pattern of this putative enzyme was studied at the transcript level. The results were further validated by cloning and expression of the putative endoglucanase gene in E. coli. by using it has been suggested that this enzyme could play important role in ethanol production.
- First crystal structure of the naturally occurring ZAG-PIP complex was reported from seminal plasma. The structural features and interactions between them have been shown to be very specific suggesting that the resulting complex of ZAG and PIP may have formed for specific function. This complex dissociates in presence of organic solvents and also retains its ligand

binding ability as in native ZAG. This study is useful in delineating the role of ZAG PIP complex in fertility and immunomodulation, thereby better understanding of reproductive physiological processes related to fertility/ infertility.

- Crystal structure of native Lactoperoxidase as well as their complexes was determined from four mammalian species at high resolution. The structure of the complexes of LPO with TB prodrug isoniazid (INH) and other aromatic compounds were also determined. A comparison of the structural and chemical characteristics of the distal heme binding site and diffusion channel in LPO with MTB catalase peroxidase suggests a similar mode of binding and action in these two proteins. This finding may be useful in the treatment of tuberculosis.

- Cloning, expression, purification and sequencing and biochemical characterization of the protein ã-glutamyl cysteine synthetase (ã-GCS) and glutathione synthetase (GS) and three dimentional structure analysis for rationalisation of the function of the proteins has shown functional activity of the constructs. In-silico homology modeling of the protein from the recently availabl homologue from yeast has also resulted in a model. The results of the result could enable understanding the mechanism of the protein which could be used to selectively target the pathogen.

- Peptidoglycan recognition protein(PGRP) was purified, crystallized and its three dimentional structure determined and studied extensively in both native and complexed states. The protein was complexed with commonly occurring Pathogen Associated Molecular Pattern (PAMPs) and other complexes. A total of 16 structures were deposited in Protein data bank. First structure of a complete PGRP-S isolated from mammary secretions of camel was also determined. It revealed that CPGRP-S forms a stable homotetramer and recognizes bacterial cell wall molecules, binds to them with high affinity and sequesters bacteria eventually killing them. It was therefore proposed to be a potentially useful protein antibiotic for controlling infections.

- The bovine PLA2 clone was expressed in E. coli The overall tertiary structure of all three active mutants was found to be similar to that of the wild type enzyme. It was shown that the active site framework remains intact in all the mutant structures. It was also established that water plays important role in maintaining the framework intact.

- The three dimensional structure of EhCaBP1 was determined . It was observed that CaBP1 was in monomer-trimer trasition . The trimer can activate the kinase but monomer can not. It was proposed that E. histolytica might have evolved dual way of regulating the endocytosis and one by calcium regulation and another by pH sensitivity.

Molecular and Developmental Biology

Some of the research projects funded in the sub-area were as follows:

- Identifcation of molecular targets for Alzheimers disease

- Genetic transformation in plant for salt tolerance.
- Retinoic Acid signalling in developing chick optic tectum
- Role of protein hydration water in the flap opening-closing mechanisms of HIV-1 Protease: Possible implications for designing new class of anti-AIDS drugs.

Research from some of the ongoing and completed projects in the sub-area revealed the following:

- PITX2 was shown to regulate plod2 gene in ovary which thus maintains the ovarian ECM and collagen metabolism. Co factors like LHX3 and GCMa were identified that interact with PITX 2 in ovary suggesting its co factor specific interaction in ovarian function. The study unravels a new challenging area of PITX2's involvement in gonadal development and function and will help to know the possible role of PITX2 in mammalian germ cell function and mechanism of gonadal development.
- The centromeres of *C dubliniensis were i*dentified and characterized Neocentromere formation and its hotspots were identified in *C albicans*. It was also shown that centromere sequence of two closely related yeasts diverge rapidly and these centromeres are formed at specific sites and are probably these regions are the fastest evolving loci in the whole genomes of these two yeasts. The research, (the centro mere specific probes) has the potential to be used as diagnostic measures to identify species in an individual.
- "Decursin" was shown to have strong antiproliferative and death inducing potential. It was also shown to induce GI cell cycle arrest in Du 145 cells and suppress EGFR pathway, one of the main pathways to control proliferation. The study suggested that Decursin possesses strong anti-metastatic potential by inhibiting DU 145 cell migration and adhesion. It has been inferred that Decursin could be promising anticancer agent in the management and prevention of prostrate cancer which is proposed to be validated further.

Microbiology

Some of the indicative research projects funded in the sub-area were as follows;

- Role of Ftsz protein in bacterial cell division
- Cloning and characterisation of DNA repair protein from Malaria parasite
- Studies on novel two domain protein hemoglobin of *Mycobacterium tuberculosis*.

The outcome of research from some of the ongoing and completed projects in the sub-area is as follows:

- P glycoprotein (PGp)(150kDa) with ATPase activity likely to be involved in insecticide resistance was purified and characterised from insecticide resistant *H armigera. T*his protein was purified and found to be a glycoprotein displaying ATPase activity.The role of Pgp in *H armigera* was investigated and found that it was involved in effluxing in of insecticide and making the pest to become resistant to different insecticides.
- In view of the crucial role played by the iron in the mycobacterial metabolism, and in designing metal based drug framework, investigators have used iron antagonistic metals like copper and their metal conjugate, and tested on *M. tuberculosis* grown under conventional medium and

high and low iron medium. Copper complexes of pyruvic acid hydrazide were shown to exhibit potent anitubercular activities.

- Genetic evaluation of biocontrol properties of two isolates of *Pseudomonas fluorescens* strains Psd and Pft1 was carried out. In this context two antibiotics, phenazine and pyrolnitrin were identified. Genetic configuration was derived by PCR identification, cloning of a pathway gene and sequencing. Biocontrol property of the wild type variant was assessed in-vitro. Plant protection response against a phytopathogen was also demonstrated**.**

HEALTH SCIENCES

The Department continued support to projects/ programmes and activities in the cutting edge and frontline areas of Bio-medical/Health Sciences.

The projects/programmes sanctioned during the year focused on strengthening of knowledge in biomedical sciences, generation of baseline data, development of diagnostic methods devices and processes, study of mechanism of action, formulation, design and development of new molecules from ingenious/ herbal plant source. Attempts are being made to identify research priority and gap areas in Medical sciences relating to current health and health system challenges at national level vis-à-vis global scenario.

During the year specific workshops were designed and organized along with specialized training programmes for generation of human resources and development of specific man-power on Cytopathology and HPV testing, sleep disorder and cytopathological practices through multimodal imaging and computer vision approach

Keeping in view trends of diseases of the pattern in the country, new projects initiated in the area of bio-engineering, biomaterials, Osteogenesis and bone regeneration, neuro-degenerative disorder, Cancer biology, Metabolic disorders (Osteoporosis, diabetes) and Ocular Diseases.

Some of the Important Research Project Initiatd during this year:

COMMUCABLE DISEASES:

- Molecular and proteomic approach for monitoring drug resistant malaria parasite.
- Foliate metabolism pathway gene polymorphisms among synmoptomaic and asymptomatic malaria patients.

BIOMEDICAL ENGINEERING/BIOMATERIALS ENGINEERING

- An innovation in distraction osteogenesis for mandibular regeneration using a refined transport distracter.
- Modeling and Experimental Investigation on Influence of Electric Field on Cell Material Interaction.
- Structural and Molecular Characterization of cutaneous cell behavior under varied physioco-chemical ambience towards improving skin tissue engineering practices.

CANCER BIOLOGY:

- Identification of a novel anti-metastasis molecule induced by OGRI and investigation of its therapeutic potentials on the different cancer types.

- Studies on Cell Signalling Molecules in Human Breast Cancer with special reference to Extracellular Signal Regulated Kinase (ERK).
- Allelic loss of mitotic checkpoint genes and their expression level in oral and esophageal cancer samples of raw betel-nut chewers in Meghalaya.
- Identification of candidate tumor suppressor genes loci in chromosomes 3,4 and 11 associated with the development of uterine cervical carcinoma.
- Characterizing the signaling network that sustains oral cancer stem cells for developing a targeted therapy.

METABOLIC DISORDER – DIABETES & OBSITY

- Role of dietary fatty acids in inducing endoplasmic reticulum stress in stromal vascular cells; Implications in the development of obesity associated insulin resistance.
- Beta cell function in youth with type 2 diabetes and its association with atherosclerosis.
- Replication of Novel type2 diabetes genes in Early onset type 2 diabetes.
- To study immunoprotective roles of methoxyisoflavones in estrogen-deficiency induced bone loss.
- Proteomic and Genomic study of testicular tissue in streptozotocin induced diabetic rat: role of Dimethy 1 4,4, Oxibis (3,5, dihydroxy benezoate) and 4,4 oxybis.

OCULAR DISEASES

- Genetic and Functional insights of Fuchs' Endothelial Corneal Dystrophy and Congenital Hereditary Endothelial Dystrophy in Indian Patients.
- Mitochondrial Genes involvement in Leber's hereditary optic neuropathy.

HAEMATOLOGY

- Regulation of Late signaling events in platelets: relevance to thrombus biology.

NEUROSCIENCES/NEURODEVELOPMENTAL/NEURODEGENERATIVE DISORDER/ MUSCULAR DYSTROPY:

- Congenital toxoplasmosis and neurodevelopmental disorder; Studies to decipher a mechanistic link through tryptophan metabolic pathway.
- Critical role of autophagic pathway in Alzheimer's disease: Evaluation of the role of Fisetin, a bioflavanoid in Regulating the autophagy through P13K/Akt/mTOR and Nrf2 signaling cascades.
- Protein aggregate myopathies a clinical pathological immuno histochemical molecular genetics and proteomic investigation.

DEVELOPMENTAL BIOLOGY

- Functional development of the visual cortex following prenatal repetitive auditory stimulation in chicks: role of noradrenaline.

- Protein ag PON1 gene variants and its association with cardiovascular disease (CVD) risk factors in women with PCOS.

MICROBIOLOGY

- Production of exopolysaccharides from the biofilm forming bacteria and their applications

METABOLIC DISORDER: THYROID HARMONE DISORDER:

- To investigate the effect of maternal thyroid hormone insufficiency on epigenetic modifications of developemtally regulated neuro-glial genes

DRUG DEVELOPMENT:

- Synthesis and Anti-cancer Activity of New Bioactive Heterocycles

DERMATOLOGY:

- To elucidate the role of ets-1 and matrix metalloproteinases in pathogenesis and repigmentation of vitiligo.

Highlights of the work done in ongoing projects:-

A) An attempt to characterize the role of MTA1 gene in the metastatic process and delineate its mechanism of action in breast cancer cells revealed that the expression of MTA1 was downregulated in the breast cancer cells MDA-MB-231 and MCF7. Cells with less MTA1 expression showed impairment in invasion, motility, adhesion and angiogenesis, indicating that MTA1 regulates these events of the metastatic cascade. On knockdown of MTA1, PTEN protein levels increased. MTA1 and PTEN colocalize and coimmunoprecipitate with each other. PTEN levels increased on inhibiting histone deacetyalse activity, such as possessed by MTA1. The activity of the downstream target of PTEN, namely AKT, decreases on MTA1 knockdown. MTA1 helps in maintaining the AKT pathway in cancer cells by inhibiting PTEN, a major antagonist of the pathway. MTA1 aids the TGF beta signaling system by downregulating SMAD7, its negative regulator. It thus influences regulation of many other genes downstream of TGF beta which might be required for tumorigenesis and metastasis.

B) The cellular AATF gene in known as a unique “molecular-switch” that connects transcriptional regulation cell cycle progression, checkpoint control and apoptosis. In an attempt to micro-dissect the AATF RNome within cancer cell lines derived from various types of cancerous tissues revealed that all the cancer cell lines had evolved with an inherent common basic mechanism to highly express a mutant-form of AATF protein hitherto unreported.

C) Molecular signaling pathways responsible for proliferation and survival of Prostate Cancer cells (DU145) were determined. Results of pilot study existence of crosstalk between EGFR and Wnt signaling in DU 145 cells, GSK3â controls this crosstalk by degrading â-catenin, activated STAT3 regulates â-catenin sub-cellular localization.

D) Results of the study on the impact of sperm DNA damage on genomic instability and survival strategies in embryonic stem cells, have shown an inverse relationship between sperm DNA damage, fertilization rate and nuclear precursor body polarization in human embryos. NMR analysis of spent medium has identified the significance of pyruvate and lactate as a potential marker in selecting the embryos which have higher implantation potential.

E) The recent identification of the antihypertensive agent telmisartan as a unique subset of selective angiotensin II (AII) type 1 receptor (AT1-R) antagonists or blockers (ARBs) that were also capable of activating PPAR-ã has paved the way for developing safe and effective PPAR-ã agonists for preventing or treating MetS and associated complications. The study, on cardioprotective mechanisms of telmisartan reveal that the dual ARB/PPAR-ã agonist telmisartan reduces oxidative stress, apoptosis and restores blood flow in ischemic regions of the heart by correcting the ischemia-reperfusion induced cardiac dysfunction observed in diabetic rats, in part via the PPAR-ã pathway.

F) In a project on "Role of Regulatory T cell Human Leprosy" demonstrated that healthy skin showed maximal expression with leprosy patients showing down regulation (>2 - >7 fold change, $p< 0.05$) in PBMC for CD3, CD8, CD28, GATA3, cytokines IFN, IL10,Il2 and IL4. Surprisingly Fox P3 was unaltered in expression. Dendrograms showed genes that were co-regulated. In contrast were skin lesions where Fox p3 was seen to be up regulated in BT patients. An expected CD3 and some cytokines also showed an up regulation ($p<0.05$). The dichotomy in expression of genes in PBMC as compared to skin lesions is considered to be a new finding and requires further study.

G) In a study to characterize several gene products involved in the basic biology of *Plasmodium* sporozoites and liver stage development demonstrated gene products into three categories viz., secretory gene products of *Plasmodium* sporozoite stages that are associated with commitment of sporozoites to host hepatocytes and also released during sporozoites migration through cells. Such antigens have relevance in inducing CD4+, CD8+ T cell and humoral immune responses. Second cluster of genes are related to the export products of the *Plasmodium* liver stages. These gene products containing export motifs will facilitate the trafficking of antigens to the hepatocyte cytoplasm and essentially induce a CD8+ T cell response. The third cluster are a group of genes encoding for signaling molecules involved in developmental regulation and critical for completion of the liver stages development. Initial work have revealed that the secretory nature of the PyS10 antigen.. The knocks out targeting constructs were successfully generated and obtained *Plasmodium* S23 knockout parasite that is currently under investigation.

H) A new *in vitro* or *ex vivo* model for the study of Proliferative Vitreoretinopathy (PVR) studies showed that cultures of RPE cells derived from a cell line (D407), in the presence of pathologic vitreous, result in extensive cell migration, and proliferation, as well as in the laying of epiretinal membrane-like structures in the presence of collagen. This new model to show that it has almost all the characteristic features describing the pathology of PVR has been characterized. Studies also contributed to development of engineered protein reagents designed to prevent the migration and/or proliferation of the RPE (Retinal Pigment epithelial cells) cells in PVR.

I) Several bio active compounds including anethole, euginol, piperine, glycyrrhizin were isolated from the Indian medicinal plants *Illicium verum, Ocimum sanctum, Piper longum* and *Glycyrrhiza glabra* and Acetyl Cholinesterase inhibition activity were evaluated and found to have potent cholinesterase inhibition activity. Another plant *Marsilea quadrifolia* a common leafy vegetable from in West Bengal was evaluated for the inhibition of cholinesterase and found to be a potent inhibitor of this enzyme.

J) Results of screening of 103 severe haemophilia A patients revealed 10 novel mutations and 12 unique recurrent mutation which helped in carrier diagnosis of a family. A hotspot mutation was detected in the exon 23 c.C6544T, p.R2163C and a novel mutation was detected in exon 21, c. G6226T, G2057Stop which could be used for antenatal diagnosis.

K) Osteoporosis is a global aging problem affecting nearly 200 million people worldwide. Natural sources for osteogenic agents have been identified. Studies are in progress to develop active osteogenic agents from this natural source for therapeutic application. K095 was the most active osteogenic agents as assessed by mineralization assay. K095 (medicarpin, a pytoalexin belonging to the pterocarpan family) inhibits the apoptosis of bone forming osteoblast cells via PI3k/Akt pathway and enhances peak bone mass in growing rats. K095 when given to Ovx mice, resulted in improved trabecular microarchitecture of bone, suggesting its potential in the treatment of postmenopausal osteoporosis (fig. 4)

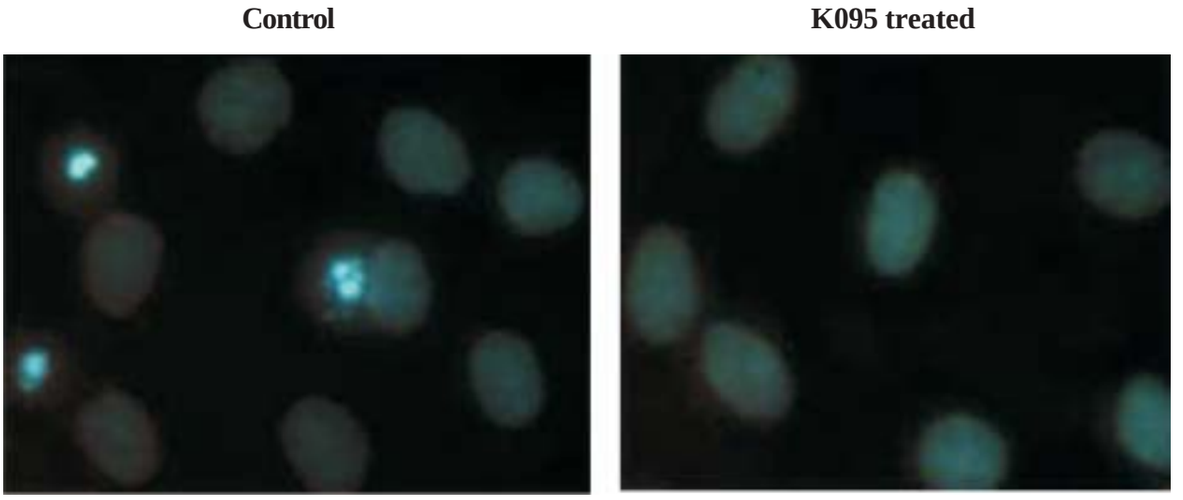


Fig 1.4:- K095 inhibits osteoblast apoptosis and increases osteoblast survival as assessed by Hoechst staining. DNA damage can be seen in control cells compared to K095 treated cells.

L) The management of shigellosis has become difficult due to appearance of drug-resistant strains of *Shigella* spp. Thus, the immunopotentiating properties of the porin, the major outer membrane protein of Gram negative bacteria has been scrutinized to establish it as an adjuvant for vaccine preparations against shigellosis. Porin elicited the downstream-signaling molecules through MyD88-TLR2 association. This eventually led to up-regulation of TRAF6, activation of MAPK and NF-êB.

M) Studies are under progress to decipher the structure-function relationship of one of the extracellular matrix components, chondroitin sulfate/dermatan sulfate in kidney during diabetes which would help in formulation of therapeutic products/drugs.

N) Results showed time and concentration dependent increase in sigE transcription when *M.tuberculosis* was subjected to surface stress induced by SDS. There is a sharp increase in transcription at a particular concentration of SDS. Studies are under progress to identify the key players responsible for the regulation of gene transcription of sigma factors which in turn help bacteria to grow under stress by inducing transcription of stress responsive genes. Mycobacteria survive under several types

of stress including surface stress exerted by lung surfactants. SDS has often been used to create surface stress on mycobacteria.

O) Results of the study to dissect the pathways of innate immune subversion by early secreted antigen-(ESAT-6) of Mycobacterium tuberculosis demonstrated for the fist time that ESAT-6 upregulates microRNA expression in macrophages considering that microRNAs are known to regulate TLR signaling in macrophages.

P) Studies are under progress to examine any differences in protein profile including posttranslational modification of proteins in patients with attempted suicide compared to age and gender matched controls using mass spectrometry based plasma proteomics.

Q) Studies showed that plakophilin3 knockdown confers a significant survival advantage post irradiation in two different cell types suggesting that it is a ubiquitous response. Identification of genes that are required for radio resistance and tumor survival could lead to novel therapeutics for neoplastic disease.

R) The role of B cells in host protection against filariasis is not clearly understood. The study revealed that B-1 cell populations were significantly low in microfilariaemic carriers in comparison to individuals with endemic normal's and people displaying chronic manifestation. Decreased levels of Ig M antibody response were observed to various antigens in mf carriers. A significant positive correlation was found between anti-actin and anti-DNA levels indicating that most of the DNA-binding antibodies found in human sera are cross-reacting with actin.

S) Studies on the use of Fresh water shell flesh (*Viviparous bengalensis*) against experimental Osteoporosis/ Osteoarthritis in experimental animals revealed that, it possess anti arthritic activity. Further studies are in progress to characterize the anti-osteoporosis and anti-arthritic factor in *Viviparous bengalensis* and the mechanisms by which the pure compound influenced OSP/OA changes in experimental animal models.

PLANT SCIENCES

In the area of Plant Sciences several projects have been supported to strengthen basic and application oriented programmes. The support was provided in cutting edge/frontier areas as well as traditional areas such as taxonomy and bio-diversity.

During the year, research projects were sanctioned in the area of Digitisation of the National herbarium of Cultivated Plants (NHCP), Identification and molecular characterization of Bean common mosaic virus strains prevalent in north western region of India, Multi-transgene stacking with PR-3, PGIP and NPR1, Gene in tobacco for induction of broad spectrum fungal resistance, Nitric oxide as a signaling agent in plant pathogen interaction, A study on molecular mechanism of *Spirulina platensis* 6-desaturase regulatory element: Exploring the role of temperature responsive positive regulatory element on Y-linolenic acid (GLA) biosynthesis enhancement, Identification of novel drought tolerant gene(s) by comparative analysis between rice and Sorghum: Isolation and validation through bacterial and in *planta* expression.), Isolation and characterization of rice heterotrimeric G-proteins and their functional validation for abiotic stress tolerance, Characterization and Identification of *Xanthomonas campestris pv. campestris* Races Causing Black rot Disease of Crucifer Crops, Control of rice root knot nematode by essential oil of indigenous medicinal

plants of Manipur, Molecular profiling of ginger rhizosphere microbial communities as a strategy for rhizome rot biocontrol, Functional analysis of members of sterol glycosyltransferase (sgt) gene family of *Withania somnifera* and *Arabidopsis thaliana* using sgt knockout mutants of *A. thaliana*.

Findings from the ongoing projects funded under the programme revealed :-

In an ongoing project on Isolation and characterization of starch and protein from different legumes at GND Univeristy, Amritsar, it has been found that Legumes with higher seed weight had high hydration and swelling capacity but had the drawback of longer cooking time. Nevertheless, these lines per se are suitable for processing and can also be exploited as a gene source, to improve existing commercial pea varieties. Swelling capacity was positively correlated to seed volume and weight. The seeds having cotyledon with higher density has slower water uptake and consequently has longer cooking time. Legumes lines that absorb more water as well as swell more during soaking require less cooking time. Large cotyledons with greater seed weight required longer cooking time and had higher hardness due to compact granular structure. Pea lines with greater seed weight are advantageous in applications where flours with high peak viscosity, final viscosity, setback and lower pasting temperatures are required. Legumes also showed a wide variation in fine structure of starch. Legume starches with higher proportion of long side chains of amylopectin had higher thermal transition temperatures and enthalpy. Starches with higher proportion of granules of size d”10 to 30 ìm had lower amylose content and higher thermal temperatures. Gel hardness, thermal temperatures were lower for starches with higher proportion of granules of size 1 to d”10 ìm. Viscoelasticity of cooked starch varies with amylose content, short side chains of amylopectin and granules size distribution. The rheological properties of the starches during heating were observed to be mainly dependent on the proportion amylose content and short side chains of amylopectin as well as swelling properties of the granules. Thermal properties were more dependent upon granule size and long-chains amylopectin whereas pasting properties were related with amylase content and short-chains amylopectin. Starches with low breakdown viscosity have been identified that are highly suitable for products where heat stability and mechanical shearing are required. The starch from the lines with high amylose content can be used in gum candies and as an additive to increase the level of dietary fibre and lower the rate of energy release without significantly affecting the taste of the products. The lines having starch that is slowly digestible are suitable for diabetic patients.

The research works under the project addressed deficits and identified research priorities and conservation needs of *Mucuna* spp. – the natural source of highly valued medicinal compound L-Dopa (Parkinson’s drug) and Protein for human diet. *Mucuna* spp. suffered from serious lapses in the area of genetic resource characterization causing considerable setback to improvement programs. The following are the achievements made during the project period:

- ⊗ Establishment of pan-India germplasm of 105 *Mucuna* accessions covering seven species from eight states and two union territories in India.
- ⊗ Evaluation of 85 accessions with 33 morpho-agronomical characters.
- ⊗ Establishment of Karyomorphological variability among different species.
- ⊗ Establishment of Biochemical variability for: protein, carbohydrates and L-Dopa contents.

- ⊗ Assessment of effect of GXE interaction on L-Dopa production.
- ⊗ Development of first germplasm descriptor.
- ⊗ Development of first germplasm catalogue.
- ⊗ Screening basic molecular markers for genetic characterization of *Mucuna* species.

In a study at Bhubanashwar, an improved somaclone of turmeric (*Curcuma longa* L.) has been screened out of eleven somaclones tested in the field for two generations containing two fold (0.9%) increase of leaf essential oil with de-novo presence Eucalyptol as major constituents over 0.49% of oil content with á-phellandrene as major constituents present in parent clone.

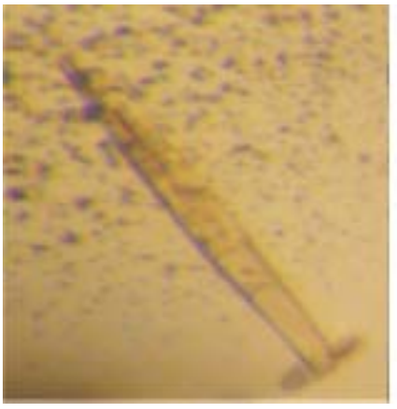
***MUCUNA* FIELD GENE BANK AT SIR M VIT CAMPUS, BENGALURU**

Fig. 1.6 : INFLORESCENCE DIVERSITY OF DIFFERENT *MUCUNA* SPECIES

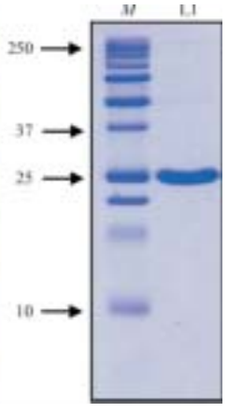
Fig. 1.7 : POD DIVERSITY OF DIFFERENT *MUCUNA* SPECIES

Fig. 1.8 : SEED DIVERSITY OF DIFFERENT *MUCUNA* SPECIES

In an ongoing project "Molecular analysis of AhpC (alkyl hydro peroxide reductase) in offering abiotic stress tolerance in *Anabaena* sp PCC 7120" *at BHU, Varanasi* the *AhpC* protein was found offer protection against abiotic stresses such as salinity, heat, UV-B, metals, pesticides, etc. This protein has been over expressed, purified and crystallized and its structure has been determined by molecular-replacement methods using the human Prx enzyme hORF6 (PDB entry 1prx) as the template. This constitutes the first report in cyanobacteria. The entire findings have been published in the form of two papers in Biochemical Biophysical Research Communication (Mishra et al. 2009) and Acta Crystallographica (Mishra et al. 2011). The structure of the cyaonobacterial *AhpC* is given below (Fig. 9).



The crystal used for AhpC data collection. The crystal grew at 291 K after four weeks to maximum 0.6 X 0.1 X 0.03mm



SDS–PAGE (12%) analysis of purified Cyanobacterial AhpC. Lane M, molecular weight Markers (kDa); lane L1, purified AhpC.

Fig. 1.9

From molecular perspective, phenomenon of fiber development in bamboo is a transcriptionally controlled event and physiological changes associated with the development could be accounted for differential expressions of different fiber specific genes. In the study Expression patterns of 51 ESTs having specific roles in bamboo fiber development have been identified at Institute of Life Sciences, Bhubaneshwar. Further investigation of some of the selected ESTs revealed that these genes are expressed differentially during different developmental stages of bamboo fiber. While at the same time they also exhibited overlapping expression pattern. Thus, suggesting that bamboo fiber metabolism is extraordinarily complex, involving pool of genes that vary in expression. The results clearly suggest that these genes are involved in several concerted mechanisms involving Ca+ signaling pathway, cell wall synthesis, hormone regulation, system maintaining cell turgor pressure and cytoskeleton synthesis pathway accountable for bamboo fiber development.

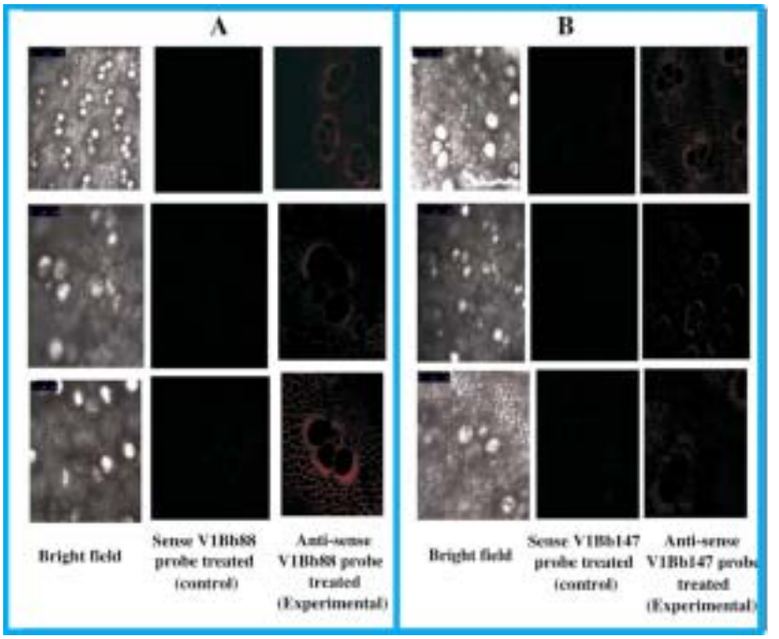


Fig. 1.10 : Bright field images of control reactions V1B688 and V1B6147

A CLSM based study to detect in-situ localization of a fiber specific gene V1Bb88 (myb domain protein) [panel A] and V1Bb147 (protein kinase-like protein) [panel B] in different internodes of Bambusa balcooa, as described in methods. The control images obtained by hybridization with sense V1Bb88 and V1Bb147 RNA DIG-11-UTP labeled probes are presented in panel A column 2 and panel B column 2, respectively. Bright field images of control reactions V1Bb88 and V1Bb147 are presented in panel A column 1 and panel B column 1, respectively (Fig. 10).

In a project at TNAU, Coimbatore, first time in India searched the antagonistic yeast and identified the antagonistic yeasts as *Pichia kudriavzevii* and *Trichosporon asahii*. Effective antagonist yeast *Pichia kudriavzevii* was prepared as talc based bioformulations to apply as seed treatment and soil application against the wide host having major soil-borne pathogens of sugarbeet *viz*., *Sclerotium rolfsii*, *Rhizoctonia solani* and *Pythium aphanidermatum*. In both of this delivery method there is a reduction in pre and post-emergence death of seedlings by the above soil-borne pathogens which leads to high population stand of crop and increased yield.

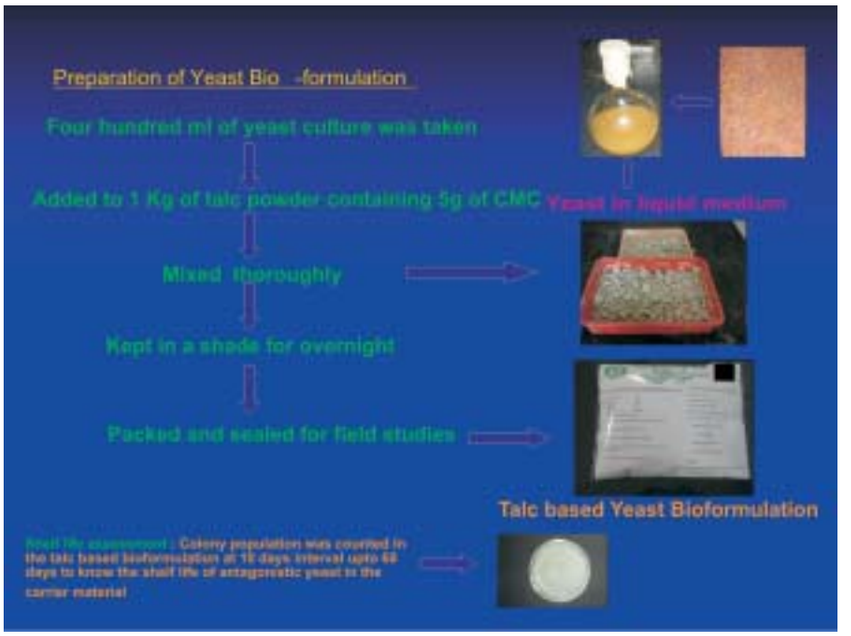


Fig. 1.11 : Preparation of Yeast Bio-formulation

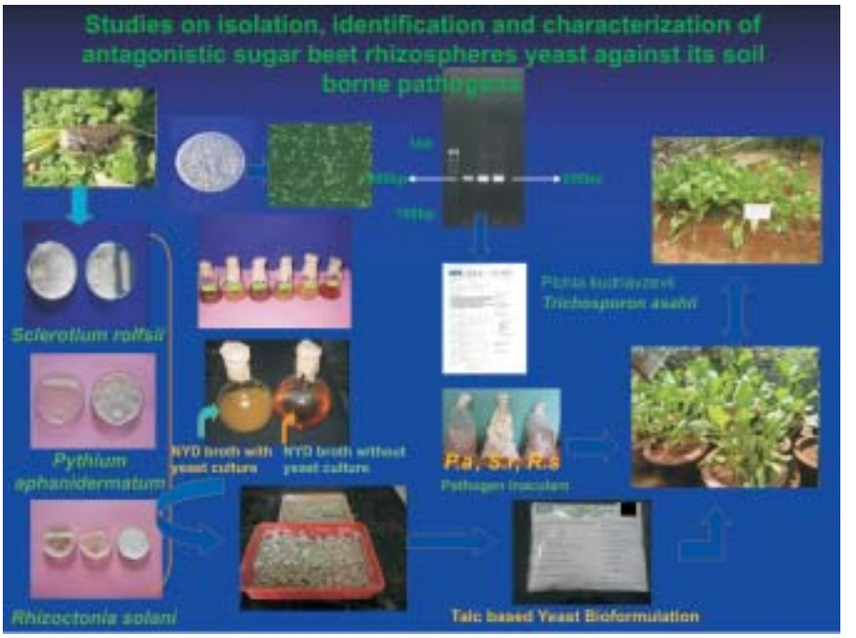


Fig. 1.12 : Studies on isolation, identification and characterization of antagonistic sugar beet rhizospheres yeast against its soil borne pathogens

Under the project on **Identification and cloning of genes involved in alternate mechanisms of NADH oxidation and their role in waterlogging tolerance in green gram ,it was found that** Waterlogging resulted in increase in nitrate reductase activity, nitric oxide production activity, and gene expression of *cytosolic-NR* and *non-symbiotic hemoglobin* (*NS-Hb*). However, the pattern of activity and gene expression showed that waterlogging induced increase in NR activity and NO production activity as well as gene expressions of *cNR* and *non-symbiotic hemoglobin* (*NS-Hb*) were greater in *Vigna*

luteola (highly tolerant) and T44 (tolerant), while very little increase was observed in susceptible cv. Pusa Baisakhi.

The waterlogging induced enzyme activity and gene expression pattern support hypothesis that cyosolic NR and NO synthesis may have a role in waterlogging tolerance, as these reactions utilize NADH/NADPH and regenerate NAD/NADP, and thus act as an alternative to fermentation for the continuation of glycolytic pathway, the only energy (ATP) generating pathway under anoxia.

Fig. 1.13: RT-PCR gene expression of nitrate reductase *and* nitric oxide synthase as affected by 24 h water logging treatment in tolerant and susceptible *green gram* genotypes (1: marker, 2: Control *Vigna luteola* , 3: waterlogged (W.L.) *Vigna luteola* , 4: Control T 44 , 5: W.L. T 44, 6: Control Pusa Baisaki , 7: W.L. Pusa Baisaki).

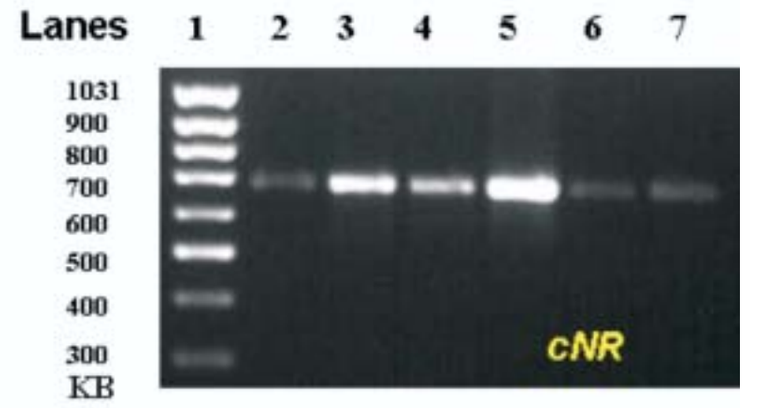


Fig. 1.14: RT-PCR gene expression of non-symbiotic hemoglobin as affected by 24 h water logging treatment in tolerant and susceptible *green gram* genotypes (1: marker, 2: Control *Vigna luteola* , 3: waterlogged (W.L.) *Vigna luteola* , 4: Control T 44 , 5: W.L. T 44, 6: Control Pusa Baisaki , 7: W.L. Pusa Baisaki).

In a study at CIMAP, Lucknow, Cultivation of *Centella asiatica* ***(Mandookparni/Brahmi)*** for the production of wound-healing and anti-Alzheimer biomolecules (triterpene centellosides/asiaticosides) in hydroponic system has been optimised for the first time in the world. Several biotic and abiotic elicitation regimes to boost the biomass and bioactive yields have also been identified for sustainability, free from climatic influences. Molecular protocols based on AFLP mapping for germ plasm screening and biodiversity management have also been standardised. The methods developed here will go a long way in addressing industry's demand for clean good quality *Centella* herb for making more than 100 herbal formulations for domestic and overseas markets.

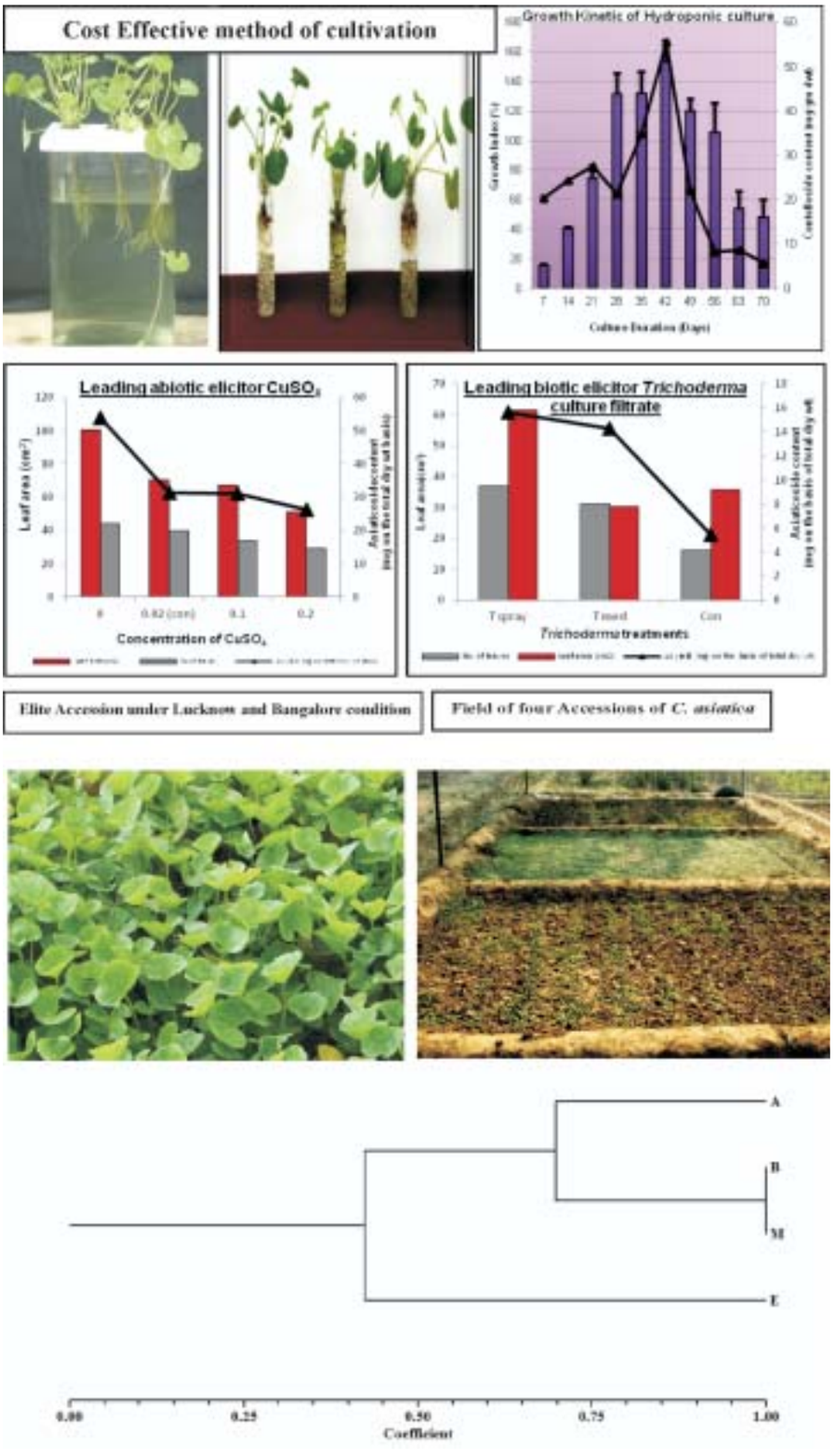

Cost Effective method of cultivation
Growth Kinetic of Hydroponic culture
Leading abiotic elicitor CuSO4
Concentration of CuSO4
Leading biotic elicitor Trichoderma culture filtrate
Trichoderma treatments
Elite Accession under Lucknow and Bangalore condition
Field of four Accessions of C. asiatica
A
B
M
E
0.00
0.25
0.50
0.75
1.00
Coefficient

Fig. 1.15

Molecular Characterisation of four field established plants by AFLP

9 Primer pairs in 64 combinations

Under the project the impact of climate change on species shift and distribution, phonological response and on the socio-economic dynamics was studied in Shimla and Kinnaur by NBPGR, Shimla. Twenty three plots were marked between 1190m to 2450 m altitude in Shimla, 19 plots between ranges 2273-3210 in Kinnaur district for and Kinnuar while 80 plots were marked between 1200m to 2275m in Chail wildlife sanctuary to undertake the research on the impacts of climate change across the altitudinal ingredients. The shift in the species distribution is being compared with the previous records mentioned in 'Flora Simlensis' 110 years before. It was found that more than 120 plant species have either shifted upward from their reported habitats or have got extinct due to changes in the ecology of the habitats. It is mainly attributed to declining snow fall and lack of appropriate chilling hours. Phonological studies were initiated in Peach, Pear, Plum and Apple, Apricot and walnut. The fluctuating phonological response and fruit setting was observed in different crops and varieties. The data on people's perceptions on the impacts of climate change and their preparedness to address the emerging challenge was also recorded.

In pigeonpea, pods are damaged by insects viz., *Helicoverpa armigera* and *Maruca vitrata* leading to significant reduction in yield. For managing the pests, entomo fungal Bioagent viz, *Beauveria bassiana* was identified by TNAU, Coimbature.

The *Beauveria bassiana* isolates *Viz*., B10 and B2 are highly virulent against pigeonpea podborer complex (*Helicoverpa armigera* and *Maruca vitrata*). The *B. bassiana* isolate B10 showed higher chitinase production followed by B2 isolate under *in vitro* which is the key enzyme responsible for insect cuticle degradation. Liquid formulation (containing *Beauveria* B2+B10+*Pseudomonas*-TNAUPf1) performed better both under glass house and field conditions when compared to talc formulation.

Damage symptoms caused by *Helicoverpa armigera* (Bore holes on the pods)

Fig. 1.16: Bioefficacy of *B. bassiana* against *H. armigera* and *M. vitrata* larvae under *in vitro* - Dead insect larvae covered with *B. bassiana* spores

Fig. 1.17: Histopathology of *H. arimigera* larva infected by *B. bassiana* (B10)

Scanning electron micrographs show the multiplication *B. bassiana* spores inside the insect body and the outer cuticle covered with mycelial growth

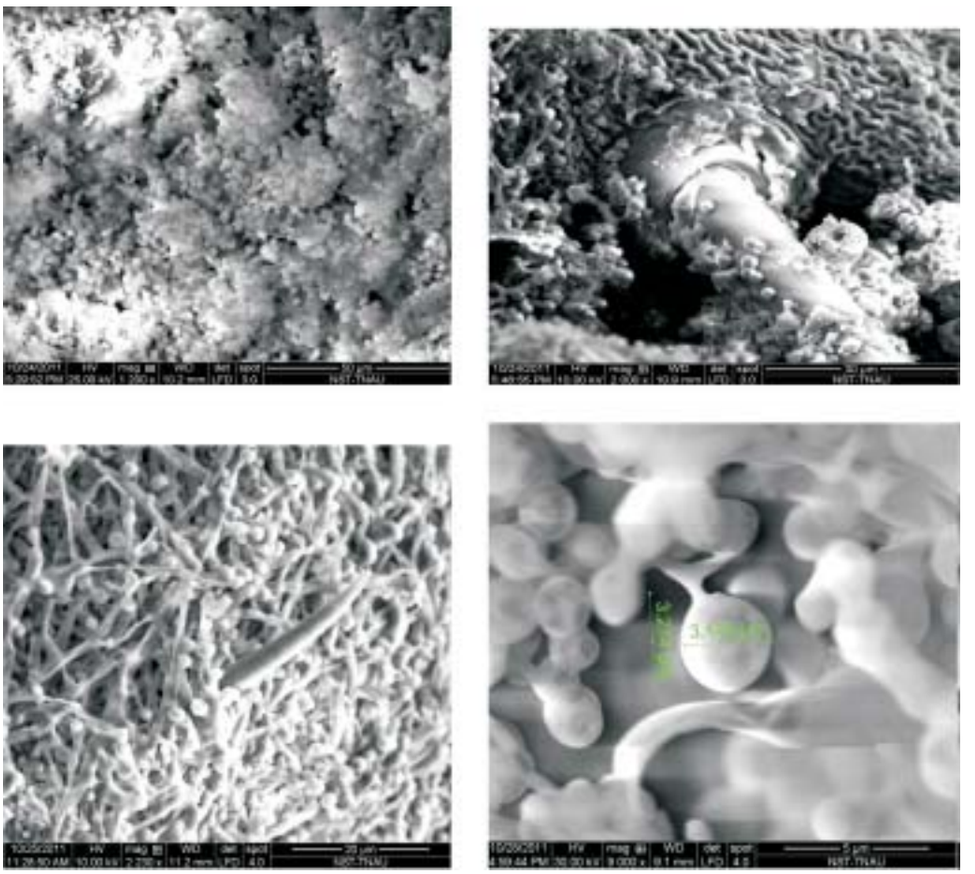


Fig. 1.18 : PCR amplification of Chitinase gene from *B. bassiana* isolates (B2 & B10)

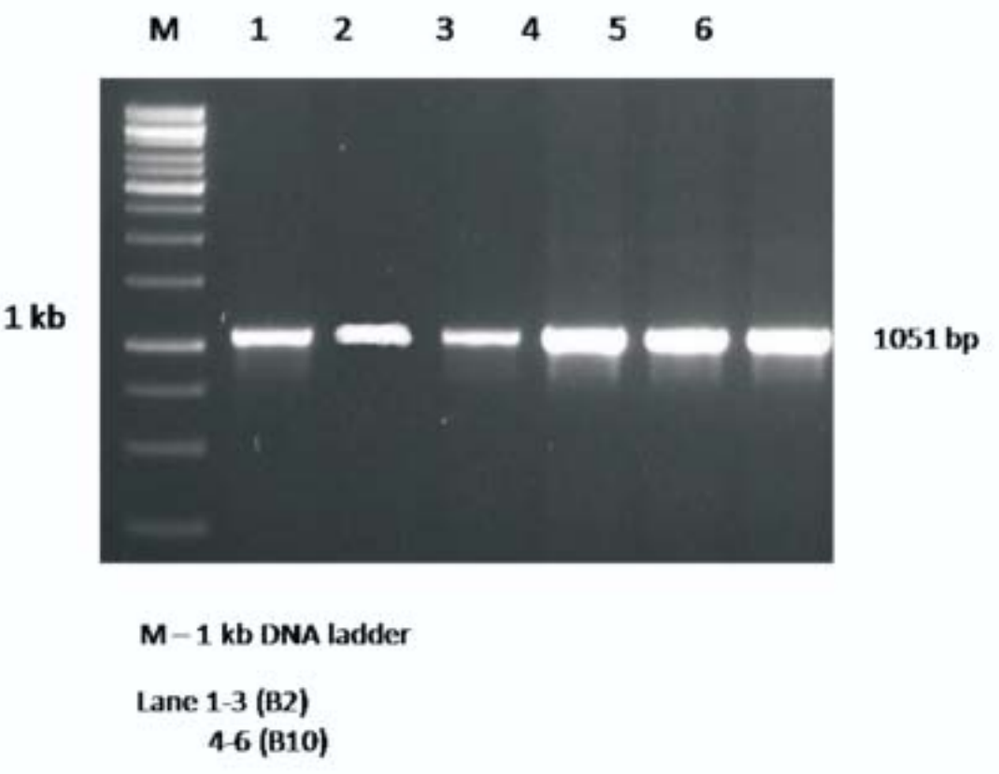


Fig. 1.19

Treatments

S. No	Talc-based formulation	S. No	Liquid formulation
1.	Beauveria B2 (ST+FS)	1.	B2 (ST+FS)
2.	B10 (ST+FS)	2.	B10 (ST+FS)
3.	TNAU Pf1 (ST+FS)	3.	TNAUPf1 (ST+FS)
4.	B2+B10 (ST+FS)	4.	B2+B10 (ST+FS)
5.	B2+TNAUPf1 (ST+FS)	5.	B2+TNAUPf1 (ST+FS)
6.	B10+TNAUPf1 (ST+FS)	6.	B10+TNAUPf1 (ST+FS)
7.	B2+B10+TNAUPf1 (ST+FS)	7.	B2+B10+TNAUPf1(ST+FS)
8.	Pesticide control [Monocrotophos (FS)]	8.	Pesticide control [Monocrotophos (FS)]
9.	Control	9.	Control

Induced systemic resistance by *Beauveria* and *Pseudomonas* in pigeonpea plants against podborer complex (Native-PAGE analysis)

B2+B10+Pf1 treated plant enhance the expression of more isozymes

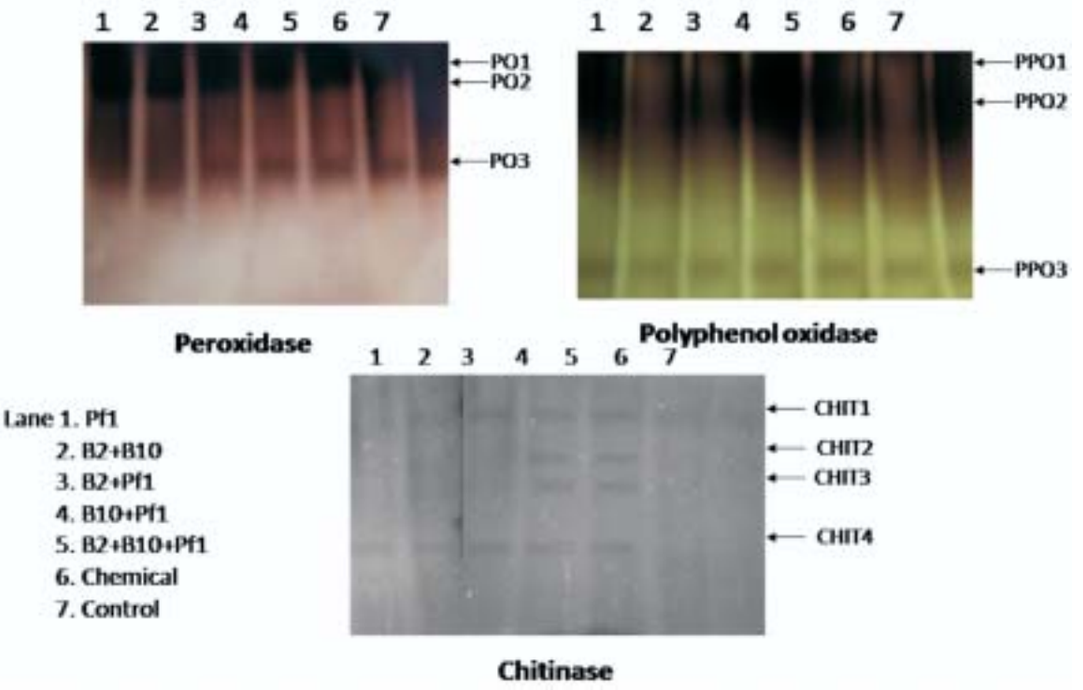


Fig. 1.20

In an ongoing project on Assessment of diversity in *Venturia inaequalis* across Jammu and Kashmir and Management of apple scrab through host resistance" at S.K. University of Agricultural Sciences & Technology of Kashmir, Shalimar Srinagar Race spectrum of 71 isolates (*V. inaequalis*) collected from different apple growing areas, determined by inoculation on a set of 14 differential cultivars, revealed the existence of 2 races in Kashmir valley. Both the races were identified as new races of the pathogen for the first time from India. Races designated as 1 and 2 contained 42 and 29 isolates, respectively. Race groups 1 and 2 contained isolates from diverse geographic regions and the isolates could not be grouped according to their geographic origin on the basis of race spectrum. All the isolates were virulent on Royal Gala and none of the isolates infected other H3 to H13. Of the seven Random Amplified Microsatellite primers, four primers viz., HBH(AG)5, DBD(CA)5, DDB(CCA)5, and HVH(TG) giving consistent banding patterns were selected for fingerprinting analysis of 71 isolates of *V. inaequalis*. The number of bands obtained with different primers ranged from 4 to 9. In all, a total of 26 consistently reproducible bands were obtained with 100 per cent polymorphism. Cluster analysis of the RAMS generated dendrograms with a cophenetic correlation coefficient of 0.82, which substantiate the accuracy of dendrogram. The dendrogram analysis of 71 isolates revealed a high genotypic diversity within *V. inaequalis* populations. Three major clusters were obtained using neighbor joining method in DARwin5.0 accommodating 31, 21 and 19 isolates, respectively. Cluster I was subdivided into three sub-clusters accommodating 13, 9 and 9 isolates, respectively. Thirteen isolates from Magmam location in central region were grouped in a single sub-cluster

(Cluster Ia). Cluster II was sub divided into 2 clusters (Cluster IIa and Cluster IIb) accommodating 11 and 10 isolates each where as the sub clusters of Cluster III contained 13 and 6 isolates, respectively. Perusal of the dendrogram (Fig. 21) further reveals that the isolates could not be categorized either on the basis of their geographical distribution or the cultivar from which isolated.

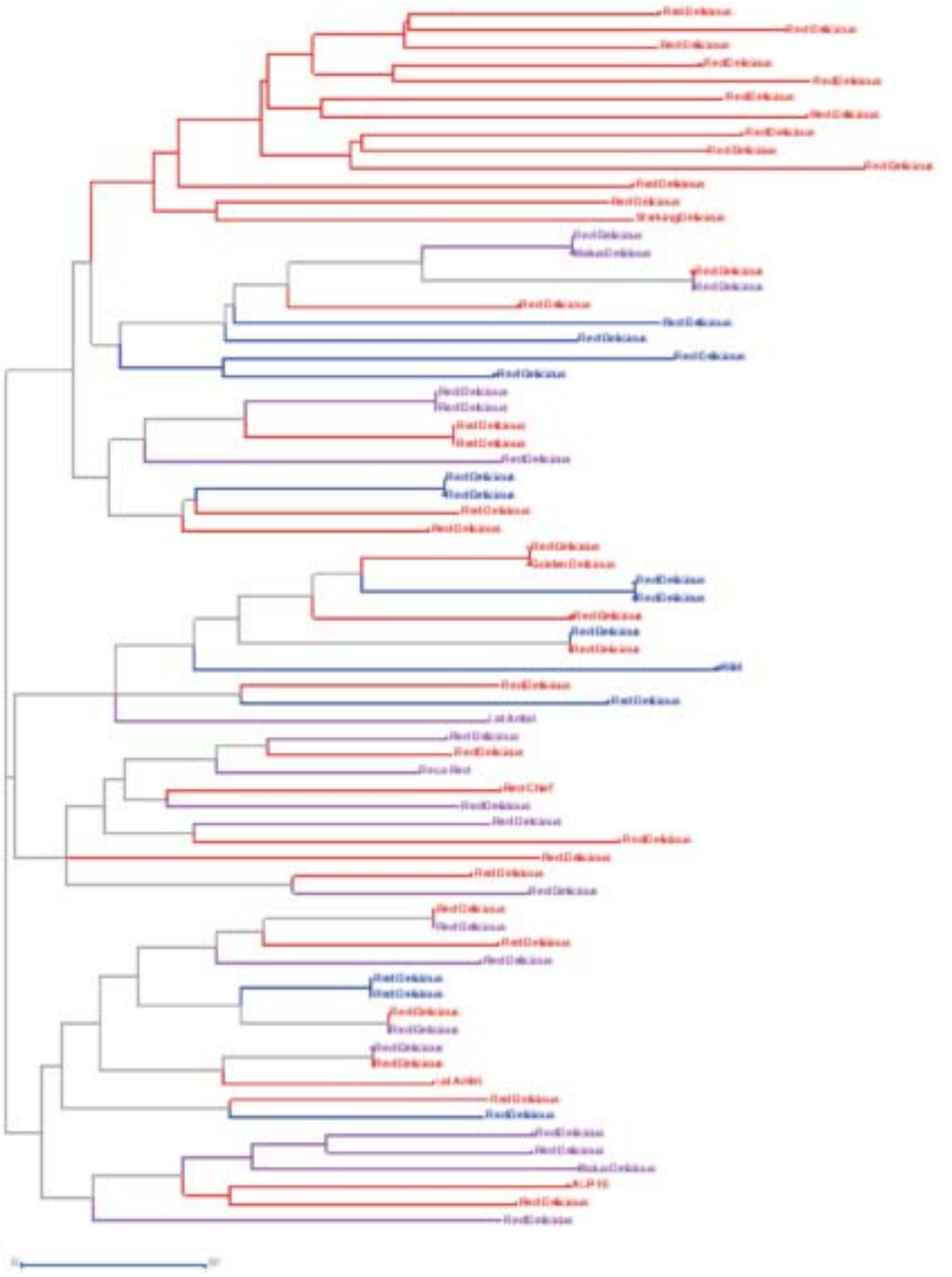


Fig. 1.21. Dendrogram of 71 isolates of *V. inaequalis* obtained through DarWin 5.0.

PHYSICAL SCIENCES

The research projects and programmes supported under Physical Sciences covered a wide range of emerging topics. The technical evaluation was done by Programme Advisory Committees (PACs) on (a) Condensed Matter Physics and Materials Science, (b) Plasma Physics, High Energy Physics, Nuclear Physics, Astronomy & Astrophysics, Nonlinear Dynamics and (c) Lasers, Optics and Atomic and Molecular Physics. The PACs also monitored the progress made in ongoing projects on a regular basis.

Condensed Matter Physics and Materials Science:

A broad spectrum of research activities were supported through the sanctioned projects.

In one of the sanction projects, the magnetic, dielectric and hyperfine behaviors of some multiferroic nanocrystalline/ nanocomposites and bulk systems will be investigated. In another project, multiferroic properties of (Pb, Sr) TiO3/AFe_2O_4 (A=Co, Ni, Mn) multilayered thin films will be studied by depositing ferroelectric and ferromagnetic materials in multilayers. Bulk and thin films of cobalt doped SnO_2 dilute magnetic semiconductors will be fabricated and the critical behaviour near ferromagnetic phase transition will be studied in another project. In a different project, studies on optical properties of strained Ge and its alloys towards the improvement of performance of group IV semiconductors based photonic devices will be made and effect of strain would also be investigated. In another project, optical properties of doped and undoped ZnO thin films made by pulsed deposition technique will be studied. Nanostructures grown by hot walled PLD on sapphire, silicon and diamond substrates would also be investigated. Electro-optical studies on transparent conducting telluride and phosphate glass ceramics doped with different oxides like ZnO, AG_2O ETC for various applications will be studied in a different project. Wide band gap p-type transparent metal oxide chalcogenides thin films for oxide electronics will be developed in another project.

In one project the structural and ion conduction mechanism of synthesized blend of polymer nano-composites electrolytes will be studied by dielectric relaxation spectroscopy. Self supporting films of polyethylene oxide doped with different salts followed by irradiation of those films with suitable swift ion beams will be developed in another project. The induced changes would be characterized with respect to structural, thermal and electrical properties. In a different project, CNT thin films will be synthesize using spin coating and CVD, followed by preparing iron oxide film by electrodeposition, spray pyrolysis and sole-gel spin coating method. In another project, protein-lipid as well as protein-metal nanoparticle composites will be fabricated at the air-water interface using the LB technique and self–assembly methods. Characterization of the films will also be done using various microscopic and spectroscopic techniques. Dynamics and micro-rheology using particle tracking based diffusing wave spectroscopy technique on the soft hybrid polymer grafted nanoparticles will be investigated in a different project. Thermal and mechanical properties of polymer nanocomposites and agro-fiber based biocomposites will be studied in another project. Preparation, characterization and optimization of PVDF-HFP based nanocomposite electrolyte for lithium-ion batteries by phase inversion technique will be studied in a different project. In a project, polymer based nanostructured composite materials for gas sensor applications will be studied.

In another project, ingle crystals of multiferroic materials (alkylammonium metal chloride) will be grown by floating zone method and structural, magnetic, electrical and thermal properties will be characterized. In a separate project, single crystals will be grown using solution growth method and characterized the grown crystals using birefringence and thermal diffusion measurements. Crystals of Potassium/sodium bismuth titanate will be synthesized and grown with a relatively higher curie temperature by flux technique in a different project. It is also proposed to synthesize and characterize phosphate and silicate based bioactive glasses and ceramics which had potential use for bio medical applications in another

project. In another project, dynamics of different metallic cations (Ag+, Cu+, Na+) in a mixed net work former glasses will be studied. "Thermal and electrical properties of borophosphate and borotellurite glasses will be investigated in one project. A systems level model for the process of golgi organization using in silico reconstitution and simulation with be develop in another project.

In one project, the effect of liquid crystal material will be studied on V shaped switching. The effect of liquid crystal-surface interactions on V-shaped switching would also be studied in that project. In another project, it is He proposed to synthesize the lyotropic liquid crystalline (LLC) materials in various roots and disperse metal and non metal salts in this phase leading to the formation of ordered mesophase along with in-situ growth of nanomaterials using the synthesized LLC as soft template. The theoretical as well as experimental investigations of physical properties of archiral and chiral liquid crystals, kinetics of phase separation will be carried out in a different project. The influence of external perturbation on these, with experimental studies focusing on physical properties of polymer disperses liquid crystals will also be studied.

In a project, it is proposed to investigate the combined effect of interactions and the magnetic field (Ferromagnetic and anti-ferromagnetic) on the Heisenberg spin-1/2 chains. Quantum dynamical study of semi-conductor nano-structures will be done in another project. In a different project, modeling of force-induced transitions of biopolymers in cellular environment will be done. Some lattice models of these would be studied by series expansion techniques. He proposed to study finite quantum systems operating between large heat reservoirs will be investigated is another project.

In one project, it is proposed to develop a hydrothermal based process for the synthesis of diamond and diamond like materials. Carbon phase diagram at relatively lower temperature and pressure would be studied in the project.

Several interesting results were reported from ongoing projects.

In a project, Charge Compton profiles of TaC, Ta N, Mo X_2 (X = S and Te), CrX (X=S,Se and Te), $HgBr_2$, HgI_2, $PbCl_2$, $PbBr_2$, GeTe, Bi_2X_3 (X=S,Se and Te) etc, were measured. Band structure calculations were also performed. Temperature and field dependent magnetic Compton profiles of Mn rich Ni-MnGa system, Ir doped $CeFe_2$, $BixCo_2$-$xMnO_4$ (X= 0 and 0.3), Ni-Mn-In alloys and Co_2MnSi were measured using magnetic Compton spectrometer available at BL08W (Beam line on high energy inelastic scattering) at the super photon ring 8GeV (Spring -8) **(Fig. 22).**

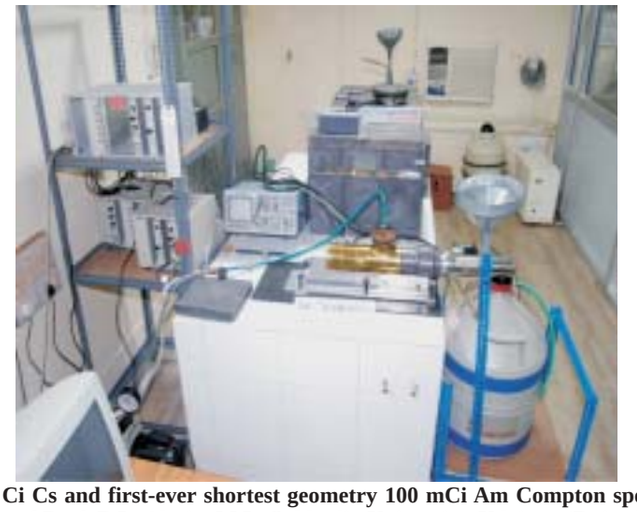


Fig. 1.22. First-Indian 20 Ci Cs and first-ever shortest geometry 100 mCi Am Compton spectrometers developed by group of Prof. B.L. Ahuja, M.L. Sukhadia University, Udaipur (Rajasthan)

The main aim of one of the projects was to develop and characterize nanometer thick ultrathin supported lipid and lipid/protein membrane mimicking bio-membrane. Langmuir-Blodgett, self-assembly and drop cast techniques were employed. Different molecular spectroscopic and imaging techniques had also been used. Studies on the incorporation and the interaction of water-soluble and surface-active proteins/ enzymes like ovalbumin, pepsin, hemoglobin, alcohol dehydrogenese etc., into different lipids like zwitterionic phospholipids (DPPC), anionic stearic acid, and cationic octadecayl amine monolayer was accomplished. Effect of salt and pH on the formation of protein/enzyme monolayer were also been studied. Hemoglobin-silver interaction and bioconjugate formation were studied by spectroscopic techniques.

In a different project dielectric properties measurement was made on the ZnO nanoparticle doped ferroelectric liquid crystals with the variation of frequency, temperature and electric field in Sc* and SA phase. Two relaxation modes i.e. goldstone mode and soft mod were observed in the frequency range covered. Optical transmittance measurement under crossed polarizer condition was also completed for the chosen samples with variation of temperature. The switching time measurement along with the texture study and other electro-optical parameters with variation of temperature was completed for all the samples.

In another project, studies of effect of electro-phosphorescent materials and device structure on increasing the efficiency of Organic Light Emitting Diodes (OLEDs) was done by fabricating prototypes of OLEDs and displays. Various experiments done with number of hole transport layers, electro-phosphorescent materials, hole blocking layers and cathode materials. It was shown that green Ir(ppy)3 gave better efficiency in comparison to red Ir complex. The green OLEDs with more than 34 Cd/A and luminance level of 10000 Cd/m2 were fabricated. It was much more than 3Cd/A targeted initially.

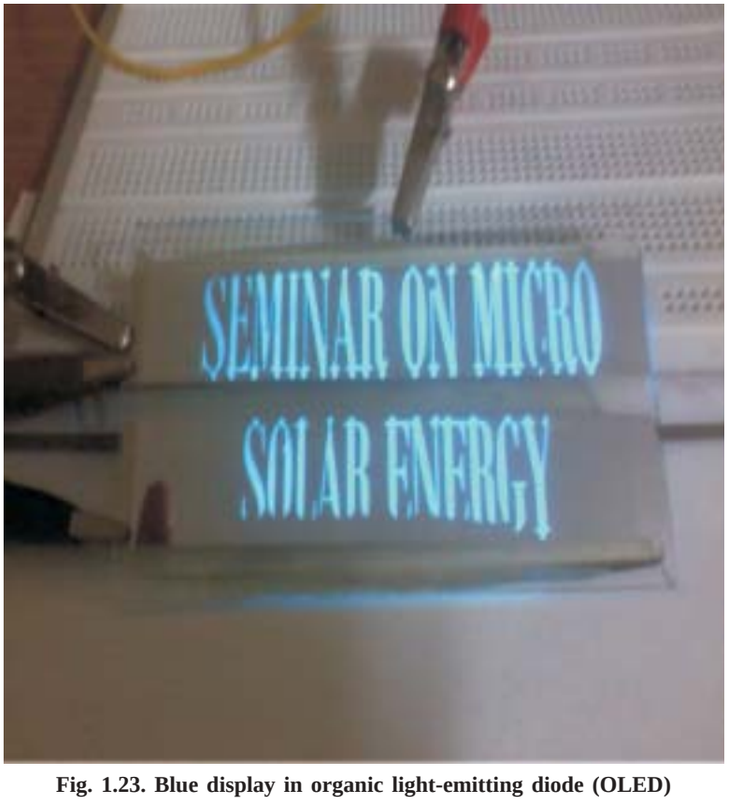


Fig. 1.23. Blue display in organic light-emitting diode (OLED)

A bio-white light conducting polymer based LED (WPLED) which shows electro luminescence (EL) for the three primary colour constituents- red, green and blue (RGB) colours was developed in one project. The white light so produced was close to the internationally accepted CIE coordinates (0.33, 0.33). Though the maximum efficiency of the WPLED was ~ 0.86Cd/A. The main reason for the success was the self trapping mechanism in the green phosphorescent dye and optimization of red and green phosphorescent dyes.

Plasma, High Energy, Nuclear Physics, Astronomy & Astrophysics and Nonlinear Dynamics :

In one of the projects Standard model with local scale invariance will be studied. This project will resurrects the concept of local scale invariance symmetry in the fundamental high energy physics. This symmetry (like others such as super-symmetry) needs to broken at low energy scales. In another projects modeling astrophysical & high-energy observations using nuclear particle physics & hydrodynamics will be done. It is planned to use equations of state of nuclear matter at high temperature and density to model putative condidates of strange stars. In a different project, TeV gamma ray emission from magnetars using HAGAR telescope of Indian Astronomical observatory at Hanle will be studied. The condidate magnetars of interest are to be selected from a list of these objects observed at MeV-GeV energies by the FERMI-LAT satellite-borne detector. Multiwavelength studies of cirrus clouds will be done in another project. It is proposed to use the ultraviolet observations from GALEX on the UV radiation field in the Galaxy and make correlation studies with measurements in optical and infrared bands to characterisation the diffuse Galactic radiation field and scattering properties of imterstellar dust.

In a project, investigate the properties of matter wave soliton excitations in single, multi-component and dipolar Bose-Einstein condensates with different potentials will be investigated through numerical methods. The dynamics and phase diagram of the scalar and spinar Bose-Einstein condensates by using both theoretical and numerical methods will be investigated in another project. ECR plasma diagnostics and applications to surface engineering of polymers and their nanocomposites will be studied in a different project. Plasma heating by neutral beam (NB) and radio frequency (RF) waves, and current drive by RF were the key element for achieving steady state tokamak plasma. Moreover, NB and RF waves would play crucial role in determining of the controlling global plasma confinement properties. The synergy of NB and RF power with electromagnetic modes, which might affect energy and particle transport in tokamak plasmas will be studied in another project. Using the QMD model and its variants for the description of heavy ion collisions at intermadiate energies will be investigated in a different project.

In addition to this, one SERC School on “Experimental High Energy Physics” was held at VECC, Kolkata during during June 16 - July 07, 2011. another SERC School on Nonlinear Dynamics” was held at Indian Institute of Science Education & Research (IISER), Pune during December 04-24, 2011. Third SERC School on “Modern trends in Nuclear structure and dynamics” will be held at IIT, Rookee during February 06 – 24, 2012,

Several interesting results were reported from ongoing projects.

In one project, SnO2 and ZnO thin films have been grown using the designed magnetron source installed in rf sputtering technique. The microstructure of both SnO2 and ZnO thin films have been modified by plasma assisted growth under unbalanced magnetron configuration. The sensors structures were developed using platinum inter-digital electrodes (IDEs) and semiconducting oxide (SnO2 and ZnO) thin films exhibiting desired surface morphology and defects. The prepared sensor structure based on SnO2 and ZnO thin films have been utilized for detecting harmful gases (H2S and NO2) and ultra-violet (UV)

radiations respectively with enhanced response characteristics, which is attributed to the growth of sensing oxide layers with controlled morphology and property under magnetic field assisted plasma.

In a different ptoject, a Microwave Plasma Enhanced Chemical Vapour Deposition (PECVD) system has been designed and fabricated. UNCD films are deposited with the variation of power, pressure and gas composition. Before deposition, different pretreatment methods have been used. Pretreatment of the substrates with diamond powder has been found to improve the nucleation, growth and surface morphology of diamond films. Raman spectra of UNCD films are found to have two predominant peaks centered at 1335 cm-1 and 1560 cm-1 and two humps at 1160 cm-1 and 1450 cm-1. A three stage model has been proposed to understand the growth and nucleation of UNCD films: Stage 1: Formation of nucleation precursor, Stage 2: Interaction of nucleation precursor with the substrate surface, Stage 3: Formation of stable nuclei and growth.

Lasers, Optics, Atomic and Molecular Physics :

Among the projects that were sanctioned, in one of the projects, Holographic techniques of coupling light with organic emitting and detecting devices will be designed and evolved. Optimization of light coupling to photoresist and photopolymer based holographic recording media will be undertaken in this project. In another project, Stable photorefractive polymers for holographic applications will be developed and characterized.

In another project, large mode (LMA)Yb–doped photonic crystal fibres (PCF's) for high power laser development and passive PCF's for high power light delivery and mode filtering will be developed. In a different project, different non-linear properties of photonic crystal fibres composed of very high air filling fraction will be studied. Study of self phase modulation, four wave mixing, Raman process and soliton formation etc. will also be accomplished. Numerical studies on the effects of undulator imperfections on spontaneous emission and FEL gain using existing Pulse Wire set up for the data will be undertaken in another project. An electromagnetic undulator and a tapered permanent magnet undulator will be fabricated in the same project.

In a different project, rare earth doped oxide and oxyfloride based glasses would be prepared for application in fibre amplifiers. Synthesis and characterization of NLO material with different combinations of thiourea and transition metal complexes will be done in another project. KN and some doped (by K_2O) KN crystals will be synthesized by employing various crystal growth techniques and the compounds will be characterized chemically to study their linear and non linear optical properties in a different project. In a project, L-analine hydro chloride, L- aniline picrate, L-alanine phosphate single crystals will be grown and characterized. Lead free bulk piezo crystals will be grown and characterized for their structural, thermal and electrical properties towards possible use of grown piezo crystal for transducer applications in a different project.

In a project, incoherent broadband cavity-enhanced absorption spectroscopy will be used in laboratories studies and subsequent field observation of gaseous trace pollutants. A spectrometer sensitive to NO_3 will also be developed. Ion beam investigation of inner-shell processes from X-ray spectra will be undertaken in another project. Electron/positron-molecules collisions will be studied theoretically. Higher order nonclassical correlations in quantum mechanical systems will be investigated theoretically in another project.

In addition to this, SERC School on "Guided Wave Optics and Devices" was held at Central Glass and Ceramic Research Institute (CGCRI), Kolkata during February 07-25, 2011. Another SERC School on "Lasers, Optical Engineering and Applications" was held at University of Calcutta, Kolkata during

December 19, 2011 – January 06, 2012. One In addition to this, SERC School on "Laser Physics and Techology" will be held RRCAT, Indore during March 05-23, 2012.

Several interesting results were reported from ongoing projects.

In one of the projects, the interection of porphyrins and phthalocyanine with various chemical vapours/ analytes by recording Raman, Infrared, UV-Visible and XRD spectra were investigated. Structure, vibrational spectra and interaction of porphyrins/phthalocyanines with chemical analytes with the help of density functional theory calculations were also completed in this project.

Spectrometer to record high resolution spectra of single quantum dot was commissioned in another project. Single quantum dot CdZnSe spectra were recorded at room temperature. Narrow single quantum dot spectra with FWHM of about 0.10 nm were observed.

In another project, a Picosecond time domain dielectric spectroscopy technique was developed and established. The technique was used for measurement of complex permittivity of polymers, biomolecules and polar liquids and their aqueous solutions. Dielectric studies were also performed on above class of substances.

Several information processing protocols using single particle pathspin hybrid entangled states were developed in a different project. Protocols for teleport, super dense coding and quantum key generation was also developed.

Output from Physical Sciences

(Data per project)

Sr. No.	Name of the PAC	No. of Ph.Ds produced	No. papers in refereed journal	No. of research manpower trained	No. of papers published in conferences
1.	Condensed Matter Physics and Materials Science	1.8	9	2.3	5.6
2.	Plasma, High Energy, Nuclear Physics, Astronomy & Astrophysics and Nonlinear Dynamics	1.2	6.9	1.8	3.9
3.	Lasers, Optics, Atomic and Molecular Physics	1.8	13	3.8	6.8
4.	**Total**	**1.6**	**9**	**2.4**	**5.24**

ENGINEERING SCIENCES

The extensive programme objectives of Engineering Sciences cover support to research efforts in a range of various disciplines within engineering sciences such as Civil, Chemical, Electrical, Computer, Material, Mining & Mineral, Mechanical Engineering, Robotics and Automation. During the year, support to both basic and applied research was continued. The Committees regularly monitored the progress made in ongoing projects. Several interesting and significant results were reported from these individual engineering science programmes, are given below:

Chemical Engineering

Chemical Engineering Programme (CEP) continues to achieve a decent balance between productivity and excellence in exciting frontline areas, involving quality fundamental research. In addition to a good number of publications in quality Journals, many of the studies would eventually create a base or find direct application in terms of process development and commercial practices. SERC Schools and workshops were conducted during the period, primarily aimed to target people from Universities, NITs and other Institutions to take up challenging R&D activities.

Salient features of the output generated from a basket of about 150 ongoing projects and 21 new projects (sanctioned during current financial year) are reported underneath.

- Devised a novel set-up to quantify Chemotaxis under controlled gradients. The set-up captures the spatial and temporal variation of the motion of E. coli. Detailed motion revealed that while the run speeds of the E coli were independent of the local concentration of aspartate (attractant), the same was not true for serine (attractant). Oxygen, which has hither to been ignored in intracellular modeling, plays a key role in chemotaxis. E coli, even in the absence of attractant, consumed oxygen and created local gradients of oxygen to which it showed biased motion. Irrespective of the magnitude of the gradient, the cell adapts to the new environment so that after some time, the motion of the E coli asymptotes to that in the absence of attractant. This time duration is referred to as adaptation time. The external motion of E coli is severely constrained by rotational diffusion, which disorients the E coli away from the direction of higher gradient. The model predictions matched with experimental observations only when the response of the intracellular pathway was highly ultra-sensitive to overcome the extracellular randomness. The parametric sensitivity of the pathway indicated that the dissociation constant for the binding of the ligand and the rate constants of the methylation/demethylation of the receptor are key to predict the performance of the chemotactic behavior.

- Synthesis of new alcohols having aromatic rings, sulphur atoms and diphenyl entities in their structural moieties has been carried out. The newly synthesised aromatic and aromatic sulphur containing molecule was converted into corrosponding (meth)acrylate. Reactions of bromodiphenyl methane were carried out with hydroxyethyl acrylate and hydroxyethyl methacrylate to produce newer monomers with aliphatic spacers in their structural moieties. Homopolymers of newer hydrophobic monomers were synthesised by free-radical solution polymerisation using azobisisobutyronitrile (AIBN) as initiator and tested for their thermal (DSC) and optical (R. I.) properties.

- Designed and developed a hybrid heating (infrared and electric) oven. Hybrid heating baking oven produces better quality bread than the conventional electrical heating baked bread. Three radiation models (DTRM, DO and S2S) were compared to identify the most suitable model in terms of applicability in electrical heating ovens. Placement of bread also influences the baking time and starch gelatinization. CFD model developed with evaporation-condensation front and phase change during bread baking process. Solidification model used within the CFD simulation to track the ice formation during freezing of coffee solution

- A multi-stage ion-exchange column was fabricated, installed and successfully operated to treat wastewater laden with dissolved aqueous solutes, using solid resins. Each stage of the perspex made column consisted of a downspout to facilitate the downward flow of fluidized resins on to the next stage, while water to be treated flowed counter-currently upward through the mesh of the stage and

voids between the resins. The present development is a significant accomplishment in that most of the present operations employed in India and elsewhere are batch, which inherently require intermittent stoppage for regeneration. The present stage wise column permits continuous operation without loading and flooding. The suitable choice of hydrodynamic conditions ensures smooth operation, with uniform flow of the fluidized resin particles on the successive stages without channeling or stagnant zones, and that of water upward through the voids between the solids. The experimental data due to the mass transfer study on the aqueous solution of nitrate and phosphate ions demonstrated more than 95% removal of the ions under different operating conditions of water-resin flowrates and inlet solute concentrations. The extent of removal of solutes in the multi-stage column was observed to be larger than that in a single stage, although the separation efficiency asymptotically leveled off with increasing number of stages. The stage-column developed in this work may also be used as a liquid-solid contactor in similar mass transfer applications, and has potential for commercialization, especially in pharmaceutical industries.

- Developed a technique to simultaneously image and track a large number of particles in a flowing granular medium. Image analysis and filtering techniques required for identifying and the particles and determining their velocities. To determine the stresses in a column of granular materials, fabricated a cylindrical Couette apparatus. The unique aspect of this apparatus is that all three components of the stress in the outer cylinder could be measured as a function of the vertical position.

Electrical, Electronics and Computer Engineering

Over the last seven years, Electrical, Electronics and Computer Engineering Programme (EECEP) has evolved into a front runner in terms of efficiency, productivity and responsiveness. There had been a significant increase in volumes (both numbers as well as funding).

Salient features of the output generated from a basket of about 200 ongoing projects and 18 new projects (sanctioned during current financial year) are reported underneath.

- An efficient scheme has been proposed for allocation of the frequency-code-time (FCT) cubes from the resource space to the users. Designed precoding schemes for MIMO systems under different channel statistics and with limited or no feedback. A linear precoding filter based only on the statistical knowledge of the channel has been proposed for DS-CDMA systems. Two system models have been proposed for MPOE and MMSE based pre-filtering for DS-CDMA systems by assuming only the first order and second order statistical parameters of channel at the base station transmitter. A system with cooperative nodes, each with multiple antennas, and design maximum likelihood detector has been proposed for such a system. Developed fair scheduling in a MIMO broadcast network based on the channel states and fairness criteria.

- Designed and developed a digital current mode control method for dc-dc converters for FPGA implementation. The salient feature of this control method is that it needs to sample the inductor currents only at the rate of the switching frequency – thereby not requiring a high speed (as a result more expensive) analog to digital converter (ADC). And also developed and verified a method for analysis and elimination of the limit cycle oscillation in the proposed digital current mode control method. A strategy to perform period by period averaging on sampled current of each phase of the multiphase converter was developed. This makes the scheme suitable for use of pipeline ADC. It may be noted that pipeline ADCs are cheaper than successive approximation ADCs but have the

limitation of pipeline delays. FPGA (Xilinx Spartan III – 400K Gates, TQFP 144 package) based digital control hardware with high speed (10M Samples/sec) 12 bit ADC, and DAC interfaces was developed. It also supports CAN and SPI data communication protocols

- Developed a novel technique to perform coverage analysis of object-oriented programs. At present, the coverage analysis techniques for object-oriented programs largely ignore analysis of specific object-oriented features by the test cases. Developed an intermediate program representation (a multi-graph) to aid coverage analysis of object-oriented programs. Apart from capturing various object-oriented features, this representation includes inheritance details at various levels and differentiates between different polymorphic bindings. Developed an efficient dynamic marking algorithm to mark the edges of the graph corresponding to the executed features of the program under test. Various inheritance and polymorphic coverage measures have been proposed in addition to the traditional coverage measures. Coverage measurement gives an accurate account of various features of an object-oriented program that are exercised by a test suite.

- An analytical model have been proposed for T-gate DGHEMT/SGHEMT incorporating the effect of channel thickness variation to calculate device characteristics like drain current, conductance, capacitance, etc. which leads to better understanding of the device operation. A two-dimensional solution of the device has also been proposed to obtain potential/electric field in the channel, threshold voltage of the device and is extended to study DGHEMT with Two Separate gate control. A 2-DEG charge control model for carrier density in the channel has been developed for separated DGHEMT (S-DGHEMT). The model is extended to calculate Id-Vg characteristics of the device. The channel thickness effect in the charge based drain current model has been incorporated as the vertical potential drop in the front electric field as it transverse the channel thickness.

- Developed a new device for the peg-free, touch less acquisition of hand (palmprint) images to build up large database of hand images. Developed the authentication using palmprint images using wavelet and fuzzy features. The achievement of the algorithm using Gabor Wavelet approach is that it does not require any core point detection algorithm. It works on partitioned windows and still achieves 97% of the recognition rates. The developed wavelet based algorithms have wide range of applications for access in the secured offices or in the attendance marking for the employees in the normal office environments. The newly developed modality based on hand back of the users is the potential candidate for biometric authentication; as it is not only easy to capture but can also operate on high recognition rates.

Material, Mining & Mineral Engineering

During the year, support to both basic and applied research was continued. 13 new research efforts have been initiated / identified for support and another 43 are under evaluation.

Research efforts supported / identified for support during the year include the following:

Development of Planar SOFC Stack Using Functionally Graded Anode Structure

Development of low Curie temperature magnetic nanoparticles for bioapplications

Design, synthesis and characterization of new biocompatible hybrid materials based on grafting organic polymers onto inorganic nanoparticles

Nano structured Ni based Heusler alloys for Magnetic Refrigeration Applications Part – Synthesis and Physical Characterization

Polymer Nanocomposites: Monolithic Encapsulation or Organic Devices

Differential membrane lipid profile and fluidity of *Acidithiobacillus ferrooxidans* during the process of adhesion to minerals

Growth and diffusion mechanism of Nb and V based A15 superconductor intermetallic compounds

Development of Calcium phosphate based machinable blockeramics

Fatigue Behaviour of an Ultra fine Grained Aluminium alloy processed by equal channel Angular pressing

Enhanced Ionic Conductivity of Solid Oxide Fuel Cell via-nano-CeO2 reinforcement in YSZ Electrolyte

Development of Bulk Ultra Fine Grained Steels of High Strength and High Ductility through Severe plastic Deformation (revised)

Development of erosion resistant duplex stainless steel for use in hydropower plants

Development of corrosion resistant HVOF sprayed Cr3C2-NiCr coatings for boiler tube steel operating at elevated temperature

Highlights of results accruing from research efforts initiated during preceding years:

- Friction pads with built-in backing plates for the MIG 27 & AN-32 military aircraft were successfully developed employing hot powder forging technology at IIT, Roorkee. The technique involves mixing of powders of suitable chemistry having metallic constituents, abrasives and solid lubricants in specific proportions. The forged friction material was subjected to variety of tests including sub-scale dynamometer test at HAL Bangalore. Efforts were made to develop brake pads by hot preform powder forging (net-shape) without involving any machining to optimize the manufacturing cost to the minimum level.

  MIG 27 stator application is very specialized high energy condition for which chemistry of sintered pads is very complex and costly. In comparison to this, chemistry developed in the present investigation is much simpler and offer wide variety of choices to suit this challenging application. Iron based brake pads which are used in military aircrafts were produced first time using a new technology namely "Hot Powder Forging' at Metallurgical & Materials Engineering Department, IIT, Roorkee, Roorkee. These brake pads have in-built backing plate and longer life. AN-32 Military transport aircraft BRAKE PADS so produced were tested on near to the actual field conditions using subscale dynamometer at HAL, Bangalore and the performance was reported to be better than the existing brake pads produced through powder compacting and sintering method.

- Efforts were made to prepare a thick crack free lead zirconate titnate (PZT) films (1-2 Microns) of morphotropic composition on nano-engineering of silicon substrate/surface at NIT, Trichy. PZT films at morphotropic phase boundary have been prepared by sol-gel process. Nano-engineering of silicon substrate was done by introducing a seed layer (thickness approx. 75-100mm) in between the silicon substrate and the PZT film. Initial experiment was carried out and XRD analysis on these films shows

that it contains cracks. Development of piezocantilever from the prepared thick film by using microfabrication technique was completed however the results were not encouraging.

- A detail study was made to synthesize monodisperse FePt nanoparticles of 3nm to 8nm size suitable for data storage applications by simple chemical method at C-MET, Hyderabad. Phase transformation of FePt nanoparticles for obtaining ordered face centred tetragonal (fct) structure at 550^0C was carried out. Synthesis and characterization of FePt nano particles with different iron and platinum compositions to improve the magnetic proprieties were also carried out. However, the results were not encouraging.

- A detail study was made to develop advanced composite material by compounding Single wall carbon Nanotube in to super tough nylon6 at IIT,Delhi. Crystallinity of the polymer matrix by X-ray diffraction method and its variation with Single Wall Carbon Nanotube were studied. In addition mechanical properties and thermal properties of nanocomposites were also studied. However, the results were not encouraging.

- Highly active copper chromite catalyst prepared by calcinations of the precipitated basic copper ammonium chromite catalyst ($CuOHNH_4CrO_4$) was successfully developed as substitute to noble metals for purification of vehicular exhaust at BHU, Varanasi. A compact and versatile laboratory tubular reactor has been designed and fabricated. An experimental set-up for performance evaluation of the prepared catalysts has been installed. In addition to this various types of conventional and novel copper chromite catalysts as well as platinum Three Ways Catalysts (TWC) were also prepared.

  There was 98% conversion of vehicles pollutants carbon monoxide (CO) to CO_2 continued at 150^0C as compared to noble metal (Pt. catalyst) which was 26% conversion. Similarly $100^{\%}$ conversion of Hydrocarbon (HC) to H_2O and to CO_2 using prepared copper chromite catalyst at 1300^0C as compare to noble metal catalyst. This ($[15\%Cu_2Cr_2O_5/Ce_{0.9}Zr_{0.1}O_2.AlO_3(20\%)$ catalyst was demonstrated to have enhanced activity not only for CO oxidation but also for n-hexane and reduction of N_2O when the precursor was calcined at 600^0C under limited oxygen environment. The enhanced activity resulted from the formation of $Cu_2Cr_2O_4$ spinal structure that was detected with XRD studies.

  In view of the outstanding longevity and of its much lower cost, the novel copper chromite based catalyst represents a very promising alternative to noble metal catalyst (TWC) for vehicular exhaust purification. Further studies of this catalyst in actual vehicle are required for its commercial applications.

- A detail study was undertaken for development of Iron-based Multicomponent & Nanodispersed Bulk Metallic Glasses through Mechanical Alloying for Industrial Applications at NIT, Tiruchirappalli. The chosen composition of Iron-based multicomponent alloys (Fe-Zr-(Si/B)-Xm X=Nb, Mo, W, Ni, Al and Cr) was synthesized in a high energy shaker mill and planetary ball mill in order to optimize the composition and structural evolution. The mechanical alloying parameters, milling speed, milling time, environment, etc has standardized in order to correlate the milling parameters with structural evolution. Detail crystallization study of bulk metallic glasses were carried out however the results were not encouraging.

- An excellent multi-scale modeling to study the role of atomic scale defects in CNT-based nanocomposite was developed at IIT, Kharagpur The project was undertaken to understand the impact of defects (vacancies & distortions) on the surface of carbon-nanotubes reinforced polymer matrix composite and the quality of the interface on the mechanical properties of the nanocomposite

through appropriate multi-scale modeling. MWCNT were characterized using TEM and/or SEM to identify and model the defects. The effect of the nano-scale defects on the interface between the polymer and the nanotubes through multi-scale Atomistic Simulation – Finite element modeling (AS-FE) simulation was determined.

- A detail study was undertaken for development of magnesium based rheocast alloys and stir cast composites for applications in engineering industries at NML, Jamshedpur. Optimization of rheocasting process parameters viz (shear rate and time volume fraction of primary solid particles, melt superheating, and mould temperature variations) were initially done. The Mg-5%Sn and Mg-5%Sn-2%Mm (Misch metal) alloys were processed through rheocast route. Misch metal is alloy consisting of about 50% (cerium), 25% la (lanthanum), 15% Nb (Neodynium) and 10% other rare earth elements with iron. Misch metal alloyed with iron is the flint (spark producing agent) in cigarette lighters and similar devices. Rheocast sample showed presence of globular shaped-a Mg ripened dendrities found in conventional cast sample. Hardness of Rheocast sample was superior to conventional cast sample of same alloy. Tribological properties like wear loss decreases for Rheocast samples. Magnesium-based alloys have enormous potential for high performance structural applications due to their light weight combine with high specific strength, superior damping capacity, etc. Based on these superior properties and a combinative requirement for reducing environmental burdens by using light weighted structures, R&D of magnesium alloys for industrial application have increased. Therefore AZ series cast Mg-alloys have been extensively studied to be used for some structural components of automobiles, aircraft, and computers. Mg-Sn based rheocast alloys have been developed in this project showed superior high temperature properties to conventional AZ series Mg alloys, which shows poor high temperature properties.

- A research project on prediction of the stability of spread footing foundation on weak floor jointed and layered rock mass using multi model finite element analysis and artificial neural network technique was undertaken at, ISM, Dhanbad. in order to perform numerical analysis of stability of surface footing foundation on layered and jointed rock mass, information regarding litho logical rock layers and rock mass properties viz. values of Young's modulus (E) and Poisson's ratio (v), Elastic bulk modulus (k) and shear modulus (G) (as calculated from Young's modulus and Poisson's ratio, with correlations from elastic theory), Shear strength as described as cohesion (c) and Internal friction were collected from the results of physical modeling tests for varying rock mass conditions conducted earlier. 2-D/3-D numerical models were also developed for different condition of surface footing foundation using appropriate rock mass properties. Analysis of stability (mainly bearing strength and settlement) under a footing on regularly bedded, jointed and layered model rock mass was conducted using Back Propagating Neural Network (BPNN) and Adaptive Neuro Fuzzy Inference Systems (ANFIS) and then compared with the results published previously in respect of physical simulation technique and with FEM analysis (Kumar & Dass, 2000;2001;2003). It was concluded that ANFIS model predicts accurately well vis-à-vis experimental results though the results predicted from BPNN model compares well with those of FEM analysis.

- A detail study was undertaken for synthesis and characterization of cellulose esters for radiation-curable coating applications at, Orissa Engg., College Bhubaneswar. The present proposal highlights the preparation of a single pack cellulose based UV-curable natural polymer for ideal coating

applications. A single pack stabilizer with an optimum combination of UV Absorbers (UVA) and Hindered Amine Light Stabilizers will be not only cost effective but also more suitable for their uniform dispersion.

Initially a cellulose powder was prepared from whatman filter No.1. These cellulose was dissolved in two solvent systems i.e. Dimethyo sulfoxide/paraformaldehyde and N,N-Dimethyl acetamide/LiCl and was fractioned to different molecular weight fractions by the addition of a non-solvent followed by estrification using acetic, propionic, butyric acid and pentanoic anhydride to corresponding esters having degree of substitution less than 2. The esters was grafted with methacrylate and á-methylstyrene moieties by reacting the esters with acrylic anhydride and m-isopropenyl- á, á'-dimethylbenzyl isocyanate (TMI). The UV-curable polymers were then prepared.

Efforts are being taken by the College to commercialize these prototype components made from UV-cured cellulose esters for authomobile and outdoor applications. Leading automobile manufacturers like TATA motors, Hyundai, Premier Automobile shall be encouraged to use these unique coatings for their automobile exterior applications.

CHEMICAL SCIENCES

Support to R&D projects in frontier areas of chemical sciences continued. Many young researchers who have taken up faculty positions in institutions of repute were supported with substantial grant to undertake research in challenging areas. The output profile of the funded projects also showed improvements both in quality and quantity, reflecting its domination in the publication share of India.

ORGANIC CHEMISTRY

Some significant results came out from the funded projects are given below:

- New neutral, *meso*-substituted tetrathia[22]annulene[2,1,2,1] and tetraoxa[22]annulene[2,1,2,1] aromatic macrocyclic architectures have been synthesized.

  These new species when fabricated as thin film organic field effect transistor devices, displayed structure as well as temperature dependent p-type semiconductor behaviour. These constituted first examples in these categories and depicted reproducible bulk-like carrier mobility (as high as 0.63 $cm^2V^{-1}S^{-1}$) on highly crystalline thin films deposited on octadecyltrichlorosilane modified SiO_2. (*Chem. Commun.*, 2011, 47, 905-907, *Chem. Commun.*, 2012, 48, 121-123.)

- Fast swelling starch based superabsorbent polymers were synthesized from *cassava* starch by suspension polymerization in presence of water and cyclohexane medium. The developed materials showed spongy appearance with a water absorption capacity of about 200g/g in 8-9 min. The hydrogels were found to have very good shelflife of more than 6 months at ambient temperature without any microbial conatamination, in spite of incporporation of starch in the material, and these can be exploited as packaging materials.

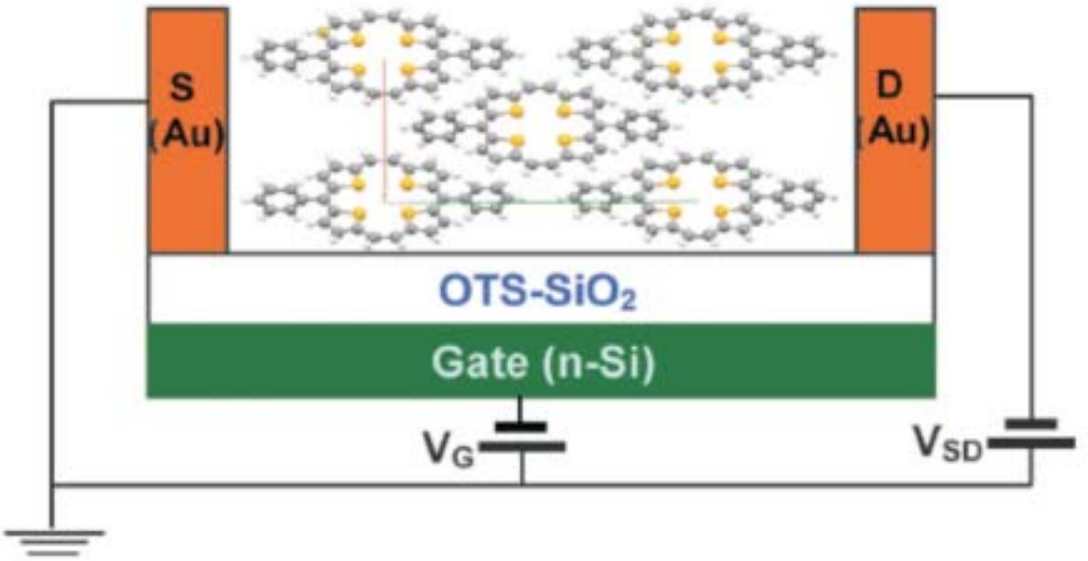


Fig. 1.24: Cassava starch based superporous hydrogels

- The discovery of copper (I) catalyzed "click" reaction to generate 1,4-disubstituted-1,2,3-triazoles has triggered explosive new developments in the area of synthesis of triazolyl compounds capable of ligating two different molecules. In spite of the noted importance of 1,5-disubstituted-1,2,3-triazoles as cis-peptide bond surrogates, synthetic approaches towards 1,5-disubstituted-1,2,3-triazoles so far have achieved limited success. A metal-free vinyl sulfone-based synthesis of 1,5-disubstituted-1,2,3-triazoles has been reported for the first time. These triazoles are easily formed in a regioselective fashion by heating under reflux a mixture of a substituted vinyl sulfone and an organic azide "on" water. (*Synlett*, 2011, 2521-2524.)

- Hydroamination, the direct addition of an amine to a carbon-carbon unsaturated bond, is an attractive atom economical route to amines, imines and enamines. The reaction is thermodynamically feasible but high activation barriers exist, even for the energetically more favourable alkynes. Homogeneous catalysts have been extensively investigated but only few heterogeneous catalysts have been found. A first example of indium catalyzed tandem hydroamination and hydroalkylation reaction of terminal alkynes with arylamines to generate á,â-unsaturated ketimines has been achieved. (*Chemical Communications* 2011, 47, 9525-9527).

- Recently the concept of hybrid antimalarials has attracted much attention for tackling the alarming problem of drug resistance, as these molecules often act on multiple therapeutic targets because of the presence of two different, covalently fused pharmacophores. In this direction, some novel stilbene"chalcone (S-C) hybrids were synthesized for the first time via a sequential Claisen"Schmidt"Knoevenagel"Heck approach and evaluated for antiplasmodial activity in in vitro red cell culture using SYBR Green I assay and studies suggested their ability to cause apoptosis in malaria parasite.

Fig. 1.25: (dx.doi.org/10.1021/jm201216y | J. Med. Chem)

- A novel strategy of catalytic green aerobic oxidation by surfactant-mediated oxygen reuptake in water was developed, which offers a new dimension to the applications of surfactants to look beyond as solubility aids and a conceptual advancement in understanding the catalytic role of surfactants in aquatic organic reactions. (*Chemical Communication*, 2011, *47*, 1797–1799)

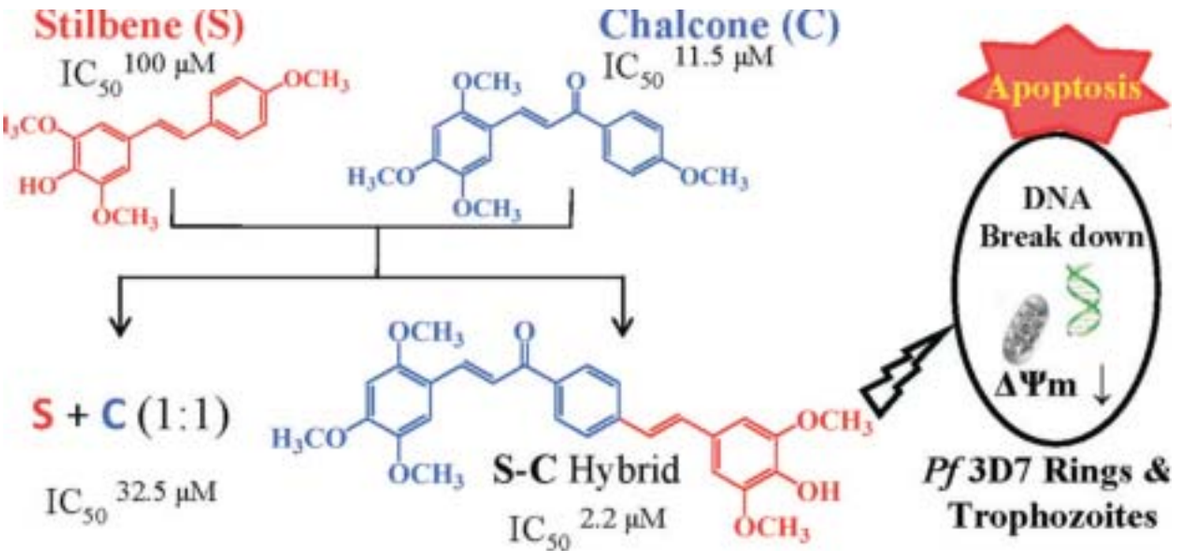


Fig. 1.26: Stillbene – Chalcone hybrid

- Thiophenes are widespread in nature and have emerged as a class of important heterocycles due to their presence in a broad spectrum of natural and synthetic organic molecules with diverse biological properties. An efficient and experimentally rapid protocol for the synthesis of hitherto unreported 2,3-dicarboalkoxy-4-aroyl/heteroaroyl/alkanoyl thiophenes has been developed promoted by 4-dimethylaminopyridine (DMAP). This method allows a clean and general synthesis of previously inaccessible and synthetically demanding thiophenes containing the ferrocenyl group. The speed,

experimental ease, and high yields of this process are improvements over existing methods to access this important substructure. (*J. Org. Chem.* 2011, *76*, 8009-8014)

- A semantically rich representation format for chemical structures suitable for reaction modeling as well as for the evolving Semantic Web has been developed. Description of chemical structures in multiple semantic layers including the electronic environments in terms of 'electronLink' has been done for the first time. This promises a new way of representing the chemical reaction and to model the reactivity.

  (*Journal of Chemical Information and Modeling* – 50, 2010**,** pp 755-770. DOI 10.1021/ ci100052b)

INORGANIC CHEMISTRY

Some achievements arising from the projects supported in Inorganic Chemistry are listed below:

- Gold nanorod based plasmonic-fluorescent, plasmonic-magnetic and plasmonic-fluorescent-magnetic hybrid cellular probe were synthesized which can be used as dual imaging or imaging-separation purpose. In the hybrid probes the nanorod component acts as dark field contrast agent, quantum dot acts as fluorescence probe and magnetic iron oxide offers magnetic separation. { *ACS Appl. Mater. Interfaces*, 3(2011)3335-3341; *J. Phys. Chem. C*, 115(2011)19612-19620 (highlighted in Nature India, 29 October, 2011)}

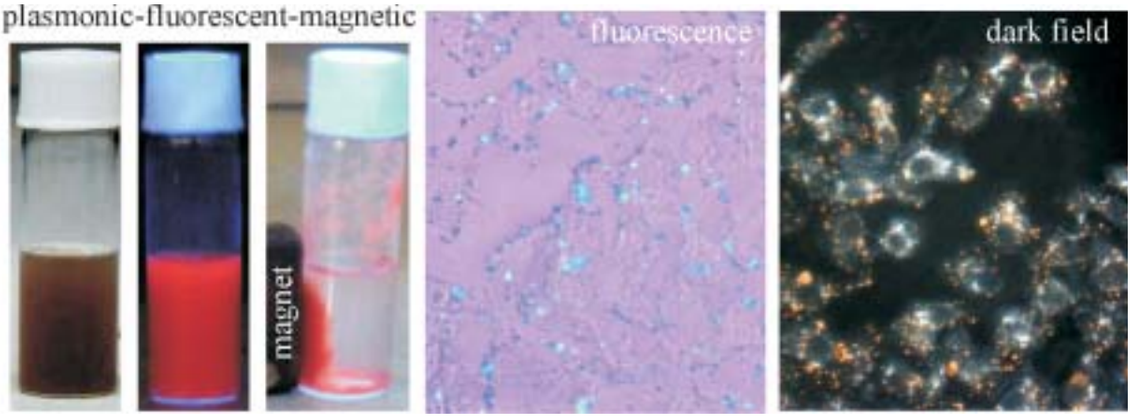


Fig. 1.27: Solutions of nanorod hybrid and images of cells after labeling with functional nanorod hybrid.

- A study on larval developmental phases of Drosophila melanogaster, which has orally ingested water-soluble carbon nano-onions was undertaken. The nano-onions are synthesized from wood waste, and they are used to image the entire life cycle of this species—from egg to adulthood without any toxic effect.

  The fluorescent organisms excrete the fluorescing material, and upon removal of the nanoparticles from their diet, they revert to their normal form demonstrating the reversibility of this process. This nontoxic fluorescent probe would be a viable alternative to barium meal in X-ray imaging of humans. (Small **,** 2011, *7*, 3170–3177)

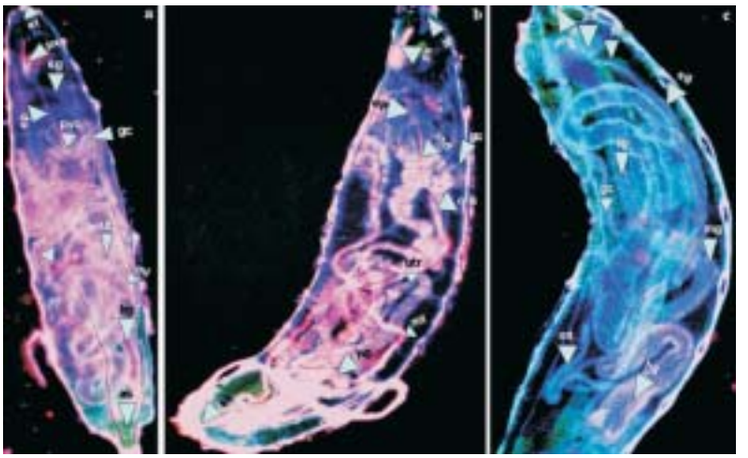


Fig. 1.28 : Images (merges of 385, 488, and 561 nm filters) of *Drosophila melanogaster* at the larval stages showing organ details

- Covalent organic polymers have been widely used for sensing nitroaromatic explosives. Unlike covalent polymers, supramolecular polymers are easy to synthesize, soluble in common organic solvents and thus easy to fabricate them for practical applications. π-electron rich H-bonded polymeric chain of 9,10-bis(1,3-dicarboxylicphenyl-5-ethynyl)anthracene and it's discrete ester analogues have been synthesized and the supramolecular polymer showed very efficient sensing of nitroaromatic explosives in both solution and solid state compared to the discrete ester analogue. The H-bonded polymer represents the first example of a supramolecular polymer for efficient sensing of nitroaromatic vapour. **(** *Chem. Commun.* 2011, *47*, 10046)

- Functional models of *CloR*, the enzyme involved in the biosynthesis of clorobiocin, an aminocoumarin antibiotic have been developed. The model complex has been shown to react with dioxygen to oxidatively cleave benzilic acid to benzophenone. The oxidant formed is capable of converting cyclohexene to *cis*-cyclohexane-1,2-diol with both oxygen atoms derived from O_2. This is the first biomimetic iron(II) complex where a new mode of dioxygen activation leading to the formation of an iron(IV)-oxo-hydroxo oxidant has been documented (Angew. Chem. Int. Ed. 2011, 50, 11129–11132).

Some of the salient achievements in the projects sanctioned under "metal based drugs" program are given below:

- Design and synthesis of new iron(III) and oxovanadium(IV) complexes that show photo-induced DNA cleavage activity in red light within the PDT spectral window have been achieved and these complexes show significant photocytotoxicity and poor dark toxicity in different types of cancer cells. The IC_{50} values compare well with the FDA approved PDT drug Photofrin. The results on SMVT targeted iron(III) complexes having a biotin unit are unprecedented in the chemistry of metal-based anticancer drugs (*Dalton Trans.*, 2011, DT-ART-06-2011-011115).

- Work has been initiated on bioorganometallic complexes in PDT (EJIC cover page, *Eur. J. Inorg. Chem.*, 2011, 1379-1386). The concept is new and some encouraging results showing positive effect of the organometallic moiety on the photo-induced DNA cleavage activity of the 3d-metal complexes. Subsequent reports on ferrocene-conjugated oxovanadium(IV) and zinc(II) complexes

have shown significant PDT activity with low dark toxicity (*Dalton Trans.*,2011. DOI: 10.1039/C1DT11102G; *Eur. J. Inorg. Chem.*, 2011, ASAP, 10.1002/ejic.201100836).

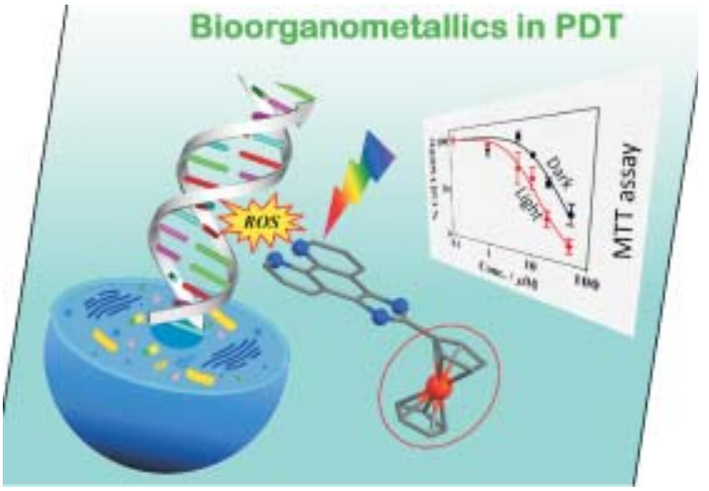


Fig. 1.29 : Bioorganometallics in PDT

PHYSICAL CHEMISTRY

Some interesting results obtained in ongoing projects are given below:

- Novel techniques that employ 1H NMR for chiral analyses and are cited in the literature with various acronyms, such as, DQ-SERF, BASE-â-COSY, CH-SERF, CH-DQSERF, BASE-z-COSY, CESS-COSY, C-HETSERF, SSMQNMR, SSDQ-J-Resolved, SS3Q-J-Resolved, ù1-het-CH-SERF, ù1-het-CH-DQSERF and ù1-het-CH-TQSERF have been developed. These experimental techniques not only resulted in efficient removal of spectral overlap of enantiomers but also enabled their analyses by yielding incredible high resolution. The chiral discrimination using proton NMR, which was largely ignored earlier due to difficult-to-analyse nature of 1H NMR spectra, can now be routinely employed for small and medium sized molecules. The significant contribution has been made and the polysaccharide xanthan liquid crystalline medium has been proposed both for chiral discrimination and the measurement of residual dipolar couplings in water soluble chiral molecules.

- Structure and dynamics of water in the grooves of a long DNA duplex using molecular dynamics simulations with TIP5P potential at low temperature have been studied and signatures of dynamical transition in both translational and orientational dynamics of water molecules have been found in both major and minor grooves of a DNA duplex. It has been shown that groove water exhibits markedly different temperature dependence of its properties from the bulk. Entropy calculations reveal that the minor groove water is ordered even at room temperature, and the transition at T~255K can be characterized as strong-to-strong dynamical transition. It is also demonstrated that the confinement of water in the grooves of DNA favours the formation of a low density four-coordinated state that makes the liquid-liquid transition stronger.

- Theoretical calculation has been done for the photoelectron spectra of Na3 cluster by exploiting beyond Born-Oppenheimer theory, where the diabatic Potential Energy Surfaces are constructed by

employing molecular symmetry adopted Non-Adiabatic Coupling Terms. Such calculated spectrum agrees quite well with the experimental one. The effective Hamiltonian for a given surface temperature has been formulated invoking the Bose -Einstein probability factor. Such Hamiltonian provides the correct trend of sticking probability (chemisorption and physisorption) with respect to the experimental one.

- A new controlled polymerization, coined as SET-RAFT (Reversible Addition Fragmentation Chain Transfer), has been developed. The utilization of the same has been demonstrated for the controlled polymerization of monomers such as cyclohexyl methacrylate and vinyl carbazole. New trithiocarbonate based (smell free) CTAs have been synthesized and characterized. Few alternating copolymers have been synthesized and these are observed to form porous structures under suitable conditions. The formation of stable dispersion of CdS nanoparticles of 4 nm size is demonstrated using the polymers synthesized.

- The power of Onsager's non-equilibrium thermodynamics has been demonstrated for electron transfer at liquid/liquid interfaces. The derivation of the partition function for Ising models in all dimensions will be a break-through in science since this is considered impossible. An entirely novel approach using graph theory has been attempted to deduce the partition function and all thermodynamic properties therefrom.

- The relation between the aggregation propensity and intrinsic emission in PAMAM dendrimers was established for the first time. Higher order complex structure (fractal type) was achieved by self-assembling PAMAM dendrimers. A dendritic system exhibiting positive solvatochromism over a range of 100 nm has been synthesized and transparent and instant gelation in dendritic systems was observed in the absence of conventional gelating motif.

GREEN CHEMISTRY

Some of the new projects supported were:

- Environmentally benign inorganic colorants
- Development of bi-functional heterogeneous catalysts based on lacunary polyoxometalates for the environmentally benign production of fine and intermediate chemicals
- Green photochemical processes: Utility of solar/visible light and ecofriendly photocatalysts in organic transformations
- Enhance biodegradation of polymer: Influence of surface properties, molecular weight and type of surfactant on biofilm formation and biodegradation
- Rongalite as a useful green reagent in organic synthesis

In an ongoing project, use of waste flexible plastic film (laminated multi layered film) as a new raw material for coating the aggregate used for flexible pavement construction has been demonstrated.

A two week school on "Green Chemistry-Research, Teaching and Applications: Exploring Opportunities in Green Chemistry" was organized. The school introduced Green Chemistry concepts to the academia and facilitated sharing of knowledge and promotion of research in the area.

MATHEMATICAL SCIENCES

The Mathematical Sciences Programme promotes research in the areas of Mathematics, Statistics, Operations Research and Theoretical Computer Science. Programmes/activities related to manpower development/training involving research students/young faculty members from the universities/ colleges/ research institutions are also being supported under the programmes in various areas of mathematical sciences.The highlights of the progress/achievements are as follows:

Support to Research in mathematical Sciences:

- 23 new research projects were supported during the year in the areas including Algebra, Variational Inequality, Graph theory, Game Theory, Wavelet Analysis, Differential Equations, Mathematical Modeling, Statistics, Bayesian Statistics, Stochastic Modeling, Queuing Theory and Optimization etc.
- Support to about 100 ongoing research projects in various areas of Mathematical Sciences was continued.
- As an outcome of research activities under ongoing projects more than 120 research papers have been published in the Journals of National and International repute.
- 2 group monitoring workshops were held to review the progress of the ongoing projects.

Support to the Centres/ Core Group research facilities:

Support to the following Centres/Core Group research facilities which have been setup to intensify research in various frontline/thrust areas was continued. Highlights of the progress are as follows:

- **Centre for Mathematical Sciences at Pala in Kerala-** The focus of the research remained in the areas of fractional calculus, special functions, statistical distribution theory, geometrical probability, stochastic processes, discrete mathematics and astrophysics. 12 research scholars are being trained in these areas. 20 research papers have been published/accepted in the journals of National and International repute during the year. First of the sequence of 4 camps of undergraduate training programme in various areas of mathematics with 36 participants was completed in September 2011. The second, third and fourth camps will be in November and December 2011. Leading researchers from South Korea, Finland, Germany visited the Centre and gave series of lectures at the Centre benefitting the research working at the Centre.
- **National Centre for Advance Research in Discrete Mathematics at Kalasalingam University, Krishnankoil, Tamilnadu -** The focus of the research remained in the area of Discrete Mathematics. 10 research scholars are being trained in this area. Five research scholars have completed Ph.D. 25 research papers have been published/accepted in the journals of National and International repute during the year. The centre continued its Research Oriented Lecture Series in Discrete Mathematics and Theoretical Computer Science and regularly organized one day seminars on all second and fourth Saturdays of every month, which are being attended by the research scholars and young faculty members from academic institutions in the region. Academic collaborations were established with some of the leading expert in medical application of Graph Theory between HEIG-VD, Switzerland and Kalasalingam University.
- **Centre for Interdisciplinary research in Mathematical Sciences (CIMS) at Banaras Hindu University (BHU), Varanasi -** The focus of the research remained in the areas of Bayesian Statistics,

Discrete Mathematics, Mathematical Modelling, Stochastic Modelling, Wavelets and Functional Analysis. 10 research scholars are being trained in the above areas. More than 35 research papers have been published/accepted in the journals of National and International repute during the year. Four instructional workshops/training programme were organized in the areas of Statistical Estimation and Modelling, Differential Geometry, Graph Theory and its Applications and SPSS. Leading researchers from U.S.A Canada, South Korea and Romania from abroad and IISER, Pune, IIT Mumbai, VNIT, Nagpur, TIFR Mumbai, IISER Bhopal visited the centre and gave a series of lectures benefitting the research worker at the Centre. A lecture series were organized by the faculty of the CIMS.

- **Centre for Mathematical Biology at Indian Institute of Science, Bangalore-** The focus of the research remained in areas of Mathematical and Computational Neurosciences, Mathematical Genomics and Proteomics and Mechanics of Cells and Tissues. 6 research scholars are being trained in the above areas. 12 research papers have been published/accepted in the journals of National and International repute during the year. Research work was carried out on probing the allosteric mechanism in Pyrrolysyl-tRNA Synthetase using Energy-Weighted Network Formalism, Rule- based modeling of iron homeostatis in tuberculosis, Identification of Important voids and pockets in biomolecules, Use of Dendrimer in Drug delivery and HIV inhibition, Dynamic clamp of hippocampal subicular neurons-effect of adding HCN channel conductance on neuronal properties, Complex Dissociation Pathway of the HIV-1 gp120-CD4 Bond.Application of an algorithm developed under the program for guided prediction of residue level structural information from low resolution cryoEM maps aided in recognition of changes in protein-protein interfaces in the coat of the dengue virus as the virus matures. A classification of prokaryotic protein kinases using clustering of homologues depending upon residue similarity levels was done. Development of a new alignment-free approach to classify multi-domain proteins using biological homogenety index and area under the curve and application to human protein kinases was done. Development of an algorithm to align the hidden Markov models of protein domain families and its application to recognize remote homology and characterization of stability of domain folds of multi-domain proteins using energy calculations was done.
- **Centre for Mathematical Sciences at Banasthali University, Rajasthan-** The focus of the research remained in area of Discrete Mathematics and Statistical & Mathematical modeling. 4 research scholars are being trained in the above areas. 25 research papers have been published/ accepted during the year. Three workshop/training programme were organized in the areas of Number Theory, Algebra and Inventory modeling.
- **Centre for Mathematical Sciences at CR Rao Advanced Institute of Mathematics, Statistics and Computer science, Hyderabad-** The focus of research remained in the areas of discrete mathematics, graph and digraph theory with applications to social, biological, physical and behavioral sciences, bio-informatics and dynamical systems, cryptography, combinatorics, Bayesian analysis, design of experiments, biometrics, orthogonal arrays, time series and econometric models with applications to national developments, theoretical computer science, signal processing, analysis of algorithms and complexity, financial mathematics and Modernization of the Indian Statistical System etc. 10 research scholars are being trained in the above areas. 22 research papers have been published/ accepted in the journals of National and International repute during the year. Two research level books and one proceeding of International workshop on Graph Theory were published. Three research level workshops on Statistical and Mathematical Modelling including data collection and

analysis, Set–valuations, signed graphs and Geometry and Applications and Statistical Genetics were organized. Leading researchers from Standford University, University of illions at Chicago, Kyushu University, Japan from abroad and Indian Institute of Science, Bangalore, Indian Statistical Institute, Kolkata visited the Centre and gave series of lectures at the Centre benefitting the research working at the Centre.

Prof. C.R.Rao of the centre was awarded the **Guy Medal in Gold** of The Royal Statistical Society, London for his contribution to statistical theory and methodology, including unbiased estimation, variance reduction by sufficiency, efficiency of estimation, information geometry, as well as the application of matrix theory in linear statistical inference.

The **Guy Medal in Gold** is awarded triennially to those "who are judged to have merited a signal mark of distinction by reason of their innovative contributions to the theory or application of statistics". Prof. C. R. Rao is the first non-European and non-American to receive the award.

Fig. 30: Award of Guy Medal in Gold of The Royal Statistical Society to Prof. C. R. Rao by the president of Royal Statistical Society, London.

- **National Mathematical Sciences Initiative-**The support to National Mathematical Sciences Initiative was continued at Indian Institute of Science, Bangalore to organize thematic programmes on different topics at the interface between mathematics and other disciplines including compact lectures/ workshops/seminar etc. An **International Conference on Mathematical Biology was held on July 04 - 07, 2011, Mini-Symposium on Analysis and simulation of biomolecular structures was held on July 08, 2011. Workshop on "Introduction to Network Science" was held on August 29 - September 02, 2011 and on "Networks: Structure and Function" was held on November 04 - 05, 2011.**

Programmes for Manpower development: Following Training programmes/Workshops/SERC Schools were held/initiated during the year**:**

- **SERC Schools-**A SERC school on "Matrix valuable calculus and statistical distribution theory and applications in data analysis, model building and astrophysics problems" was held from 27th April-27th May,2011 at Centre for Mathematical Sciences, Pala. 31 participants from all over the country got benefitted by attending the SERC School. Another SERC school on "Development and transformation theory of ordinary and basic hypergeometric functions" was held from 16th May to 14th June, at Gorakhpur.50 participants from all over the country got benefitted by attending the School.

- **Human Resource Development in mathematics-**This is a new initiative and is being coordinated by Institute of Mathematical Sciences, Chennai to develop human resources in Mathematical Sciences through training of research workers by Adjunct and visiting professors from leading research institutes at select university centers, providing travel grants to Indian researchers to work at centers of excellence and holding Annual Instructional Schools on applications of mathematics. An eminent researcher from Transylvania University, Romania will visit N.I.T. Warangal as a visiting professor for a period of two months and will deliver lecture courses on contemporary topics in applied mathematics.

- **National Programme on Differential Equations**: **Theory, Computation & Applications**- This is new initiative which will be coordinated by Indian Institute of Technology, Bombay to create Human resources and knowledge generation in academia and industry in the area of Differential Equations. A series of workshops/training programmes are planned to be held at various institutions in the country covering theory, computation and applications of Differential Equations to create a pool of trained mathematicians to support the advancement of science and technology in general and reap its benefits for the development of the society, promote fruitful interaction between academia and industry and provide a platform for academic interaction and collaborative research amongst mathematicians and scientists in the country.

- **National Meet of Research Scholars-** A National Meet of Research Scholars in Mathematical Sciences (NMRSMS-11**)** was organized at Indian Institute of Technology; Kharagpur to train the research students about research methodologies and to improve the presentation skill etc. 52 participants from all over the country attended the meet.

Training Programme/ Workshops/ Colloquium etc:

10 Training Programmes/Workshops/Colloquium etc were organized at various/universities/ colleges/ other institution spread allover the country on the following topics to train Indian research students/ young faculty members and to keep themselves abreast with the latest developments in mathematical sciences: Modeling Analysis and Industrial Applications of Advanced Operations Research Techniques, Optimization and Business Analytics, Decompositions of Graphs and Product Graphs, Nonlinear Analysis with Applications to Optimization and Game Theory, Introduction to Graph Algorithms and Applications, Vedic Mathematics etc.

Ramanujan Galary at Periyar Tamilnadu Science & Technology Centre, Chennai:

Support was continued to Ramanujan Galary at Periyar Tamilnadu Science & Technology for upgrading it on the life and work of genius Srinivasa Ramanujan to inculcate the spirit of mathematics among the children and researchers**.**

CHAPTER 2

STRENGTHENING INSTITUTIONAL CAPACITIES IN RESEARCH AND DEVELOPMENT

To address the issue of lack of infrastructure facilities for imparting good quality higher education and conducting advanced research a programme for selective strengthening of their infrastructure for post-graduate education and research in emerging areas the **Fund for Infrastructure Strengthening of Science and Technology (FIST)** continued to be a successful ongoing scheme of the Department of Science and Technology. Synergies were established during the last year with Ministry of Human Resource Development through University Grants Commission for extending support for civil and building infrastructure for departments and academic institutions receiving support through FIST. During the Eleventh plan period total of 715 departments were supported through a fund of Rs. 782.63 crores. Of these 118 new departments and 52 colleges had been added during the year 2011-12. **Consolidation of University Research, Innovation and Excellence (CURIE)** for women only universities has benefited all the six women only universities in the country in strengthening their R&D infrastructure. An incentive based program called "**Promotion of University Research and Scientific Excellence" (PURSE)** was implemented by the Department to specifically boost the University Sector. 30 universities were added to the list of **PURSE** awardees during the year 2011-12 making the total number of such awardees to 44. The Department has set up **sophisticated analytical instrument facilities (SAIFs)** in different parts of the country to provide the facilities of sophisticated analytical instruments to the research workers in general and specially from the institutions which do not have such instruments to enable them to purse R&D activities requiring such facilities and keep pace with development taking place globally. **Intensification of Research in High Priority Areas (IRHPA)** a complementary programme to the SERC programme with activities consisting of setting up of units/ core groups around an eminent scientist and major National Research facilities to nucleate research activities in these areas. **Mega Facilities for Basic Research** aims to create Mega Science facilities and launch Mega Science programmes in and out of the country to improve access to such state-of-the-art facilities for the Indian scientific community, especially from the academic sector. India has joined a major partner in establishing Facility for Anti-proton and Ion Research (FAIR) at Darmstadt in Germany, the construction phase of the project has begun.

FUND FOR IMPROVEMENT OF S & T INFRASTRUCTURE IN UNIVERSITIES AND HIGHER EDUCATIONAL INSTITUTIONS (FIST)

Considering the aspect of strengthening the teaching and research infrastructure in Universities/Colleges and various academic institutions, nearly a decade ago, the Program "**Fund for Improvement of S& T infrastructures in Universities and higher educational institutions (FIST)** was launched by the government during FY 2000-2001. The program was launched to provide basic infrastructural facilities for teaching and research and promoting research and development in emerging areas. The program has enabled many departments across the country to perform competitive research, established modern teaching and research infrastructure and has enabled the departments to attract fresh talents.

Currently, the Program is operated at three levels Level 0, Level 1 and Level II for seven subject areas such as Physical Sciences, Chemical Sciences, Life Sciences, Engineering Sciences, Earth and Atmospheric Sciences, Mathematical Sciences and PG Colleges. The Program covers all sectors of Science and Technology departments including Agriculture and Veterinary sciences and Medical Sciences. A three tier structure, FIST Advisory Council, FIST Advisory Board and seven expert committees are in place for execution of the Program.

At present the total number of Departments supported under the program are 1505 [Level 0-42, Level I-1324 and Level II are 139]. The total recommended Budget Rs 1136 Crores [Level 0- Rs 25.0 Crore, Level I- Rs 744 Crore and Level II- Rs 367 Crore].

Based on the advertisement inviting fresh proposals in the year 2011, the proposals received were 444 (Level 0-123, Level I- 223, Level II-98). Finally, the total number of proposals recommended by FIST Advisory Board for support were 118. (Level I- 109 and Level II- 09). The total budget recommended for support: Rs 128.62 Crores (Level I – Rs 93.63 Crores, Level II- Rs 32.69 Crores). In the year 2011, 78 new Departments and 40 Departments for repeat Support are identified. The figure below shows FISTAB recommended budget during 2000-2004 and 2005-2008.

FIST has enabled many departments to strengthen the teaching and research infrastructure by installing some of the state of the art facilities. Some of the major facilities installed in the department like High Resolution Transmission Electron Microscopy, 400 MHz NMR, 600 MHz NMR, Thermo-Mechanical Stimulator, Confocal Microscope, RT-PCR, Powder X-Ray Facility, Scanning Electron Microscopy, X-Ray Diffractometer with Temperature Variation Facility, Protein Sequencing Platform, Electron Probe Micro Analyzer, Vacuum Melting Furnace, Atomic Force Microscopy, Raman Spectroscopy, Thin Film Deposition systems such as Thermal Evaporation Setup, Electron Beam Evaporation, DC, RF and Magnetron Sputtering Systems, Chemical Vapour Deposition Systems, Nano-Imprint Lithography, Single Crystal X-Ray Facilities with CCD attachment, UTMs, High Resolution Mass Spectrometer, High Power Computational Facility. Apart for acquiring these facilities, the Departments supported under the program have also established a computer laboratory with FIST support. These facilities have been extensively being used by research scholars, students and faculty members in the department. The departments of small universities and colleges have also been benefited by acquiring Text Books for the Department Level Library.

Review and monitoring of the project is an important aspect of the Program. The progress achieved in the program is reviewed in one of the three categories such as i) Through Progress Report ii) Through Presentation by the Department and iii) Through On the spot visit of the Expert Committee to the department. The Review of the project are carried out at the Mid Term of the Project and one at the end of the project duration. The Mid-Term review rating is judged very critically while considering the second time support to a particular department. The projects are graded as Excellent, Very Good, Good and Satisfactory.

FIST support is based on Competitive grant model. However due to regional imbalances, region specific packages have been evolved. North-Eastern Region package (2008) and Jammu & Kashmir Package (2009) were initiated for augmentation of the teaching and research facilities at the S&T departments of the Colleges and Universities. A Special package for Bihar State has been initiated in the year 2011-12 and a monitoring committee has been constituted.

CONSOLIDATION OF UNIVERSITY RESEARCH FOR INNOVATION AND EXCELLENCE IN WOMEN UNIVERSITIES (CURIE)

During 11th Plan, Department has initiated a special programme "CURIE" (Consolidation of University Research for Innovation and Excellence in Women Universities) in 2009 to enhance R&D infrastructure in women universities. Since 2009, 6 Women Universities namely, i) Avinashilingam Women University, Coimbatore, ii) Banasthali University, Banasthali, iii) SNDT Women University, Mumbai, iv) Sri Padmavati Mahila Visvavidyalayam, Tirupati, v) Karnataka State Women's University, Bijapur , and vi) Mother Teresa Women's University, Kodaikanal have been supported for 3 years under CURIE programme. This new initiative is expected to make an impact on the quality of research output from these universities.

PROMOTION OF UNIVERSITY RESEARCH AND SCIENTIFIC EXCELLENCE (PURSE)

An incentive based program called "Promotion of University Research and Scientific Excellence" (PURSE) was formulated by the Department to boost the University Sector. 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 period 1996-2006 and 1998-2008, 44 performing universities whose h-index ranging from 56 to 26 have been considered for support ranging from Rs 30.0 Crores to Rs 6.0 Crores. The Universities are provided flexibilities with respect to expenditure types and selection of equipments etc. DST–PURSE intends to provide support to universities essentially for research man-power cost, augmentation of equipment and computational facilities, establishing research infrastructure, research consumables, travel, contingencies and maintenance of the facilities.

Some of the salient features of the program are as follows:

- The support provided to each university has been classified under '**Flexible**' and '**Fixed**' Components.
- The expenditure heads in '**Flexible Components (80-85%)'** are totally flexible among the expenditure heads like support for acquiring Equipment, Consumables, Infrastructure Facilities and Networking & Computational Facilities.

- The support areas in **'Fixed Components (20-15%)'** covers expenditure heads like Manpower Cost (10-15%), Contingences (1%), Travel (1%), Seminar/Workshop to organize or to attend abroad (1%) and Maintenance (2 %).

- No budgetary quotations for any equipment and other items are required for releasing grants by DST under this program. University will only inform DST about the equipment and other items as identified by them before acquiring and University would be responsible for all procurements.

- 'Manpower' to be engaged under this program should be for research and technical support and engaged on contractual basis and should not be equated with permanent faculty position.

- No support was made available for the building and civil construction related activities under PURSE initiative.

- Decision of Utilization of grants across different Departments of the Universities to be taken solely by the University.

- No Overhead amount is allowable under this Program.

DST has supported 14 Universities under this Program in 2009-10. Table 1 shows the Universities supported under PURSE program in 2009.

Table- 1: List of Universities supported under PURSE Program in 2009

S. N.	University	h-Index	Research Grant
1.	University of Delhi	56	Category A
2	University of Hyderabad	54	
3	University of Punjab	50	Rs.10.0 crore per year for 3 years
4	University of Pune	44	Category B
5	Jadavpur University	43	
6	Banaras Hindu University	42	Rs.5.0 crore per year for 3 years
7	University of Madras	37	Category C
8	University of Bombay	37	
9	Jawaharlal Nehru University	33	Rs.3.0 crore per year for 3 years
10	Anna University	31	
11	Karnataka university	30	
12	Aligarh University	30	
13	University of Rajasthan	27	Category D
14	Andhra University	26	Rs 2.0 crore per year for 3 years

A Programme Management Board (PMB) has been constituted to access the progress achieved in the projects in various universities. Review of PURSE Program in 14 Universities supported in year 2009 have been completed and second installment of funds have been released to many universities which were supported by DST under this program.

Table 2 shows the Thirty new Universities identified under the Program. The funds have been released to these new Universities identified under the PURSE Program and the Universities are in process to acquire the facilities.

Table 2 : **Identification of New Universities under PURSE Program during 2010-2011.**

S.No	*University*	*h-index(1998-2008)*	*Category*
1.	University of Calcutta, Kolkata	42	**Category B**
2.	Annamalai University, Annamalainagar	41	
3.	Bharathidasan University, Trichi	37	**Category C**
4.	Bharathiar University, Coimbatore	37	
5.	University of Burdwan, Burdwan	36	
6.	Guru Nanak Dev University, Amrisar	36	
7.	Sri Venkateswara University, Tirupati	35	
8.	Mahatma Gandhi University, Kottayam	35	
9.	University of Jammu, Jammu	34	
10.	Cochin University of Science & Technology, Cochin	34	
11.	M S University of Baroda, Vadodara	33	
12.	Shivaji University, Kolhapur	33	
13.	Utkal University, Bhubaneswar	33	
14.	Madurai Kamaraj University, Madurai	32	
15.	University of Kerala, Trivandrum	32	
16.	Osmania University, Hyderabad	32	
17.	Dr Harisingh Gour University, Sagar	32	
18.	Mangalore University, Mangalore	31	
19.	University of Kalyani, Kalyani	31	
20.	University of Mysore, Mysore	30	
21.	University of Lucknow, Lucknow	30	
22.	Pondicherry University, Pudducherry	30	
23.	CCS Haryana Agricultural University, Hisar	30	
24.	Bangalore University, Bangalore	30	
25.	Punjab Agricultural University, Ludhiana	29	**Category D**
26.	Tamil Nadu Agricultural University, Coimbatore	27	
27.	University of Agricultural Sciences, Bangalore.	28	
28.	Alagappa University, Karaikudi	27	
29.	Sardar Patel University, Anand	26	
30	North Eastern Hill University, Shillong	26	

Category A University @ Rs 10 Crores per University per year for 3 years.
Category B University @ Rs 5 crores per University per year for 3 years.
Category C University @ Rs 3 crores per University per year for 3 years
Category D University @ Rs 2 crores per University per year for 3 years

SOPHISTICATED ANALYTICAL INSTRUMENT FACILITIES (SAIF)

The Department of science & technology has set up sophisticated analytical instrument facilities (SAIFs) in different parts of the country to provide the facilities of sophisticated analytical instruments to the research workers in general and specially from the institutions which do not have such instruments through its Sophisticated Analytical Instrument Facilities (SAIF) programme to enable them to purse R&D activities requiring such facilities and keep pace with development taking place globally. At present the Sophisticated Analytical Instrument Facilities (SAIFs) are being supported by DST at IIT, Chennai; IIT, Mumbai; CDRI, Lucknow; Panjab University, Chandigarh; NEHU, Shillong; Nagpur University, Nagpur; IISc, Bangalore; AIIMS, New Delhi; Gauhati University, Guwahati; IIT, Roorkee; CVM, Vallabh Vidyanagar and Sophisticated Test & Instrumentation Centre (STIC), Kochi.

ANALYTICAL INSTRUMENT FACILITIES AVAILABLE AT THE SAIFs

The SAIFs are equipped with instruments such as Scanning Electron Microscopes, Transmission Electron Microscopes, Electron Probe Microanalyzer, Secondary Ion Mass Spectrometer, ICP, NMR, EPR Spectrometers, Mass Spectrometers, X-ray Diffractometers and Thermal Analysis Systems etc. to meet the needs of research workers in various areas of science & technology. Instrument facilities were strengthened during the year in the areas of Electron microscopy, X-ray Diffractometry, Thermal Analysis, Molecular characterization and Elemental analysis to meet the current and emerging needs of research community. Some of the major instrument facilities installed at the SAIFs during the year are 200 KeV Transmission Electron Microscope at the SAIF, New Delhi, Single Crystal X-ray Diffractometer at the SAIF, Guwahati, FT-Raman Spectrometer at the SAIF, Chennai and X-ray Fluorescent Spectrometer at the SAIF Chandigarh, The following instrument facilities are further being added to the existing SAIFs to strengthen them: 700 MHz FT-NMR Spectrometer and Elemental Analyser at the SAIF Lucknow, ESR Spectrometer at the SAIF, Mumbai, Wavelength Dispersive X-ray Fluorescent Spectrometer at the SICART, Vallabh Vidyanagar and Thermal Analysis System (TG/DTA) at the SAIF, Kochi. The SAIFs over the years have acquired the capabilities of repair and maintenance of instruments and a substantial number of the instruments with them are being maintained in-house.

ANALYSIS PROVIDED/OTHER ACTIVITIES UNDERTAKEN

Analysis Provided/Usage of the facilities

- A wide range of sophisticated analytical instrument facilities/techniques are being provided by the SAIFs to the research workers from all parts of the country. The instrument facilities at the SAIFs are meeting the analytical needs of scientists for materials characterization including qualitative/ quantitative elemental, molecular/compound analysis/characterization, structure determination, microstructure analysis and surface topographic studies etc., and enabling them to pursue research in various frontline areas of S&T.
- Services like solution to analytical problems including development of analytical methods for specific needs, sampling problems, spectrum analysis and interpretation of results etc. are also being offered by the SAIFs. Facilities and assistance for sample preparation are also being provided to the users.
- The facilities at the SAIFs facilitated research in various areas of Science & Technology. Some of these include synthesis of a variety of organic compounds, drug intermediates, extraction/study of natural products/screening for their biological activities, drugs & pharmaceutical research, research in

various areas of Chemical sciences, Study of biomolecules and their structure elucidation, Research in Condensed matter physics/material science, Nano-science & technology, studies related to crops/ seeds, insecticides, various diseases etc. About 1,000 research papers were published by the users of the SAIFs with the support from the facilities provided.

- About 15,500 research workers from all over the country utilized the facilities provided by the SAIFs during the year. These included research workers from almost all the universities in the country. About 86% of the users are from academic sector.
- About 1,25,000 samples were analyzed at the facilities during the year.

Workshops/Training programmes/Short term courses organised

Workshops/training programmes/short term courses were organized by the SAIFs on use and application of various instruments and analytical techniques to create awareness among the research community about them and on maintenance/repair/operation of the instruments for technicians. Some of the workshops/training programme/short term courses organized are as follows:

- A workshop on 'Scanning Electron Microscopy in Life Science Research' by SAIF, Shillong.
- A workshop on basic principles, preparatory methods and biological applications in Transmission Electron Microscopy by SAIF, Shillong.
- A training programme in Electron Microscopy for scientific investigators by SAIF, New Delhi.
- A training programme in Electron Micriscopy for technical personal/operators by SAIF, New Delhi
- A workshop on Electron Microscopy by SICART, Vallabh Vidyanagar.
- A workshop on 'Single Crystal X-ray Diffraction and Crystal Analysis' by SAIF, Kochi.
- A workshop on 'Procedures and Applications of XRD and XRF' by SAIF, Guwahati
- A workshop on 'Nuclear Magnetic Resonance Spectroscopy' by SAIF, Chennai.
- A workshop on NMR techniques by SAIF, Kochi.
- A workshop on Mass Spectrometry by SAIF, Lucknow.
- A workshop on Chromographic techniques by SICART, Vallabh Vidyanagar.

Apart from the above workshops/training programmes the SAIFs at Lucknow and New Delhi also organized short term training programme/summer training courses on various instruments/techniques for post-graduate and research students.

Analytical techniques developed/significant analysis done/research work facilitated.

Some of the analytical techniques developed/significant analysis done/research work facilitated by the SAIFs are as follows:

- In a research work done at the SAIF, Bangalore, the novel three components chiral derivatization protocols have been derived for ^{1}H and ^{19}F NMR spectroscopic discrimination of a series of chiral hydroxyl acids by their coordination and self-assembly with optically active á-methylbenzylamine

and 2-formylphenylboronic acid. These protocols have been demonstrated on enantiodiscrimination of chiral amines and hydroxyl acids.

- Worldwide constant efforts to enhance S/N in NMR spectroscopy are being pursued. In this direction Adiabatic Cross-Polarization has been implemented at the SAIF, Bangalore for liquid crystalline systems and as much as 90% enhancement in S/N has been observed. The technique has further been incorporated as a part of the pulse sequence for the 2D-Separated Local Field (SLF) Spectroscopy experiment and about 50% increase in S/N has been observed. Other schemes such as Ramp-CP in Proton Detected SLF experiments have been incorporated and significant enhancement in S/N has been observed.

- A new polarization pulse sequence DAPT developed at the SAIF, Bangalore has been applied to several novel systems. The pulse sequence has been used for polarization transfer between spin 1 and spin ½ nuclei such as deuterium and carbon. It has also been used for observing the so-called forbidden Overtone Transitions. The advantage of the DAPT sequence as a correlation tool and as a tool for measurement of dipolar coupling between these systems has also been demonstrated. The experiments lead to obtaining very useful information about the systems.

- In a research work facilitated by the SAIF, Chennai, two dimensional Rotational Overhauser Effect Spectroscopy (ROESY) was carried out to prove trapping of the clusters in the CD cavity.

- A study which revealed the possibility of producing highly polar Polyvinylidene Fluoride (PVDF) films in a facile manner avoiding the uniaxial stretching or clay addition methods was facilitated by SAIF, Mumbai.

- Development of a one-pot chemical process using BF3.Et2O for the synthesis of a new class of 1 (15f11) abeotaxanes from normal taxanes was facilitated by SAIF, Lucknow.

- In a study conducted at IIT Delhi, inhibition of Candida albicans growth by lemon grass oil (LGO) and Lemon grass oil vapour (LGO vapour) at 288 ìg/ml. and 32.7 ìg/ml concentration respectively was found. Assessment of cell damage by LGO and LGO vapour was facilitated by SAIF, New Delhi. The study suggests potential application of LGO vapour phase against infections caused by C. Albicans.

- In a research work done at H.S. Gour University, Sagar, on the basis of sustained release behavior and skin retention, it has been inferred that oleic acid vesicles can serve as a potential carrier for the topical localized delivery of bioactives. This work was facilitated by the SAIF, New Delhi.

- A study which indicated that Tc-HPâCD is a promising radiopharmaceutical and may serve as molecular nanoprobe for infection imaging was facilities by SAIF, New Delhi

During 11th Plan capabilities of the SAIFs for materials analysis were augmented. Facilities for surface analysis, high resolution ultrastructure analysis, high resolution mass spectrometry and elemental analysis at ppt level etc. were added to meet the emerging needs of the research community in areas including chemical, physical and life sciences and material science etc. Currently about 30% more research workers are fulfilling their analytical needs in a year through the SAIFs as compared to the last year of the 10th Plan. About 10,000 of the users of the SAIFs are from less endowed institutions which don't have the required facilities with them. 25% more samples are being analysed currently in a year as compared to the last year of the 10th Plan.

INTENSIFICATION OF RESEARCH IN HIGH PRIORITY AREAS (IRHPA)

IRHPA is a complementary programme to the SERC programme with activities consisting of setting up of units/ core groups around an eminent scientist and major National Research facilities to nucleate research activities in these areas. The scheme has contributed to augment general R&D capabilities at academic institutions and national laboratories in the areas of Palaeomagnetism, Low temperature and high magnetic field, Crystal Structure, Robotics, Laser Spectroscopy, Structural Biology, Surface Science & Technology, Computational Fluid Dynamics, Technical Acoustics, Geocentrifuge for Engineering applications etc.

One project has been sanctioned under Physical Sciences during this period. This project is to i) initiate and expand experimental activities in several growing areas in condensed matter physics, including semiconductor spintronics, nanoscale manganites, carbon nanotubes and graphene, quantum dots/wires, organic semiconductors etc. ii) Build adequate infrastructure for the supply of liquid nitrogen and liquid helium to enable uninterrupted low temperature experimental research activities, and future expansion of low-temperature research, iii) Develop an advanced cryogenic facility to meet to the rapidly increasing demands of cryogenic fluids, in particular, liquid helium for a wider research community.

During the last decade, use of advanced instruments for generating data in various branches of earth sciences has increased many folds. The advanced geochemical and isotope geology facilities are considered as basic requirements and available in many Universities in the developed and developing countries, including China. But in India, the facilities had not grown enough to accommodate the demand of the faculty and research scholars, as many had no access to such sophisticated facility and were forced to depend on laboratories abroad. This seriously hampered the quality of isotope research in the country and severely restricted training of young researchers in the field of isotope geology. To overcome the above, limitations and to meet the ever increasing requirements of the researchers of India, DST through the SERC focused on creation of the state-of-the art R&D infrastructure facilities for sustaining research in the a academic and research institutions spread over the country.

DST has been supporting state-of-the art R&D infrastructure facilities through IRHPA (Intensification of Research in High Priority Areas) programme. for strengthening infrastructure. In addition, major analytical facilities for carrying out earth science research were also created taking into consideration the research activities in and around the institutions, taking commitment form the institution to maintain the system and extend the facilities to the other institutions not only in their region but also from all parts of India.

The Earth Sciences Division of the DST has taken advantage of the above schemes and has liasoned with the leading earth scientists and encouraged them to evolve proposals for consideration under the IRHPA scheme. As a result, the following facilities have been created:

- Thermal Ionisation Mass Spectrometer (TIMS) - IIT Roorkee
- Thermal Ionisation Mass Spectrometer (TIMS) – Pondicherry Univ.
- Inductivity Coupled Plasma – Atomic Emission Spectrometer – ICP- AES at JNU, New Delhi.
- Stable Isotope Mass Spectrometer – IIT, Kharagpur
- Inductivity Coupled Plasma – Mass Spectrometer – NGRI Hyderabad – cost sharing basis CSIR & DST
- High Pressure Temperature Facility - National Centre of Experimental Mineralogy & Petrology, Univ. of Allahabad.

- Accelerated Mass Spectrometer – (Berillium 26 / C / A1) – Institute of Physics, Bhubaneshwar.
- Ar-Ar Geo-Thermochronology Laboratory- IIT Bombay.
- Laser Ablation Multi Collector –ICP MS at NGRI Hyderabad – cost sharing basis CSIR & DST
- Electron Probe Micro Analyser- IIT Kharagpur.
- Fission Track Dating Laboratory-Kurukshetra University, Kurukshetra.
- Geomagnetic Laboratory- Mizoram university, Aizwal.
- Stable Isotope Ratio Mass Spectrometer- PRL, Ahmedabad.
- Electron Probe Micro Analyser- IIT Bombay.

Fig-2.1: Electron Probe Micro Analyser lab at IIT Kharagpur

Fig-2.2: Ar-Ar Geo-Thermochronology Laboratory at IIT Bombay

In addition, major analytical facilities for carrying out earth science research were also created taking into consideration the research activities in and around the institution, commitment from the institution to maintain the system and extend the facilities to the other institutions not only in their region but also from all parts of India. Besides, the above mentioned facilities, the DST has also catered to needs of Earth Science community for analytical / major element chemical through its Regional Sophisticated Instrument Centres (RSIC) Programme.

The specific goals of each of these facilities was to provide geochemical/geochronological/ stable isotope/ experimental petrological data to other research programmes in respective areas on collaborative (or with minimum charge) basis and to undertake research programmes on certain challenging areas of Earth and Environmental sciences. A second aim of these research facilities was to generate trained manpower (e.g. PhD students), who will carry forward the knowledge gained. Most of these facilities have made excellent research contribution since their inception and researchers from universities have considerably benefited.

Large numbers of students have also been trained in these fields who have got exposures to the state of the art instrumentation otherwise confined to only few national laboratories and not always accessible by larger masses of university earth scientists or students. It has been a humble beginning although limited in a large country like India when more often than not a comparison is made with China.

There were few projects supported under the Intensification of Research in High Priority Area (IRHPA) programme of the Research & Development Scheme. While new proposals have been supported, the review of the proposals already on-going was also undertaken. The highlights of the progress of few proposals and the methodology adopted and the likely outcome of new proposal in the area of Engineering Sciences are given below:-

- **Design and development of an autonomous mini helicopter.**

  During the last year, the Project Coordinator Professor Venkatesan of IIT, Kanpur has successfully completed the tethered flying for the mini helicopter. The proposal aims to developing avionic package for autonomous flying ability of a mini helicopter along with its structural design. In the Project Advisory Team (PAT) meeting held recently on 23rd December, 2011 the progress made so far was presented to it. The work modules addressed in the proposal are broken in three broad areas namely Electronics, Mechanical and Control. The team has undertaken tasks of design, development and testing of several components of the helicopter in all the three areas like variety of sensors, remote communication, actuators, load measurement and test rigs, blade design, flight simulation etc. The research team has lifted the helicopter using tethers to a limited height for a limited time but is yet to test it without tethers. The progress was rated as "excellent" by the PAT and the coordinator has been advised to fly the helicopter in an open ground with the help of a flying hobbyist or an expert flier and make observations during this flight. This flying exercise be done along with packing the current ground electronics on board with support from vendors registered with National Aerospace Laboratories, Bangalore. The technical documentation of the work done so far is being done shortly.

- **National Programme for Micro Air Vehicle**

  The Department had enrolled itself in the National Programme on Micro Air Vehicle (NP-MICAV) along with Defence Research and Development Organization (DRDO) this year. The national mission has been evolved through interactions of Expert Committees set up by the Aeronautics Research &

Development Board (AR&DB). One of its main objectives is to develop MICAV technologies at sub-system as well as systemic level using the expertise that is available with the reputed institution of higher education in public & private sector, the industry as well as within the national labs of the Government. It would also have the other objective of capability development in the area. Some of the critical technology development areas that are going to be focussed upon in this National Mission include advance composite materials, miniature sensors and MEMS sensor technology, Ground station technology including real time imaging processes, on board information storage and processing, collaborative mission flights, Swarm control and inter-communication with other MICAVs or Ground Vehicles etc.

The NP-MICAV also addresses challenges in basic research that includes aerodynamic design for low Reynolds Number applications, power supply optimization, novel material design, multi-functional and morphing structures, collision avoidance etc. The whole programme has three levels of review, evaluation and monitoring Committees apart from independent experts. During this year 18 proposals have been approved and supported by DST in various academic institutions and 20 projects have been supported by DRDO in national labs, some in academic institutions with one in partnership with private industry. The first display of an autonomous MAV was made by the DRDO few months back.

- **National Facilities for Combustion Research with Research Centres at IIT, Madras and IISc, Bangalore**

The S&T Steering Committee for the 11th Five Year Plan had recommended that the Government takes up Combustion Research & Development as a priority item because of its direct relevance to the economic growth of the country. In addition the impact of Combustion R&D on the automotive and energy sector would offset the investments made in this topical area. The Department in a pro-active way engaged itself in identifying researchers in the area of combustion by setting up a Task Force. It was informed that the number of researchers in this area is limited to 50 out of which 38 researchers were located in the two institutions namely IIT-Madras, Chennai and IISc-Bangalore. The task force entrusted its members with responsibility of evolving 2 or 3 proposals. Two separate proposals were received from IIT-Madras, Chennai and IISc, Bangalore which were merged in a joint proposal so that the researchers at both the institutions work in a coordinated manner. This combined proposal was vetted and strongly recommended by the panel of industry experts drawn from automobile sector, power & energy sector and the propulsion sector.

The tangible deliverables of this centre of this facility would be to

1. Setting up of 10-12 important complex experimental test rigs of international standard
2. Development of 8-10 advanced laser spectroscopic diagnostic methods
3. Building of 10-12 prototypes & development of 10-15 novel processes
4. Solving of 3 key "grand challenges in combustion" for automotive, energy, and propulsion sector
5. Development of skilled manpower in combustion research: about 50 PhD, 100 MS/MSc, 200 MTech over 5 years, and training to additional 200 professionals from industry/ R&D/ academia through centres
6. Enhancing intellectual products (publications/patents) of researchers

The research areas that they would be focusing upon can be broadly classified under (i) Fuel; (ii) Combustion Basics iii) Flow and Transport Processes; (iv) Diagnostic and Modeling; (v) Technology Development and (vi) Safety.

In addition the Department has also initiated SERC schools in the area of Combustion Engineering details of which have been given under the PAC on Mechanical, Civil and Robotics and Manufacturing.

MEGA FACILITIES FOR BASIC RESEARCH

This programme was launched to create Mega Science facilities and launch Mega Science programmes in and out of the country to improve access to such state-of-the-art facilities for the Indian scientific community, especially from the academic sector.

Under this programme, several important developments took place during the year.

Regarding the Facility for Antiproton and Ion Research (FAIR) project, at Darmstadt in Germany, the construction phase of the project has begun. Three important FAIR bodies viz. FAIR Council, the In-kind Review Board (IKRB) and the Administrative & Finance Committee (AFC), with India as a Member, have been constituted. Technical meetings were held for identifying items suitable for in-kind contribution from India. And, the Seed Funding extended earlier for R&D and prototyping work for some components of the FAIR project continued during the year.

Assembling of beamline for macromolecular crystallography and high pressure physics at the Elettra Synchrotron Radiation Facility at Trieste, Italy continued during the year.

Support to CMS, ALICE and LHC Grid projects at the Large Hadron Collider at CERN, Geneva continued during the year. Excellent results were reported from the runs of the LHC during the year.

In CMS project, production of ten large area Resistive Plate Chambers for the end-cap region of CMS was done at BARC, Mumbai. Analysis with the complete 7 TeV dataset involving ã +Jets (inclusive) cross section measurements has been carried out. Also, Drell-Yan cross-section has been measured with CMS at LHC energy 7 TeV. Search for Zprime particle has been performed and mass limit has been set at 1TeV. Study of Underlying Event in proton-proton Collisions at LHC energy has been performed. Search for Higgs in associated production has been done. Indian groups shared detector related responsibilities as part of the CMS collaboration.

The utilization of ALICE is going on in full swing with the LHC running excellently both for proton-proton collisions at 7 TeV and lead ion collisions at 2.76 ATeV. All the detector systems are working; people are taking shifts at CERN as per the requirements laid down by the Collaboration and also taking part in the analysis of data and dissemination of results.

After obtaining the environment clearance for the India-based Neutrino Observatory (INO) project, the process of financial sanction for the project was initiated by DAE.

Sanction of the proposal by Indian physicists to collaborate in Neutrino Projects at Fermilab (USA) was under process.

Scientific deliberations on other important projects - participation in construction of the Thirty Metre Telescope (TMT) at Mauna Kea in Hawaii, the Square Kilometre Array (SKA) and one arm of the Laser Interferometer Gravitational Wave Observatory (LIGO) continued during the year.

CHAPTER 3

STRENGTHENING OF HUMAN CAPACITY IN RESEARCH

The Department of Science and Technology has initiated several initiatives to strengthen the human capacity in research. **"Innovation in Science Pursuit for Inspired Research (INSPIRE)"** is a pioneering & innovative programme developed and implemented by the department to attract, attach, retain and nourish talented youth for strengthening the R&D base. During 2011-12 more than 1.2 lakh INSPIRE Awards, 43,000 INSPIRE Internships, about 5,000 Scholarships for higher Education, 650 INSPIRE Fellowships and 48 INSPIRE Faculty Awards have been awarded .

During the year, schemes like International Olympiads FAST TRACK SCHEME FOR YOUNG SCIENTISTS,. THE JC BOSE NATIONAL FELLOWSHIPS, THE, RAMANUJAN FELLOWSHIPS, SWARNA JAYANTI FELLOWSHIP SCHEME, UTILIZATION OF SCIENTIFIC EXPERTISE OF RETIRED SCIENTISTS (USERS) and BOYSCAST continued to support outstanding scientists in their pursuits total of 207 scientists received the JC Bose Fellowship, 155 received the Ramanujan fellowship, and 45 the Swarnajayanthi fellowship. Fellowship support was also provided to 1500 young scientists, and about 2500 project grantees.

INNOVATION IN SCIENCE PURSUIT FOR INSPIRED RESEARCH

"Innovation in Science Pursuit for Inspired Research (INSPIRE)" is an innovative program developed and implemented nationally by the Department of Science & Technology to attract, attach, retain and nourish talented youth for strengthening the R&D base. INSPIRE has three components namely **a) Scheme for Early Attraction of Talents for Science (SEATS), b) Scholarship For Higher Education (SHE) and c) Assured Opportunity for Research Careers (AORC)** with five sub-schemes**.** It was approved by the Government of India in November 2008 at a total cost of Rs.1979.25 crores for the 11th Plan Period and launched by the Hon'ble Prime Minister on 13th December 2008.

Schemes for Early Attraction of Talent for Science (SEATS) has two sub-schemes namely **INSPIRE Award and INSPIRE Internship.** While the first sub-scheme envisages providing once in a lifetime award of Rs.5000/- per student to one million students in the age group of 10 to 15 years, the second sub-scheme provides opportunities for interactions with leading national and international academicians and scientists to more than 50,000 top one per cent meritorious students pursuing science at class XI standard.

During the 11th Plan period, under **INSPIRE Internship more than 380 Science Camps** including three VIJYOSHI events at Delhi/Bangalore, Asian Science Camp at Mumbai and Four Science Conclave events at Allahabad have been organized across the country and **more than 90,000 students** got the

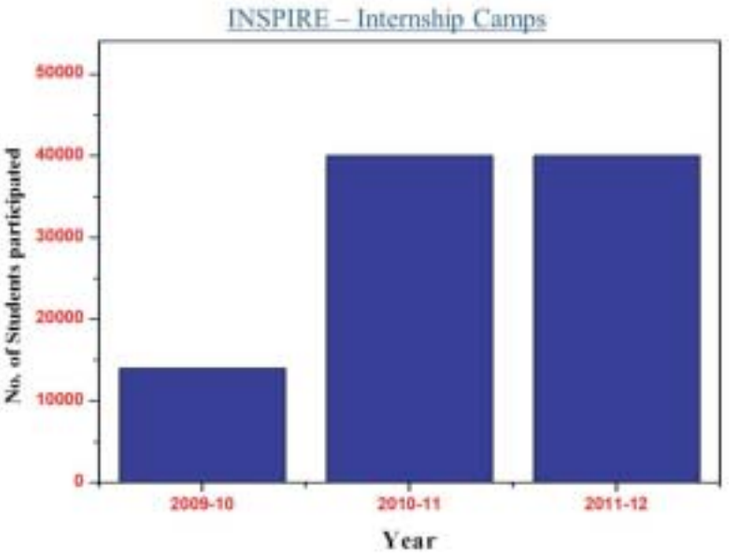


Fig-3.1

opportunity to participate in these Camps. However in the current year more than 160 Science Camps have been sanctioned so far to cover 40,000 students. Many such Science Camps are also in the pipeline in next 3 months i.e. till March 2012. In these INSPIRE Internship Camps students were given an opportunity for 5 days to interact with large number of global/ national science leaders from India and abroad including 23 Nobel Laureates/ Field Medalist.

Fig-3.2

Scholarship for Higher Education (SHE) aims to enhance rates of attachment of talented youth to undertake higher education in science intensive program by providing scholarships and mentoring through summer attachment to performing researchers. The scheme would offer 10,000 Scholarship every year @Rs 0.80 lakh per year for undertaking Bachelor and Masters level education in natural sciences for the talented youth in the age group 17-22 years. The main feature of the scheme is in mentorship support being planned for every scholar through **INSPIRE Scholarship.** Currently **3610 INSPIRE Scholars** selected through competitive examination route and **5507 INSPIRE Scholars** selected through State/Central Boards examination are receiving scholarship for pursing their 5 years Integrated MS or M.Sc. degree or three year B. Sc. Degree in basic & natural science courses at the national institutes like IISERs, IITs, Universities and colleges in the country. With the proactive measures i.e. by taking both State and Central Boards into this scheme, the enrollment of student in the 2011 has improved significantly and it is expected that more than 6000 students will be offered this scholarship to the students who passed +2 in the year 2011. There is considerable enrollment of girl students in this scheme.

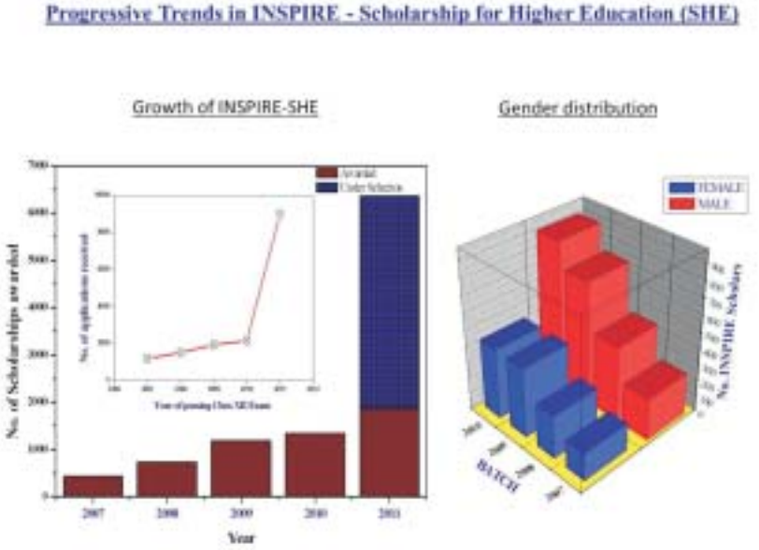


Fig-3.3

Assured Opportunity for Research Careers (AORC) scheme has two sub-schemes namely **INSPIRE Fellowship** and **INSPIRE Faculty Award.** The first sub-scheme envisages opportunities to the first Rank holder in their university level post-graduate programs in both basic and applied sciences including engineering, agriculture, veterinary and medicine for pursuing doctoral degree at any recognized University and any other academic Institutions in the country. The second sub-scheme is for offering a contractual and tenure track positions for 5 years in both basic and applied sciences including engineering, agriculture, veterinary and medicine for pursuing post-doctoral research at any recognized University/ Academic Institutions/ Laboratories in the country.

During the 11th Plan period, 640 in the year 2010-11 and 655 in the year 2011-12 **INSPIRE Fellowships** have already been offered to the students for pursuing their doctoral program at different Universities, Laboratories and academic Institutions across the country. Another about 600 students have provisionally been selected and are waiting for their enrollment into doctoral program to avail the INSPIRE fellowship. **INSPIRE Faculty Scheme** initiated in the year 2011-12 has selected now 48 candidates for

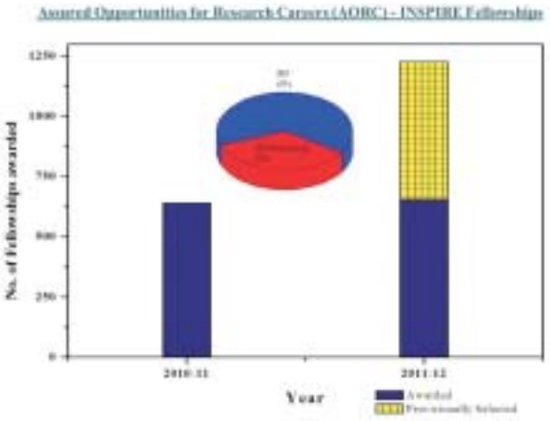


Fig-3.4

offering **INSPIRE Faculty Award**, out the total applications of 463 received in the 1st announcement.

OPPORTUNITIES FOR YOUNG SCIENTISTS

Realizing the importance of development of Scientific Manpower for taking up research in challenging areas of S&T, the Department in its 11th Plan has decided to focus upon the schemes that are facilitate encouraging, supporting and nurturing Science students and Young Scientists in a coordinated manner.

FAST TRACK YOUNG SCIENTISTS SCHEME:

FAST track scheme for Young Scientists has evolved as one of the prestigious and popular programmes at the national level. The scheme encourages Young Scientists to take up R&D in innovative and challenging areas that they might have identified during the course of their research work. This has resulted in training of scientific manpower required to meet the challenges in the future. Screening and monitoring mechanism was strengthened further for getting "quality" output from these scientists, thus making them candidates for receiving prestigious awards in national and international forums. Special efforts were made to identify and encourage active young scientists working in institutions in remote areas.

Several projects in frontier areas were supported. This support has helped young researchers to undertake independent research. The budget limit for a project was increased to Rs. 23 lakh while the individual fellowship amount has been increased to Rs. 35,000/ pm.

The following are some of the interesting results obtained :

- A biomimetic system having two zinc ions as a functional mimic of the metalloenzyme has been developed. This study sheds new light on the possible role of two metal ions at the active site of metallo- â -lactamases and is expected to help in designing novel irreversible inhibitors for the binuclear zinc enzyme. The effect of antibiotic resistance on thyroid hormone synthesis have also been investigated, and it has been shown that the heterocyclic thiol side chains present in some of the commonly used cephalosporin-based antibiotics possess strong antithyroid activity. The enzymatic hydrolysis of the â-lactam ring in such antibiotics leads to the formation of thiols, which undergo tautomerism to produce the corresponding thiones. The efficient and irreversible inhibition of peroxidasecatalyzed iodination by the thiones suggests that the production of â -lactamases and subsequent hydrolysis of antibiotics would adversely affect the thyroid activity by inducing hypothyrodism. These studies indicate that the antithyroid activity of heterocyclic side chains must be taken into account in the design of new antibiotics based on cephalosporins.
- A new method for generation of sulfonyl nitrene from NN-dibromo p-toluentsulfonamide without a catalyst has been reported for the first time and this method has been demonstrated by utilizing it for aziridine synthesis. A new CoFe2O4-Cr2O3-SiO2 nanocomposite having photoluminescence property has also been prepared and this nanocomposite exhibit photoluminescence property without the addition of an external marker. The prepared nanocomposite was used for staining the cultured Hela-cells for the fluorescence imaging detection of the cells.

➢ A novel method for the synthesis of versatile and efficient gelators for solvents of extreme polarities has been developed. Interestingly, these hydrogelating amphiphiles are intrinsically antimicrobial. In situ synthesis of Ag nanoparticle within these hydrogels improves its antimicrobial activity against both gram-positive, gram-negative bacteria and fungi. At the same time hydrogelators showed substantial biocompatibility to mammalian cells (Figure 31). This hydrogelating matrix additionally having pH-responsiveness will have significant applications in biomedicine.

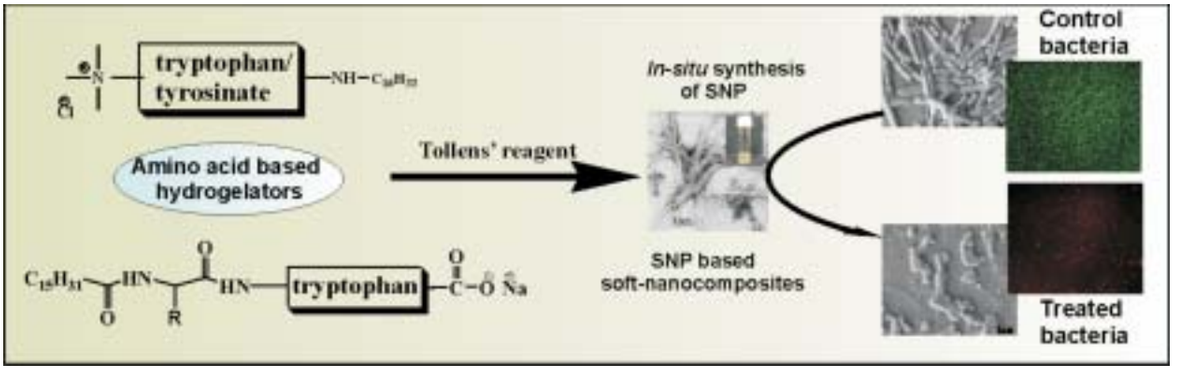


Fig. 3.5 : Hydrogelators showing biocompatibility

A novel and generalized supramolecular strategy has been established to achieve self-sorted assembly of donor and acceptor chromophores. Molecular design has been demonstrated to gain control over mode of co-assembly of these chromophore mixtures both in molecular and macroscopic level. These findings appear to be highly relevant in organic photovoltaic applications.

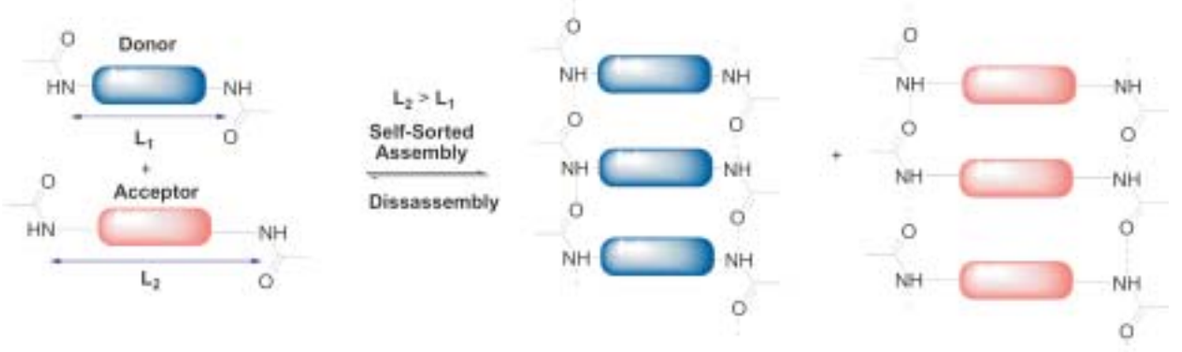


Fig. : 3.6 Schematic presentation of newly established supramolecular design for self-sorted assembly of donor and acceptor chromophores

BETTER OPPORTUNITIES FOR YOUNG SCIENTISTS IN CHOSEN AREAS OF SCIENCE AND TECHNOLOGY (BOYSCAST)

The BOYSCAST programme of DST provides opportunities to the young Indian scientists/ technologists below the age of 35 years, who hold regular positions in recognized S&T institutes in India, to visit reputed institutions abroad, interact with scientists there, get exposure to latest research techniques and conduct R&D in frontline areas of Science & Technology. Under the BOYSCAST programme, fellowships of three to twelve months duration are provided every year to the selected young Indian scientists for conducting research/undergoing specialized training in reputed overseas research laboratories/

institutes. During the year, fellowships were awarded to 76 young scientists in the areas including Surface engineering, Advanced/novel materials, Nano-science & technology, Electronic materials and processing, Nonlinear optics and optical materials, Microfabrication/Micromachining, Signal processing technologies, Biomedical engineering, Quantum computing, Machine intelligence, Earthquake engineering, Synthetic methodologies, Organometallic chemistry, Supramolecular chemistry, Biophysical chemistry and structural biology, Molecular electronic structure and dynamics, Photochemistry, Ecological engineering, Molecular biology of biotic/abiotic stresses in plants, Plant microbe interaction, Crop biotechnology, Transgenic plants and animals, Genetic engineering, Reproduction technology, Stem cell research, Molecular epidemiology, Industrial microbiology, Modelling for new drug development, Drug delivery system, Evolution and dynamics of Indian Lithosphere, Seismology, Paleoclimatology and Paleoenvironment, Regional and global climate studies and prediction, Algebra, Wavelet analysis etc. The fellows have joined the host institutes abroad. It is envisaged that the expertise gained by the young scientists/technologists during the fellowship period will lead to initiation/strengthening of the national programmes in these areas as well as further generation and spread of expertise at the national institutes.

During the 11th Plan period, 323 fellowships were awarded as compared to 221 fellowships awarded during the 10th plan period. On an average, a BOYSCAST fellow has been able to publish one research paper during his stint abroad.

THE JC BOSE NATIONAL FELLOWSHIPS

Department instituted JC Bose fellowship, to recognize active scientists and engineers for their outstanding performance and contributions. Fellowship is scientist–specific and very selective, open to Indian Nationals residing in India. The fellowship is granted for a period of five years. The value of the fellowship is Rs. 25,000 per month in addition to the Fellow's regular income. In addition, it carries a research grant of Rs. 10.00 lakh per annum. 206 JC Bose fellows are supported till date in various science streams. The JC Bose fellows have average published 6.5 papers per year per fellow in journals of impact factor of 3.6, and has produced average of one PhD per year per JC Bose fellow.

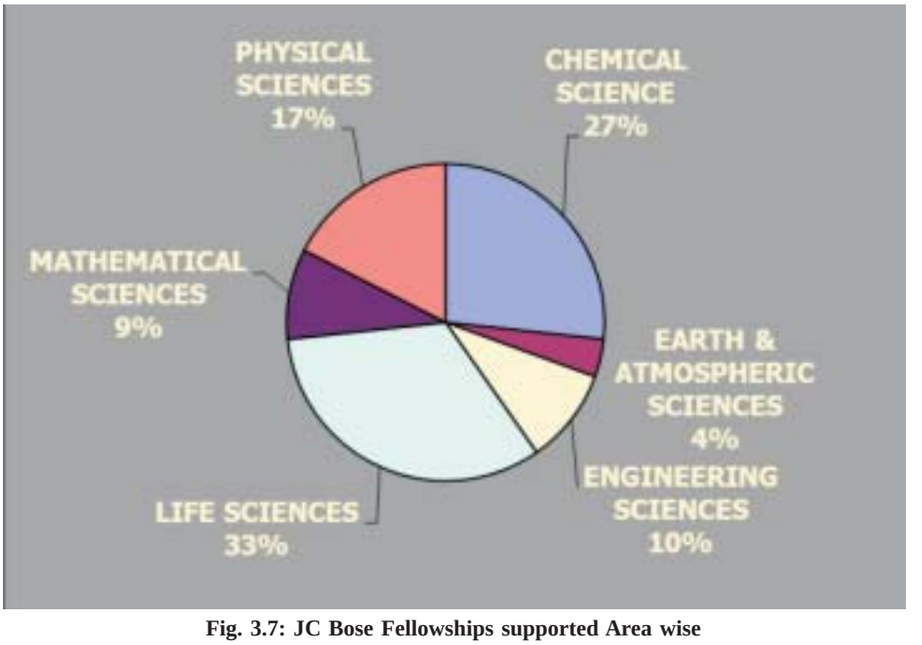


Fig. 3.7: JC Bose Fellowships supported Area wise

THE RAMANUJAN FELLOWSHIPS

The department instituted Ramanujan Fellowships for brilliant scientists and engineers from all over the world to take up scientific research positions in India. It is especially directed at those scientists who want to return to India from abroad. The Ramanujan Fellows can work in any of the scientific institutions and universities in the country and they are eligible for receiving regular research grants through the extramural funding schemes of various S&T agencies of the Government of India. This fellowship is open to scientists and engineers below the age of 60 years. The duration of Ramanujan Fellowship is five years. The value of the fellowship is Rs.75,000 per month. Each Fellow, in addition, receives a research grant of Rs. 5.00 lakh per annum. About 155 Ramanujan fellowship are offered till date in different areas.

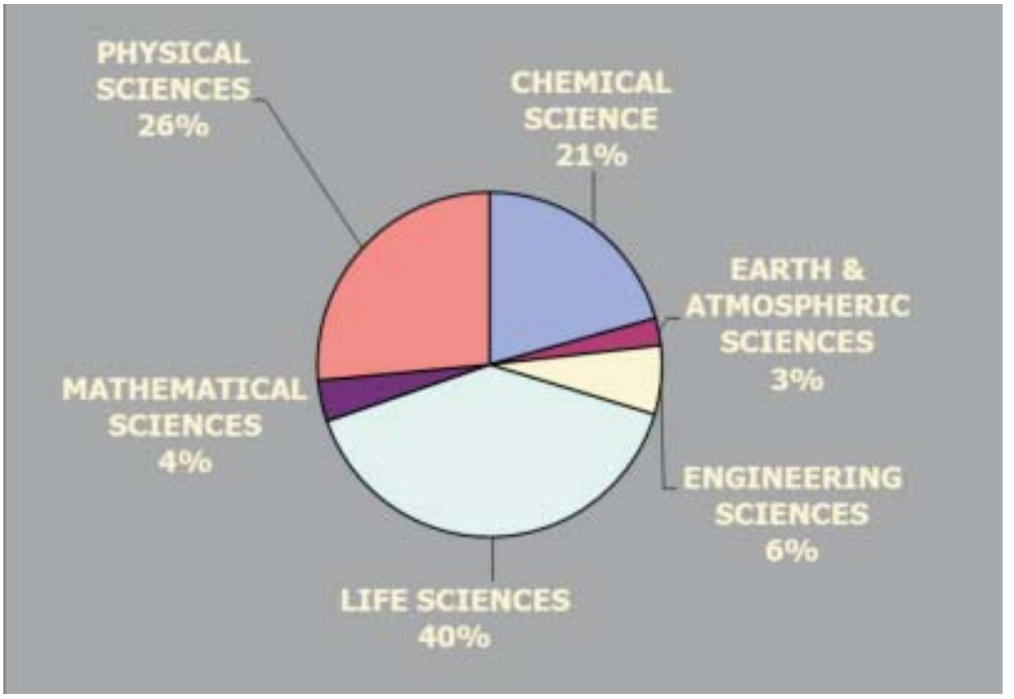


Fig. 3.8: Ramanujan Fellows supported area wise across the country

SWARNAJAYANTI FELLOWSHIP SCHEME

The scheme was launched by the Government in 1997-98 to commemorate the 50th year if India's independence. Under the scheme fellowship is provided to few outstanding young scientists upto the age of 40 years as recognition for the research work done by them in Science & Engineering. The Department has awarded 90 such fellowship since 1997-98 and many of the fellows that were selected were subsequently selected as Bhatnagar Fellow or were selected as INSA or Academic Fellows.

During the year the scrutiny of the 232 applications covering all areas was undertaken with rigour by the Subject Area Expert Committees. The presentations of the projects of the shortlisted candidates were securitized by these Committees. Finally 15 candidates were shortlisted for the National Core Committee.

The National Core Committee has selected the following 6 candidates for the SwarnaJayanti Award this year that has been approved by the Empowered Committee of Secretaries.

Swarna Jayanti Fellowship Awards – Year 2011

Sl. No.	PI Name	Discipline
1.	Dr Narayan Pradhan, IACS, Kolkata	Chemical Sciences
2.	Dr Binod Srinivasan, IIT, Kanpur	Earth & Atmospheric
3.	Dr Mahesh S Tirumkudulu, IIT, Mumbai	Engineering Sciences
4.	Dr Jayandharan Rao, CMC, Vellore	Life Sciences
5.	Dr Amalendu Krishna, TIFR, Mumbai	Mathematical Sciences
6.	Dr Bedangadas Mohanty, VECC, Kolkata	Physical Sciences

The Department will be undertaking an exercise during 2012 to quantify and assess the output of the Young Scientists supported under the Scheme and also organize a workshop for them to interact with other Young Scientists and research students.

ASSISTANCE FOR PARTICIPATION IN INTERNATTIONAL CONFERENCE

The objective of the scheme is to provide travel assistance to the Indian Scientists working in educational/ academic institutions and National R&D laboratories enabling them to participate in the International Conferences/Workshops etc. This provides an opportunity to the Indian scientists to interact with their foreign counterparts which enable them to present their findings and results at an International level for a better peer reviewing.

SEMINAR/SYMPOSIA AND ASSISTANCE TO PROFESSIONAL BODIES

The scheme for seminar/symposia and assistance to professional bodies aims to promote active involvement of Professional S&T Bodies and Science Academies for National Development; encourage and support Professional S&T Bodies and Science Academies for promoting interaction amongst themselves, fermentation of new ideas for societal development and extend financial, logistic and administrative support to scientific groups and scientific institutions/universities in the country for organising scientific events.

UTILIZATION OF SCIENTIFIC EXPERTISE OF RETIRED SCIENTISTS (USERS)

The Department during the seventh five-year plan introduced the scheme Utilisation of the Scientific Expertise of Retired Scientists (USERS). The main objective of the scheme is to utilise expertise and potential of large number of eminent scientists in the country who remain active and deeply motivated to participate in S&T development activities even after their retirement. The scheme has continued to play a significant role in involving a large number of retired scientists in S&T developmental activities. During the period there is revision of upper age to 70 years and Honorarium payable is enhanced to Rs.20,000/- per month of superannuated Investigators/Scientists/ Technocrats. The main activity under the programme is preparation of books/monographs/state-of-the-art reports. 20 projects were sanctioned during this financial year to superannuated scientists.

Some of the major publications are : High Energy Materials- Propellants, Explosives and Pyrotechnics; Cercosporoid Fungi of India; Elements of Nuclear Theory; Thermal Imaging Technology: Design and Applications; Medical Veterinary and Public Health Important Mites and Ticks: A Handbook; Sacred Forests: Their Ecology and Diversity; Mycotoxins Problem and its Management; Nuclear Reactions; Exotic Nuclear Excitations; Swift Heavy Ions for Materials Engineering and Nanosturcturing; Zoological Survey of India; Applied Mineralogy; Crop Physiology; Problems and Solutions in Optics and Photonics; Heat and Mass Transfer; Microbial Biotechnology for Sustainable Agriculture, Horticulture and Forestry; An Introduction to Seed Pathology; Iron Ore Deposits and Banded Iron Formations of India.

CHAPTER 4

TECHNOLOGY DEVELOPMENT

They being implemented by the Department of Science and Technology aim at several and diverse objectives. Therefore, several sub-schemes have therefore been designed to serve differing objectives. The **Drugs and Pharmaceuticals Research Programme (DPRP)** was initiated by DST in 1994-95 for promoting Industry-Institutional collaboration in drug and pharmaceuticals sector. This programme aims at enhancing capabilities of institutions and the Indian Drugs & Pharmaceuticals Industry towards development of New Drugs in all systems of medicine. The **Instrumentation Development Programme (IDP)** provides an integrated and cohesive approach for supporting R&D Programmes for indigenous development of affordable instrumentation in the country. The mandate of the **Technology Development and Demonstration (TDD)** is to provide financial assistance to the industrial concerns and other agencies attempting development and commercial application of indigenous technology or adapting imported technology for wider domestic application. TDD embarked upon new approaches during the year 2011-12. Convergent solutions to energy problems of rural India have been accorded high priority. The objective of the **Water Technology Initiative**, initiated in August 2007 is to promote R&D activities aimed at providing safe drinking water at affordable cost and in adequate quantity using appropriate Science and Technology interventions evolved through indigenous efforts. Under **Winning Augmentation and Renovation (WAR)** for water, convergent solutions for 17 different types of water challenges in 12 clusters have been supported during 2011-12. More than 60 technology demonstrations have been supported in different locations in the country. **Solar Energy Research Initiative (SERI)** is aimed at improving efficiency of devices, systems and sub-systems, to promote innovative R&D based demonstration projects for 24x7 off grid power supply. DST's initiative on Solar Energy is positioned upstream with thrust on enabling knowledge based R&D activities for entire gamut of solar technologies including balance of systems. During the 11th Plan, DST has already embarked on a solar energy initiative aimed at achieving practical solar energy devices and systems that are scalable. Under **Cognitive Science Research Initiative**, Department has provided provides support for basic science, infrastructure development and human resource development. The **Technology Systems Development (TSD)** programme supports activities aimed at developing and integrating technologies to evolve technology systems both in the advanced/emerging areas and in traditional sectors/areas.

DRUGS AND PHARMACEUTICALS RESEARCH PROGRAMME

The Drugs and Pharmaceuticals Research Programme (DPRP) was initiated by DST in 1994-95 for promoting Industry-Institutional collaboration in drug and pharmaceuticals sector. This programme aims at enhancing capabilities of institutions and the Indian Drugs & Pharmaceuticals Industry towards development of New Drugs in all systems of medicine. The specific objectives of this scheme are:

- To synergise the strengths of publicly funded R&D institutions and Indian Pharmaceutical Industry in developing drugs in areas of national relevance.
- To create an enabling infrastructure, mechanisms and linkages to facilitate new drug development.
- To stimulate skill development of human resources in R&D for drugs and pharmaceuticals.

Achievements of XI Five Year Plan

Extensive efforts for funding projects resulted in providing grant-in-aid to 39 projects (23 public private partnership collaborative projects, 14 projects for creation of national facilities and 2 grants-in-aid projects to industry for neglected diseases besides that 30 loan projects to pharma R&D industries.

The PPP projects were implemented for development of drugs for diseases such as leprosy, Malaria, Tuberculosis, Japanese Encephilitis, Syphillis, Leishmaniasis, Filariasis, HIV/AIDS, Tetanus, Measles, Drug resistant enteric fever, Hepatitis B, Skin disorders like Leucoderma and psoriasis, Gastrointestinal disorders like Diarrhoea and Cholera besides infections leading to Trypansomiasis and Ascariasis. Diabetes, Hypertension, Cardiovascular disorders, Dengue besides addressing neurological diseases like dementia and Parkinsons Disease. Joint research proposals are also supported for the drug development involving the Ayurvedic, Unani and Siddha systems of medicine for the scientific validation of at least five formulations of the Indian System of Medicine (ISM) including Veterinary medicines, National Facilities in selected areas related to Drug development.

During this period 14 national facilities were created in different national labs, public funded educational institution/universities on Bio-safety level-4, standardization and quality control on medicinal plants, cGMP pilot plant for extraction, formulation and packaging of traditional herbal medicinal formulation, clinical research facility for stem cell, nano-microparticle based biomaterials advanced drug delivery systems, upgradation of clinical trial infrastructure of Unani System, drug targets through functional cell dynamics, herbo-metallic preparations, bio-equivalence, Rasayana products, clinical facility with GLP & GCP standards for ISM etc.

During this period 30 loan projects were funded to Indian Pharma industry for development of drugs such as inhibitors of Undecaprenyl pyrophosphate Synthase, process for co-enzyme Q10 from solanesol, inhibitor for Chronic Obstructive Pulmonary Disease, vaccine for Pancreatic Cancer, drug delivery system for treatment of Osteoporosis, manufacture of immunodiagnostic kits for rabies, Synthetic Ribozyme - an

Anti-cancer agents, research facility for large animals (beagle dogs), ayurvedic formulation for allergic diseases, H-1 receptor agonist for allergic disorders, drug for treatment of controlled hypertension and end organ damage, treat acute kidney injury, etc.

Also two grants-in-aid projects funded for conducting clinical trials in neglected diseases such as Malaria and Kala Azar.

The following products have been commercialized – **Alquit** (A herbal product for the control of animal ecto-parasites) by M/s Natural Remedies Pvt. Ltd., Bangalore; **Bonista** (Parathyroid Hormone as injectable for Ostepoprosis) by M/s Virchow Biotech Pvt. Ltd., Hyderabad; **Receptol** (A colostrums based protein for the management of HIV/AIDS) by M/s Biomix Networks Ltd., Mumbai; **Rhoclone** (Anti-Rho-D immunoglobulin Injection (Monoclonal) 300 mcg developed for hemolytic disease of the new born) by M/s Bharat Serums & Vaccines Ltd., Mumbai

9 New molecules are under different stages of trials. The 3 new molecules under Phase-I trials are RBx 7644 (Anti-biotic by Ranbaxy, Gurgaon), LL-4858 (Anti-tubercular by Lupin Ltd., Pune), CT1 (Anti-hyperglycemic agent by CDRI, Lucknow), TRC-4186 (Diabetes and aging related Vascular complications by M/s Torrent Pharmaceuticals Ltd. 3 new molecules under the Phase-II clinical trial are RBx 11160 (Anti-malarial by Ranbaxy, Gurgaon), DRF-7295 (Anti-Cancer by Dabur Research Foundation), Mw+ Chemotherapy (Cancer by Cadila Pharmaceuticals Ltd.). Similarly, one new molecules permitted for Phase-III Clinical Trial are 80/574 (Hypolipidemic Agent by CDRI, Lucknow).

So far 22 product patents and 13 process patents have been obtained the programme has also enabled the training of young scholars in handling sophisticated instruments.

Projects supported and achievements during 2011-12

Collaborative Project

- Development of diagnostic kit for detection of Mycobacterium tuberculosis complex & Mycobacterial species among Jawaharlal Nehru University, New Delhi / Lal Path Labs Ltd.

Loan Projects

- Design and synthesis of novel curcumin analogues and metabolites for the enhancement of bio-availability and for anti-cancer application at M/s Sami Labs Limited, Bangalore
- Process up-scaling, pre-clinical & clinical evaluation of PBL 2270: A novel Oxazolidinone for the treatment of Gram Positive Resistant pathogents at M/s Panacea Biotec Ltd., New Delhi
- Clot Specific Streptokinase (SMRX11), A Novel Thrombolytic for the Treatment of Cardiovascular Disease - Preclinical toxicological and pharmacological studies in cynomolgus monkey at M/s Symmetrix Biotech Pvt. Ltd., Chandigarh
- Development of Anti-inflammatory and burn wound healing formulations from traditional leads at M/s Parker Robinson Pvt. Ltd., Kolkata
- Lead optimization and IND enabling tox, safety pharmacology studies of a novel 5-HT4 Ligand for the treatment of cognitive disorders at M/s Suven Life Sciences Ltd., Hyderabad

National facilities

A National Facility project on Therapeutic and Prophylactic intervention strategies against Human and Animal Biosafety Level 3 (BSL3) Pathogens endemic to India at Indian Institute of Science (IISc) Bangalore is ongoing since 1.4.2006. Major equipments have been procured and installed. The BSL 3 facility has suffered long delays in its completion and validation. The facility is being validated by an independent third party of international repute. The process of validation involves repeated testing and alteration of every aspect of the facility which is time consuming since there does not exist within India even a single independently validated BSL3 facility. The facility would be owned, maintained and run by IISc Bangalore after completion of the project duration.

Fig. 4.1: Close up View of PLC-Controlled Autoclave at BSL-3, IISc, Bangalore

Fig. 4.2: TB Animal Experimentation Lab at BSL-3, IISc, Bangalore

The 'Clinical Trials Registry-India (CTRI)' an online platform for the registration of Clinical Trials was launched on 20th July, 2007 at the National Institute of Medical Statistics (ICMR), New Delhi on a National Facility project under DPRP. It aims to collect information on all prospective Clinical Trials to be undertaken in India and make this information available to the public. An upgraded version of the CTRI software application developed by NIC is functioning. While the CTRI is meant preliminary for trials conducted in India, the CTRI also undertakes registration of trials conducted in other countries in the region not having a registry of their own. DCGI has made trial registration in the CTRI mandatory for all those to seek approval from DCGI with effect from 15.6.2009. Status of CTRI as on March 2011 is given below:

Status of CTRI	**March 2011**
Number of Hits	>2,20,000
Number of Registered Users	3408
Number of Trials Received	3114
Number of Trials Registered	2314
Number of Prospective Trials	877
Number of Ongoing Trials	1068
Number of Completed Trials	363
Number of Trials under review/waiting approvals	134
Number of Trials sent back for Modifications	666

The facility on Neurotoxicity Research at University of Madras, Chennai has been established and equipped for identification of Neurotoxicity and Development of Drugs which are neurosafe and neuroprotective. Neurotoxicity is commonly defined as any permanent or reversible adverse effect on the structure or function of the central and / or peripheral nervous system by a biological, chemical or physical agent. Work is progressing to develop biomarkers in neurotoxicology. Standard Operating Procedures (SOP's) have been developed for all major equipments with reference to (i) analytical procedures (ii) functional changes (iii) biochemical changes (iv) assessment of oxidative stress (v) molecular changes (vi) creation of database.

National Facility for the development of Herbometallic preparation of Ayurveda, Siddha and Unani is ongoing at SASTRA University since April, 2009. Under this project, organoleptic, macroscopic and microscopic parameters of *Tamarindus indica* Linn, which were not prescribed in the Ayurvedic Pharmacopoeia have been established for the first time.

A National Facility for Drug Discovery through New Chemical Entities and Instrumentation support to small manufacturing pharma enterprises is being established at Saurashtra University, Rajkot with contribution from DST, Gujarat Government and Saurashtra University. The new building is being constructed to house all sophisticated instruments purchased under the project from DST funds. The building of national facility is being constructed with donation of Dr. Dipchand Gardi and would be known as Dr. Dipchand Gardi Drug Research Centre. During the project duration, more than 1000 new chemical entities were synthesized and characterized. Further they were screened for various biological activities like anti cancer, anti inflammatory, anti tubercular and MDR revertors and anti HIV. 4 lead molecules were

discovered with other Indian and foreign collaborators. One 2007 Indian patent has been filed. The project has so far resulted in 12 publications.

A National R&D facility for Rasayana products in Indian Systems of Medicine is ongoing at Foundation for Revitalization of Local Health Traditions is ongoing since April 2010. Major equipments have been procured on the project. The project has resulted in one research publication.

A Transmission Electron Microscope and Ultramicrotome facility for toxicity screening of nanoparticles used for drug delivery and to elucidate its mechanism of action has been set up at National Institute of Pharmaceutical Education & Research (NIPER) Mohali.

Fig. 4.3: TRANSMISSION ELECTRON MICROSCOPE at NIPER, MOHALI

Interaction Meets, conferences & Workshops

Grants have also been sanctioned for organizing several interaction meets between Academia and Industries involved in R&D and products development in Natural Products and Modern System of medicine. These are as follows:

- Financial support for organizing an international event entitled "Life Science Conclave 201" - Enabling Growth through collaborative R&D and Technology Transfer to be held during 29th and 30th August, 2011 at hotel Lalit in New Delhi at CII, New Delhi
- Financial assistance to the event entitled "3rd Herbal International Exhibition-cum-Summit ONM Medicinal, Aromatic Products and Spices" (Hi-Maps) during 15-16th January, 2011 at NSIC Exhibition Complex, New Delhi.
- Financial assistance to the conference organized by the Associated Chambers Commerce and Industry of India (ASSOCHAM) entitled "Impact of Intellectual Property Regime in Pharma, Post 2005" to be held on 11th October, 2011 at Hotel The Royal Plaza, New Delhi at ASSOCHAM, New Delhi.
- Financial support for organizing 1st Biennial National Conference of India Academy of Science & Nature (IASN) in association with the Department of Life Sciences, Agra College, Agra and National

JALMA Institute for Leprosy and Other Mycobacterial Diseases (ICMR), Agra during 30th November and 1st December, 2012 at JALMA Institute for Leprosyand other Mycobacterial Disease, Agra

Vision of Drugs and Pharmaceutical Research Progaramme for 12th Five Year Plan

- New initiatives for transfer of technology on translational path
- Animal health related projects need to be enlarged.
- Popularization of DPRP by organizing regional workshops and brainstorming meeting with academic and industry/industrial associations.
- Monitoring & evaluation needs strengthening.
- Success stories of the programme could be made in the form of CD.
- GLP/GMP should be insisted in the institutions and industry.
- Clean Pharma Technology through green chemistry could be adopted.
- Human resource development in analytical wet labs / equipment handling is to be organized through short training programmes/summer/winter schools.
- Brainstorming session with pharma industries for partnerships and further improvement/
- Human resource development centre in 5-6 centers in the country including boarding & lodging facility with state of the art infrastructure both in drug development in biotech products development / pre-clinical animal studies / PKPD / Bioequivalence / Bioavailability / safety pharmacology / clinical research etc. to be attended.
- Special coverage for biostatistics protocols development and powerful software and capacity building.
- The development of vaccines with a link to Ayurveda and Siddha drugs, adjuvants and vaccines, vaccines and green chemistry could be emphasized.
- Diabetes and related complications, cardiology, cardiovascular disease, are likely to become important in the future and special thrust could be given to this sector.
- Diagnostics are likely to become more important. Research on various monoclonal antibodies and its application for diagnostics could be encouraged. Similarly, medical appliances also deserve more focus under this programme.
- Standardization, scientific validation of Ayurvedic/Siddha formulation be continued.

INSTRUMENTATION DEVELOPMENT PROGRAMME (IDP)

The Instrumentation Development Programme (IDP) of Department of Science & Technology (DST), Government of India was initiated in **1975** and is a programme through which the Department of Science and Technology **(DST)** promotes **R&D programmes** for indigenous development of instrumentation. IDP provides an integrated and cohesive approach for supporting R&D Programmes for indigenous development of affordable instrumentation in the country.

Major Achievements of XI five year plan:

Technologies demonstrated/transferred

- On-Line Mango Sorting System using Soft X-Ray Imaging designed and developed by Chennai Centre of Central Electronics Engineering Research Institute (CEERI), CSIR MADARS COMPLEX, Taramani, Chennai-600113
- Design & development of improved non-electronic Soil Testing Kit with Soil Health Card and Fertilizer recommendations by Raja Balwant Singh College, Agra
- Development of a continuous feed equipment for extraction of Aloe Vera Gel at Central Institute of Agricultural Engineering (CIAE), Regional Centre, Industrial Extension Project, Tamil Nadu Agricultural University (TNAU), Coimbatore
- Development of Automatic Remote Accessible Rain-Gauge at Indian Institute of Science , Bangalore
- Commissioning and installation of 2Nos. already developed membrane separation system for textile industry to reduce pollution by recycling by Synthetic and Art Silk Mills Research Association (SASMIRA), Sasmira Marg, Worli, Mumbai-400 030
- Development of Electronic Nose Instrument for Agro Products by Center for Development of Advanced Computing (C-DAC) E2/1 Block GP, Sector-V Salt Lake Kolkata-700091
- Development of Continuous Feed Equipment for Extraction of Aloe Vera Gel by Central Institute of Agricultural Engineering, CIAE-Regional Centre, Industrial Extension Project, TNAU
- Moisture evaluation with microcontroller based instrument for measuring trace moisture present in transformer oil by Electroceramics Division, Central Glass and Ceramic Research Institute (CGCRI), Kolkata-700 032
- Development of NIRS based on-line instrument for quality assessment in Edible Oil Industry by CEERI, CSIR MADARS COMPLEX, Taramani, Chennai-600113
- Design and develop an Infant Ventilator by PSG College of Technology, Coimbatore
- Development of a kit for estimation of Arsenic in water by Kolkata University, West Bengal
- Development of improved version of magnivisualizer (a low cost tool for early detection of cervical cancer by visual inspection) by Institute of Cytology & Preventive Oncology, NOIDA

New Grant-in-aid projects

The multi institution - industry collaborated grants-in-aid projects (75) are supported in the identified thrust areas of Analytical & Optical Instrumentation, Sensors & Allied Instrumentation, Industrial Instrumentation and Medical & Health Care Instrumentation.

Creation of National Hub Facilities

Instrumentation hub is a theme based establishment for development of commercial models of laboratory prototypes developed in the laboratory as per industry/user specifications. The programme has established the following two such hubs:

- Sensor-Hub at CGCRI, Kolkata for commercial prototype development/ incubation of Solid State Sensors & Electronic Nose etc.
- National Hub for Healthcare Instrumentation development at Anna University, Chennai for commercial prototype development/ incubation of Health Care Instrumentation

Capacity building Activities

- Several Training programmes towards the human resource capacity building were organized on repair & maintenance of bio-medical instruments, industrial instruments, optical instruments in five different places in the country.
- Brainstorming session/ Technology awareness workshops & seminar symposia in five different places in the area of instrumentation development were organized.

Cluster of Projects meetings Theme based discussions/interaction meetings involving experts, researchers and industry representatives were initiated to formulate new proposals in specified areas. Such meetings on textiles, food processing, food processing (emphasis NER), water pollution monitoring, chemical & electro-chemical sensors, bio-process instrumentation, analytical and sensor related instrumentation, medical and healthcare instrumentation, biophotonics and bioelectronics received a good response from scientific community.

A glimpse of various activities pursued under IDP during 2011-12 that lead to development of some potent technologies is as follows:

Technologies Developed and Transferred under IDP

Design and development of Infant ventilator by Department of Mechanical Engineering, PSG College of Technology, Coimbatore, Tamil Nadu

A high-end **infant ventilator** was developed by PSG College of Technology (PSG) and Pricol Medical Systems Limited (PMSL) of Coimbatore. The Infant ventilator has advanced modes of ventilation to meet the dynamic needs of new-born baby and touch-screen display with attractive graphical user interface while keeping the cost of ownership at the lowest possible level without diluting the safety norms. The technology is completely indigenized to provide a better after-sales service and support. The Technology of infant ventilator was transferred to PMSL on 29th September, 2011. PMSL will launch the product during the next financial year after clinical validation, thus making the treatment of neonatal respiratory care available to a large section of the society.

Infant ventilator developed at PSG College of Technology, Coimbatore with Pricol Medical Systems Limited (PMSL) partnership

Moisture evaluation with microcontroller based instrument for measuring trace moisture present in transformer oil by Electroceramics Division, Central Glass and Ceramic Research Institute (CGCRI), Kolkata-700 032

The humidity sensor devices were developed using porous ã-alumina based sensor elements. The moisture absorbed on the pores improves the dielectric property, which in turn, makes the capacitance higher at higher absorption of moisture. The objective of the work was to develop thin film porous dielectric material for detection of moisture in the range of 5-20 ppm. The sensitivity and characteristics to trace moisture has been evaluated by LCR meter and Chilled mirror hygrometer. The developed sensor calibrated an electronic device for low range moisture measurement in hand held devices for environmental and meteorological monitoring. For low range moisture detection in transformer oil application, ceramic based humidity sensor with adequate sensitivity over the moisture range from 5 to 20 ppm has been developed using a new method (sol-gel). Contract will be signed with M/s Nisha Engineering Corporation, 285/B, B.B.Ganguly Street, Kolkata 700012. They agreed to purchase humidity sensor with meter from CSIR-CGCRI. For field testing of developed prototype meters has been sent to M/s Nisha Engineering Corporation, Kolkata.

Fig. 4.4: Prototype of trace moisture analyzers handed over to the party (Nisha Engg. Co.Kolkata)

New Projects sanctioned under IDP

Eighteen new projects in the area of textile, quality control, medical and sensor based instrumentation have been supported with industry collaboration at various National Institutes/ Universities/ Engineering and Medical Colleges:

- Development of Instrument for Tea Quality Monitoring at University of Calcutta, West Bengal
- Development of sensor for the detection of adulteration in Oil at University of Kolkata, West Bengal

- Inspection of Warp and Weft lacking in textile web material using wavelet and artificial intelligence at Kongu Engg. College, Perundurai, Erode – 638 052, Tamilnadu
- Development of a Plasma based System to Synthesize Nanotitania and Study its Self Cleaning Effect at F.C.I.P.T., Institute for Plasma Research, Gandhinagar – 382 044, Gujarat.
- E-pick counter for power looms at Sarvajanik College of Engg. & Technology, Athwalines, Surat – 395 001.
- Design and Development of Electro-active sensor fabrics for monitoring body kinematics and vital signs at PSG College of Technology, Coimbatore – 641 004, Tamilnadu .
- Development of an efficient staple yarn characterization unit with multi sensor fusion and field programmable gate array (FPGA) based data reduction card at Bengal Engineering and Science University, Shibpur, Howrah 711 103 WB.
- Development of simple Surface Plasmon Resonance based detection of pollutants in water at University of Madras, Guindy Campus, Chennai- 600 025.
- Development of Digital Signal Processor (DSP) controlled Infra Red (IR) Laser absorption based in-situ gas sensor for Industries at SAMEER, IIT Campus, Hill Side, Powai, Mumbai– 400076.
- Design of a compliance monitored clubfoot brace for management of clubfoot deformity in children at Christian Medical College, Vellore, Tamilnadu.
- Design of Pulse-jet Filtration Apparatus at National Institute of Technology, Jalandhar – 144011 Punjab - 144 001.
- Design and develop and indigenous automatic single fibre length measurement instrument for long staple fibres, like wool, pashmina, angora etc. at Wool Research Association, Kolshet Road, Thane – 400 607.
- Indigenous Development of table-top Surface Plasmon Resonance (SPR) set up at University of Delhi, Delhi-110 007.
- Design & Development of Prototype Plasma Treatment System and Process Optimisation to Modify the Surface of Polyester & Nylon Fabric to Improve its Adhesion with Polyurethene (PU) & Polyvinyl Chloride (PVC) Coatings/Lamination at F.C.I.P.T., Institute for Plasma Research, Gandhinagar – 382 044, Gujarat.
- Lab scale precision I – V and C – V real time analyzer for design and development of a selective gas for sensor at BESU Shibpur, Howrah-7111West Bengal
- Hardware based Field – type E-Nose for Flavor detection of Tea using Metal Oxide Semiconductor (MOS) sensors at Tezpur University, Napaam-784028 Assam.
- Design of Ultra Power CMOS Cell for Temperature Sensor in VLSI at Birla Institute Technology, Mesra, Ranchi-835215 (JH)
- Functionally impregnated zeolite based potassium sensor at NIIT Trichy, Tamilnadu.

National facilities to Promote Commercialization of Developed Instruments

Sensor Hub, CGCRI, Kolkata: The Sensor Hub was established at Central Glass and Ceramic Research Institute (CGCRI), Kolkata with the grant from the Department of Science & Technology (DST), Government of India and Council of Scientific & Industrial Research (CSIR), New Delhi for a period of five years. The sensor hub will take the batch production of sensor and related instruments leading to commercialization of laboratory prototypes developed in the research laboratories. The participating institutions are CGCRI, Kolkata; C-DAC, Kolkata; Jadavpur University, Kolkata; University of Kolkata; and Bengal Engineering and Science University, Shibpur, Kolkata. The work plan primarily included development of products such as Tea Sensors and Sensor Array with associated electronic nose; Gas Sensing Devices for Methane and Carbon-monoxide; and Polymer based Gas Sensor for detection of Carbon monoxide etc.

National Hub for Healthcare Instrumentation Development (NHHID) at Anna University, Chennai : National Hub for Healthcare Instrumentation Development (NHHID) is a national facility established under Instrumentation Development Programme (IDP) of DST, Govt. of India at Anna University, Chennai to promote and accelerate development of indigenous healthcare instrumentation. This Hub is a sophisticated facility which will serve as the translational platform and incubator; and can be used for technology up-scaling or prototype development or development of instruments in substantial number for market validation. The 15 projects under the Hub have been grouped into three major categories: Instrumentation for infectious diseases, Patient/Home Care Devices and Medical Devices. The Hub partners include Anna University Departments: (CBT CME ECE ME MIT) and institutes namely CECRI, IISc (CEDT), CMC, CSIO and MVC. Additional institutions like PSG College of Technology and CCMB, Hyderabad will also be associated through cluster-of-projects approach.

Technology Promotion/Technology Commercialization/Capacity Building activities conducted under IDP

- Technology Awareness Meet on "Online Quality Assessment in Edible Oil Industry" at CSIR Campus, Taramani, Chennai-600 113 on 2nd June, 2011
- Development of recommendations for setting up a mission mode programme for medical instrumentation and devices development through Science and Technology by Sree Chitra Tirunal Institute for Medical Sciences & Technology, Thiruvananthapuram
- Brainstorming session on "Instrumentation on Application of Plasma Technology in Textile Processing and Allied Areas" at F.C.I.P.T., Institute for Plasma Research, Gandhinagar – 382 044, Gujarat
- Investigator-Investor Meet for exhibiting prototypes developed under Medical and Healthcare Instrumentation was held on June 27th 2011 at NHHID, Anna University
- A brainstorming seminar **on Quality Measurement of Aromatic Rice by Electronic Nose & Vision System** for the rice growers, rice scientists, rice marketeers at all levels, exporters, agro enterprenuers and all the stake holders in rice community The Rice Research Station (RRS) under the Directorate of Agriculture, Government of West Bengal and Centre for Development of Advanced Computing (C-DAC), Kolkata
- Workshop on Sensor Interface & Integration in R&D Work by Department of Mechanical Engineering, PSG College of Technology, Coimbatore, Peelamedu, Coimbatore – 641004, Tamilnadu. The three

day workshop was organized during 26-28th September, 2011

- Training Programmes (4) on Repair and Maintenance of Bio-Medical Instruments for Technocrats/ Users from Armed Forces at Vadodara on August 29 to September 09,2011, Delhi on October 10 to 21,2011, Udhampur on November 14-24, 2011 and Vadodara on January 16 to 27,2012 by Central Scientific Instruments Organisation, Delhi Centre.
- Technology Awareness Workshop on Fabric feel tester by Department of Textile Technology, IIT-Delhi on December 3, 2011
- **Cluster of Projects Meet for Food Processing Instrumentation with special emphasis on North Eastern Region by Instrumentation Development Programme of DST, Govt. of India** held at Tezpur University from 13-14th October, 2011
- Cluster-of-Projects Meet for affordable medical and healthcare instrumentation at National Hub for Healthcare Instrumentation Development (NHHID), Anna University, Chennai-605 025 on June 28, 2011.

Representative prototypes recently developed under the IDP

1. Development of an instrument for measurement of opening force of fibrous assemblies by Department of Textile Technology, Indian Institute of Technology (IIT), New Delhi.

The opening force measurement instrument is a unique device which can record the torque required to open or teased out fibres from sliver, rovings or , comber lap . The instrument can be used by Synthetic Fibre manufactures: for optimising spin finish & crimp**;** Textile machinery manufacturers: for optimising needle/ wire points geometry of opening elements**;** Spinning mills: for process & quality control in terms of fibre selection, speeds & settings adjustments etc; and Academic and research institutes: for research on fibre friction, processing behaviour.

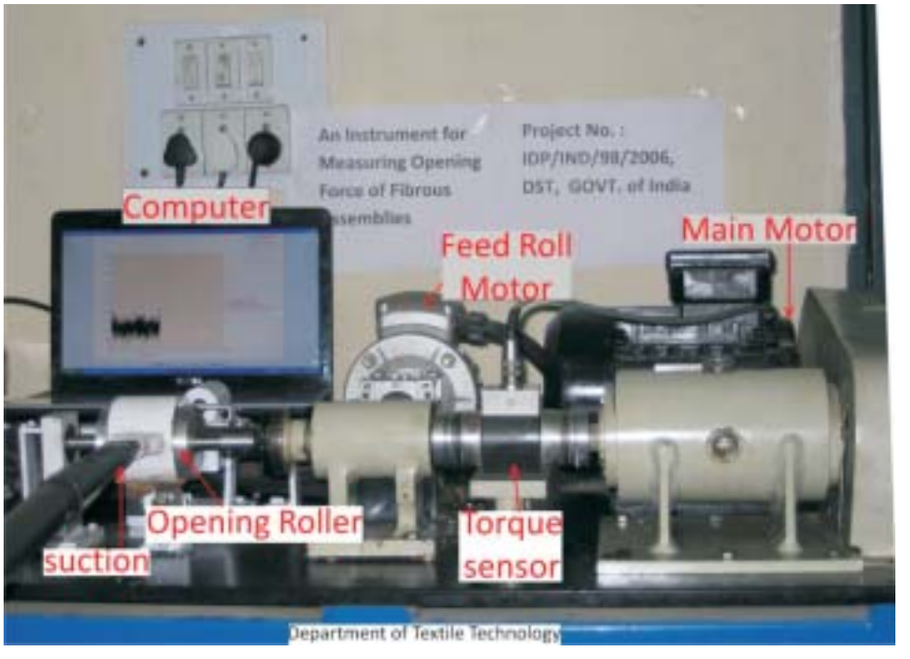


Fig. 4.5

2. Design & Development of Creep Testing Apparatus for Geotextile

The main objective of the project is indigenous development of a Tensile Creep apparatus for accurately measuring this parameter strictly as per international specifications (ASTM D-5262). The equipment should be dedicated equipment and universally applicable for testing of various types of geotextiles, geogrids and geomembranes. The proposed creep tester has been developed as per the design specifications. The main features include, evaluation of extension of the test sample at two points with 100 mm gauge, continuous data record with help of datalogger and computer interface for plotting of the creep curve

Fig. 4.6: Creep Testing Apparatus for Geotextiles developed at SASMIRA

3. Design and Development of clamping devices for testing tensile properties of High strength Technical textile fabrics

Wide width strip method (**Test method ASTM D 4595)** for tensile testing is applicable for high tenacity fabrics that include woven fabrics, non-woven fabrics, layered fabrics, knit fabrics and felts that are used for technical textile application. The greater width of the specimen specified in this test method minimizes the contraction effect of those fabrics. In some cases, 100-mm width specimens may be substituted for 200-mm width specimens, to minimise the contraction effect. The objective of the project is to develop new clamps (grips) for better gripping of high performance textiles during tensile testing by wide width method. The development of wide width wedge action grips and wide width hydraulic grip for high tenacity fabrics as per the design specifications ahs been completed.

These grips have been checked for their reliability and accuracy and are being used for testing of high tenacity fabrics.

Fig. 4.7: Wedge Grips

Fig. 4.8: Hydraulic Grips

4. Design and development of Health & Physical fitness monitor by Department of Mechanical Engineering, PSG College of Technology, Coimbatore, Tamil Nadu

Multi-parameter monitoring equipment is designed & developed by PSG College of Technology and M/s. Pricol Medical System Limited, Coimbatore. The Multi-parameter monitor systems will find wide applications in Hospitals - intensive care units, operation theaters, emergency and even in Ambulance. The equipment will be capable of measuring parameters like electrocardiogram (ECG), invasive and noninvasive blood pressure, pulse rate, pulse oximetry, body temperature, respiration rate, end-tidal CO2 and other specialized parameters. The equipment is integrated with sensors to measure, display and document physiological information about the patient. Currently, there is no indigenous manufactures of Multi-parameter monitors in India. Also, there is a need to develop cost effective indigenous multi-parameter monitors which will meet the hospital requirements both in urban and rural areas. The system will be an import substitute to international manufacturing. The final prototype will be launched by the end of 2012.

Fig. 4.9: Health & Physical fitness monitor – First model

Fig. 4.10: Software developed for interfacing the OEM modules

5. Design and development of a computerized instrument for measurement of fabric feel by nozzle extraction by Department of Textile Technology, Indian Institute of Technology (IIT) Hauz Khas, New Delhi-110 016

Fabric *feel* is a generic term for the tactile sensations associated with fabrics, and it markedly influences consumer preferences of textile products. Although fabric handle is still being judged subjectively to a large extend, the need for objective method to measure the fabric handle has always existed. The proposed instrument will be very helpful to the industries who are dealing with the production, evaluation and applications of textile fabrics for process control, quality control and quick decision making.

Fig. 4.11: Instrument for measurement of fabric feel by nozzle extraction developed at IIT, Delhi

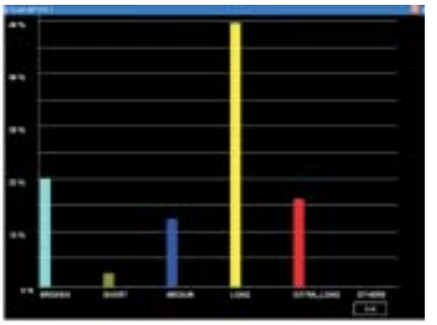
6. Development of Integrated Electronic Nose and Vision (EVN) System for Quality Estimation of Basmati Rice by Center for Development of Advanced Computing E2/1 Block GP, Sector-V Salt Lake Kolkata-700091.

The instrument is developed to assess the quality analysis of rice (Basmati & other varieties) in a quantitative manner and targeted for Rice producers/growers and exporters; agricultural centers/ research laboratory; food processing laboratories; food safety & quality laboratories. The Non-specific Array of Sensor (MOS based) is used in the fabrication of E-nose. The salient features include portable system for ease of field mobility, PC interfacing using USB port, instant report generation, print out facility etc. to make it user friendly.

ANNADARPAN – Electronic Vision for Quality Analysis of Rice

Software Screen for Rice Quality Analysis

Electronic Vision system for Rice Quality Analysis



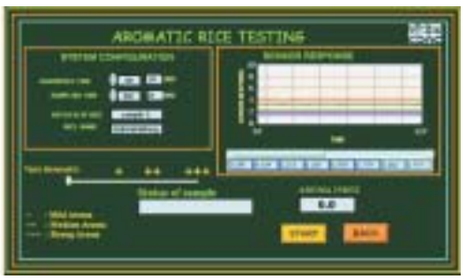
Bar graph for Different Rice Grades

Fig. 4.12

Electronic Nose for Quality Analysis of Aromatic Rice (AMMAR)

E-Nose System for Basmati Rice

Odour Delivery System



E-Nose Software Screenshot

Fig. 4.13

7. Development of NIRS based on-line instrument for quality assessment in Edible Oil Industry by CEERI, CSIR MADARS COMPLEX, Traramani, Chennai-600113

Technology Awareness Meet **on On-line Quality Assessment in Edible Oil Industry** & On-site demonstration of the product at User Industry along with CSIR – CFTRI, User Industry and DST created higher impact to the Edible refineries, entrepreneur, & instrument manufacturers. First time a

Fig. 4.14: System at laboratory under test

Fig. 4.15: On-line measuring System at industry Plant II from 6th May to 8th June 2011

team of **CSIR-CEERI** have joined hands with experts from the Lipids Sciences Department of Central Food Technological Research Institute (**CSIR-CFTRI, Mysore**), along with supporting user industry, **M/s Kaleesuwari Refinery Pvt. Ltd** (manufacturer of **Gold Winner Sun Flower Oil** brand) who has contributed 10 %percentage of project Cos executed the project .

8. Design and development of controlled melting and freezing system for preparation of ultra pure crystalline materials for optoelectronics by Centre for Materials for Electronics Technology (C-MET), Hyderabad- 500 051, Andhra Pradesh

C-MET, Hyderabad has developed an indigenous controlled melting and freezing system for preparation of pure gallium indium (GaIn), gallium antimonide (GaSb), gallium telluride (GaTe), indium antimonide (InSb) alloys. The ultra high purity (UHP) alloys are of the most critical input materials required for GaSb, InSb and their related crystals, epi-structures fabrication and devices technology. InSb based gadgets find advanced micro-optoelectronic applications in the strategic aero-space and defense sectors. 4N+/5N purity gallium, indium, tellurium and antimony were used as starting material for preparation of 5N+ / 6N pure alloys. Purification and crystallization was carried out by employing of combination of zone melting, developed directional freezing and solidification processes. Majority of targeted and undesired select impurities were reduced as evidenced from GDMS and other purity test results.

Fig. 4.16: Pure InSb crystalline ingot

Fig. 4.17: Pure GaSb crystalline ingot

Two Zone Furnace

INTELLIGENT FURNACE CONTROL SYSTEM

Computer controlled directional melting/ freezing and solidification system Developed at C-MET, Hyderabad under DST Instrument Development Project

Vision for the twelfth Plan

The multi institution - industry collaborated projects will be initiated in the identified thrust areas of Analytical & Optical Instrumentation, Sensors & Allied Instrumentation, Industrial Instrumentation and Medical & Health Care Instrumentation with a focus on affordable technologies.

The efforts will be made to transfer the technologies developed at various institutions under the programme during the previous plan period. The efforts will be initiated to create the Hub facility for scientific/optical instruments and agri-engineering/food processing based instruments within the country.The technology transfer and commercialization activities will be pursued and the training programmes will be initiated for capacity building in the areas like repair & maintenance of medical/analytical instruments or sensor instrumentation etc. Cluster of projects meeting will be organized to formulate the projects in the focus areas like Non invasive medical devices, medical implants, analytical instruments and agriculture related instrumentation.

NATIONAL PROGRAM ON CARBON SEQUESTRATION RESEARCH

I. Title of the project: Mechanism and the Dynamics of Carbon Storage in the Sunderban Mangrove Ecosystem

Implementing Agency: Department of Department of Marine Sciences, College of Science and Technology, University of Kolkata, Kolkata

Approved objectives of the proposal

1. To apply reservoir models with nonlinear reservoir/flux relations and cycles.

2. To assess the effect of new nutrients on the carbon storage in the sediment in the form of geo-polymers like humates and kerogen through diagenesis

Important highlight/achievement of the work

Sundarban mangrove forest is a net sink of CO_2; with annual sequestration of 3.05 million ton carbon (Fig 1) Because of the technical difficulties in free-air carbon dioxide enrichment experimentation the responses to increasing atmospheric carbon dioxide in mangrove forests are poorly understood. This study applied box model to overcome this limitation, and the relative changes in present level of reservoirs organic carbon contents in response to the future increase of atmospheric carbon dioxide were examined in the *Avicennia* dominated mangrove forest at the land-ocean boundary of northeast coast of the Bay of Bengal. The above and below ground biomass (AGB+BGB) and sediment held different carbon stock (52.41±4.73 Mg C ha^{-1} versus 19.71±1.58 Mg C ha^{-1}). Carbon uptake (0.308 mg C $m^{-2}s^{-1}$) is more than offset by losses from plant emission (0.196 mg C $m^{-2}s^{-1}$) and litter fall (0.014 mg C $m^{-2}s^{-1}$) was more than soil CO_2 and CH_4 emission (7.9 and 1.23 ìg C $m^{-2}s^{-1}$, respectively) (Fig2). Across inventory plots Sundarban mangrove forest carbon storage in above and below ground live trees and soil increased by 11.16 and 5.56 Mg C ha^{-1} between June 2009 and May 2011. Box model well predicted the dynamics of above and below ground biomass and soil organic carbon and increasing atmospheric carbon dioxide concentrations could be the cause of the stimulation of 1.1 and 1.57 fold increase in carbon (Fig 3)

Inorganic nitrogen concentration in sediment was found low (4.04 ± 1.06 ìg g^{-1}) and it exhibited positive linear relation with nitrogen extracted from leaf (DNA-N=0.0053+0.0572 Sed-N, R^2 =0.85) and root (DNA-N = -0.1135+0.0791 Sed-N, R^2 =0.9). N: P ratios in DNA were <4. In contrast to the roots (A-T 57.63-59.01%; G-C 40.89-42.34%), the percentage of G-C-base pairs in leaves (58.42-64.38%) was greater than the percentage of A-T-base pairs (35.58-41.57%). Low abundance of nitrogen in the soil results in the occurrence of N-poor nucleotides in root DNA. The mangroves seem to assimilate nitrogen from both soil and the atmosphere with atmospheric NOx uptake playing a greater role in leaf protein content than soil inorganic nitrogen. This study supports the hypothesis that higher levels of DNA

with N-rich nucleotides in leaves relative to roots are necessary for enhance synthesis of protein to offset damage.

No. of papers/patent filed etc.

1. R.Ray, D. Ganguly, C. Choudhury, M. Dey, S. Das, M. K. Dutta, S. K. Mandal, N. Majumdar, T. K. De, S. K. Mukhopadhyay and T. K. Jana. 2011. Carbon sequestration and annual increase of carbon stock in a mangrove forest, Atmospheric Environment, Elsevier , Atmospheric Environment 45 (2011) 5016e5024

2. Raghab Ray, Chumki Chowdhury, Natasha Majumder, Manab K. Dutta, Sandip K. Mukhopadhyay and Tapan K. Jana **Sensitivity of increasing atmospheric CO_2 in affecting carbon stock of tropical mangrove forest (Comminicated to Climate Change, Springer)**

3. N majumder,C Chowdhury, R Ray and T.K.Jana. 2011. **DNA base composition heterogeneity in two *Avicennia* species in response to nitrogen limitation in the sundarban mangrove forest,India.** International journal of biological chemistry,Science Alert. ISSN 1819-155X/DOI: 10.3923/1jbc.2011.

4. T.K.Jana and D.Ganguly 2011.**Hydrogen sulphide emission as a source of non sea sulphate in aerosol over tropical mangrove forest.** International conference; Fluxes and structure in fluids, physics of geosphere, 27-30 September, 2011.Vladiostok, Russia, Extended Abstract, pp 86-88.

Patent filed

पेटेंट कार्यालय
का
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OFFICIAL JOURNAL
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THE PATENT OFFICE

निर्गमन सं. 21/2011	शुक्रवार	दिनांक: 27/05/2011
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पेटेंट कार्यालय का एक प्रकाशन
PUBLICATION OF THE PATENT OFFICE

The Patent Office Journal 27/05/2011 9149

New innovations towards technology development Our results can be used to calculate the total forest coverage to be extended in order to counter balance the anthropogenic emission of carbon dioxide from the adjacent power plants and industrial complex near Haldia and Kolkata port.

Deliverables/output after completion of the project (very brief and specific): This study revealed that Sundarbans mangrove ecosystem could enhance the extent of carbon sequestration in response to atmospheric increase of carbon dioxide as a result of anthropogenic activity.

RELEVANT FIGURES:

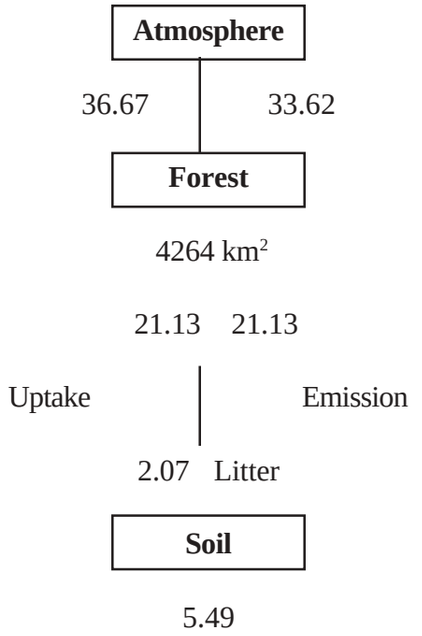


Fig. 4.18:Schematic diagram of organic stocks (Tg C in large boxes) and fluxes (Tg C a^{-1} soild straight arrow) at the Sundarbans during the study period.

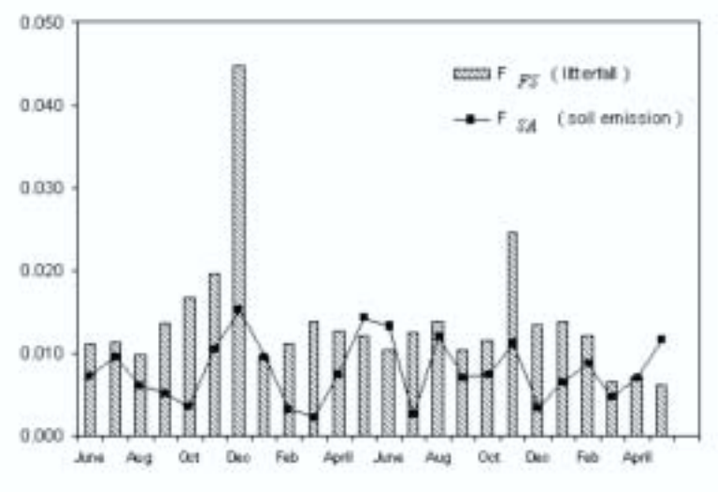


Fig. 4.19: Monthly variation of litter fall (F_{FS}) and soil emission (F_{SA})

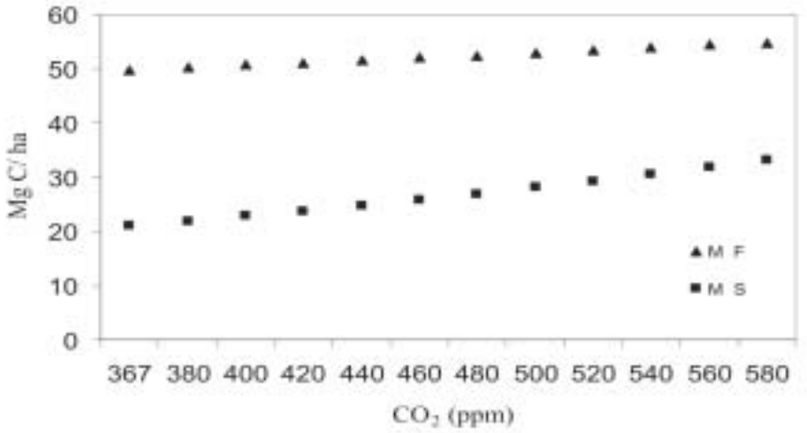


Fig. 4.20: Variation of reservoirs M_F (Above ground and below ground biomass), M_S (soil) content in response to the change of CO_2 concentration in the boundary layer

II. Title of the project: Integrated Biological and Chemical Carbon Dioxide Sequestration

Implementing Agency: Environmental Health Division, National Environmental Engineering Research Institute (NEERI), Nagpur-440020

Approved objectives of the proposal

- Screening and isolation of algae/bacteria having high CO_2 sequestration capacity with batch scale studies on CO_2 capture and sequestration by the micro-organism.Optimization of the process parameters and growth conditions for maximum efficiency
- Feasibility studies on laboratory scale sequential bioreactor for CO_2 sequestration with bacteria and algae either singly or in symbiotic association
- Application of the reactor with flue gas and study the effect of other flue gases such as SO_x and NO_x on carbon dioxide capture with bicarbonate precipitation

Important highlight/achievement of the work

Photosynthetic capability of microalgae with respect to CO_2 fixation at various percent CO_2 (0.03,1.4, 3.0, 5.0, 7.5, 12.0 and 15.0%) atmosphere, increase in calorific value at different CO_2 concentrations using two tier flask (Figure 1) have been studied. The cultures used for CO_2 fixation and sequestration viv a vis calorific value of the biomass in order of higher calorific value are Scenedesmus sp, Chlorella vulgaries, Chlamydomonas sp and Chroococcus sp were 34 kJg-1 , 28 kJg-1, 27 kJg-1 and 21 kJg-1 respectively, in order of the CO_2 fixation rate are 1.81 gl-1 -d-1, 0.36 gl-1d-1-, 0.04 gl-1-d-1 and 0.06 gl-1d-1respectively at 1.4% CO_2.

From the above studies, selected Scenedesmus sp. based on the CO_2 fixation, biomass productivity and calorific value at 1.4% CO_2 (1.81 gl-1 -d-1, 0.78 gl-1 -d-1 and 34 kJg-1) & at 7.5% CO_2 (1.79 gl-1 -d-1, 0.77 gl-1 -d-1 and 15 kJg-1) respectively. The same Scenedesmus sp. was chosen to study further kinetic parameters such as sequestration potential at various percentage of CO_2 (Fig 2). Air lift photobioreactor (ALR) microalgal CO_2 fixation system to capture CO2 with the S. obliquus has been employed in the present study. The removal efficiency (RE) found to be decreased from 90% RE at

ambient CO_2 concentration to 17% RE at 12 % of CO_2 with elimination capacity (EC) of 0.0086 g/L/d to 1.03 g/L/d respectively. The highest CO_2 removal ratio can be obtained at 260 µmol m-2s-1 light intensity

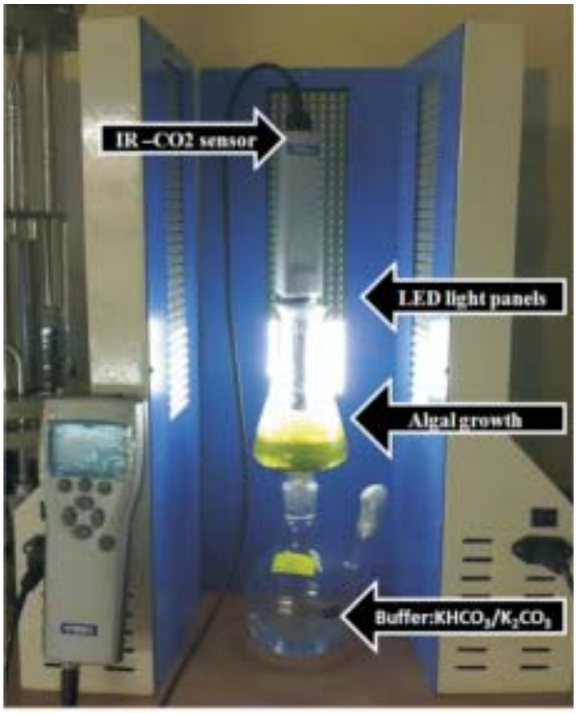


Fig. 4.21: Experimental set up showing two tier flasks with IR- CO_2 sensor at top of upper flask, artificial CO_2 generating buffer ($KHCO_3/K_2CO_3$) at bottom flask and LED light panels.

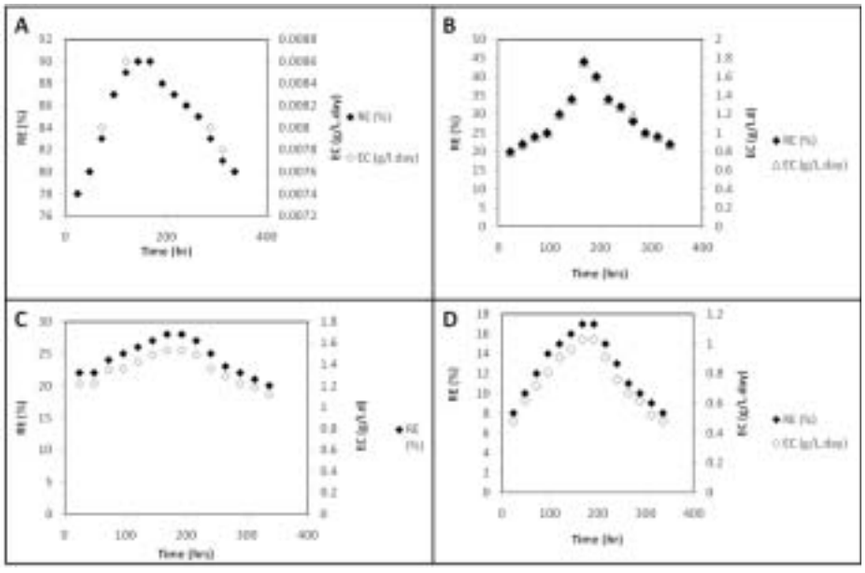


Fig. 4.22: Kinetic data for Air lift reactor operation with respect to elimination capacity vs. removal efficiency at different CO_2 Concentration (A- 0.03% , B-5 CO_2 %, C- 8 CO_2% and D-12 CO_2%)

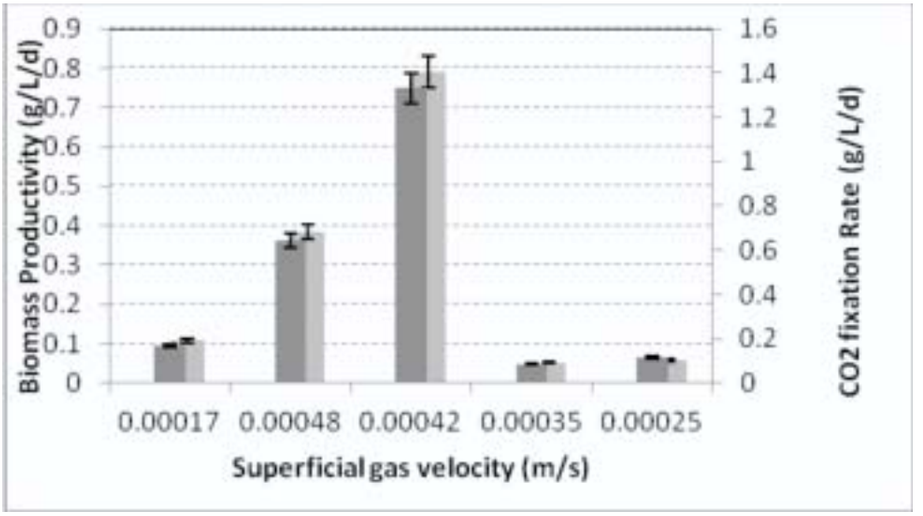


Fig. 4.23: The performance of biomass production of *S. obliquus* under different CO_2 feeding concentrations

We have also carried out biomass production of *S. obliquus* at various CO_2 atmosphere and various flow rates.

No. of papers/patent filed etc.

1. Enhanced algal CO_2 sequestration through calcite deposition by *Chlorella* sp. and *Spirulina platensis* in a mini-raceway pond. Bioresource Technology. 101 (2010) 2616–2622 **(IF= 4.45)**

2. Bio-mitigation of CO_2, calcite formation and simultaneous biodiesel precursor production using *Chlorella* sp. Bioresource technology. DOI 10.1016/j.biortech. 2010.06.012 **(IF= 4.45)**

3. Recent Advancements in Carbonic Anhydrase Driven Processes for CO_2 Sequestration. Critical Reviews in Environmental Science and Technology (2010) Publication tracking No. BEST: 556884**(IF= 7.09)**

Deliverables/output after completion of the project (very brief and specific)

Project aims to have an algal species which can sequester higher percent of CO_2 in presence of impurities such as NOx, SOx and Hg etc.

III. Title of the project: Predicting soil carbon changes under different cropping systems in soil of selected benchmark spots in different bioclimatic systems in India

Implementing Agency: National Bureau of Soil Survey and Land Use Planning, Nagpur

Approved objectives of the proposal

Important highlight/achievement of the work

(Please see the attached material)

IV. Title of the project: Mycorrhizal Symbiosis to Promote Carbon Sequestration for Sustainable Soil Fertility and Environmental Safety

Implementing Agency: Tamilnadu Agricultural niversity, Coimbatore

Approved objectives of the proposal

- To determine the verifiable carbon distribution in soil, plant and rhizospheric microorganisms in maize-mycorrhiza systems under Open Top Chamber (OTC) experimental conditions.
- To release pattern and profiling of Glomalin in mycorrhizal (inoculated) and non-mycorrhizal (uninoculated) systems using ELISA method and relate C sequestration in agro-ecosystem
- To conduct large scale field demonstration to quantify reduction of CO_2 emission to the atmosphere and conservation of C in soils
- To validate the data using standard set of Carbon Flow models such as Century and Roth C

Important highlights/achievements of the work done during 2011-12 (i.e 01.04.2011 to December,2011)

- ***Glomalin profiling (western blot analysis):*** Greenhouse, OTC and field experiments have clearly demonstrated that glomalin concentrations of mycorrhizal soils were consistently higher than uninoculated soils. However, the specificity of the glomalin production with reference to mycorrhizal colonization can be achieved using western blot analysis
- ***Rhizobox system for assessing glomalin release pattern:*** Our laboratory has designed rhizoboxes that can be used to extract the external mycelium which is known to be the site of release glomalin. Extraction of glomalin from the mycelium will help to quantify the C sequestration as a consequence of mycorrhizal colonization. This is very much required to justify the hypothesis that mycorrhizal colonization facilitates glomalin production vis-avis carbon sequestration.
- ***Data validation using C-models :*** The C stock assessment is being made in two distinct soils two maize based cropping systems viz., Maize – Cowpea – Maize (ARS, Bhavanisagar) Maize – Maize – Fallow (MRS, Vagarai) is to be fit into the model. As
- per the approved objectives, the data collected from the field experients are to be fit into Century & Roth C Models that require complete set of one year data. Presently, third crop is being cultivated and expected to be harvested in November 2011.
- ***Report Preparation:*** Statistical analysis, report writing, paper writing and filing a patent for glomalin

No. of papers/patent filed etc.

- **Subramanian, K.S.,** Vivek, P.N. and R. Rajeswari. **2010**. Impact of arbuscular mycorrhizal fungus (*Glomus intraradices*) colonization on soil carbon pools of Long-term fertility gradients. Soil Biology and Biochemistry.
- **Subramanian, K.S. 2010. "**Mycorrhizas –Potential C sequester" Paper presented at the training program "Mycorrhizas in Sustainable Agriculture, Department of Microbiology, TNAU, Coimbatore on 17.3.2010.
- **Subramanian, K.S. 2010.** Mycorrhizas and Carbon Sequestration. Paper presented at the "International Research Workshop on New Innovations in Biotechnology Applications" held at the school of Biosciences and Technology (SBST), VIT University, Vellore, Feb. 16-26, 2010.

- **Subramanian, K.S.,** Rajeswari, R. and S. Krishnakumar. **2011**. Mycorrhizas to promote carbon sequestration in maize system. Paper presented at the "National Seminar on Soil health" held at Tamil Nadu Agricultural University, Coimbatore, March. p 125, 2011.
- **Subramanian, K.S**., Gomathy, M. and Krishnakumar, S. Mycorrhizal Processes and Carbon Sequestration. Book chapter yet to be published.
- **Subramanian, K.S**. and Krishnakumar, S. (XXXX). Mycorrhizas to promote carbon sequestration in difference stages growth of maize. *Madras J. Agric., Sci.* Research article yet to be published.

New innovations towards technology development

Mycorrhiza technology may be a potential strategy to conserve carbon in soil vis-à-vis soil fertility besides reducing the CO_2 emissions from the field. The C sequestration is achieved through the accumulation of glomalin "glycoprotein" that facilitates retention of C in the long-lived pools of C in the soil. Since mycorrhizal fungus is ubiquitous, the benefits derived from the inoculation may be very appropriate for sustainable agriculture.

Deliverables/Output after completion of the project (very brief and specific)

The net verifiable C accumulation in the maize-mycorrhizal soil was estimated to be approximately 600 kg C ha^{-1} regardless of soil types or variations in genotypes.

(v) **Title of the project:** Monitoring of Carbon Sequestration through Micropropagated Bamboo Plantation in Himalayan Region

Brief objectives/goals:

- Large scale multiplication of *Dendrocalamus asper* through micropropagation.
- Total plantation in 1ha area (three replications).
- Monitoring and analysis of culm dynamics, biomass and total net production.
- Monitoring and analysis of nutrient deposition through leaf litter.

Important highlights/achievements of the work done during 2011-12 (i.e.01.04.2011 to 30th December, 2011)

Plant production of *Dendrocalamus asper* and *D. hamiltonii* through Micropropagation

- 800 plants of *D. asper* were produced through micropropagation
- Culture of *D. hamiltonii* has also been established, 40 plants are ready for transplantation.

Bamboo Plantation at ARS Majhera and Sealdeh.

Plantation of various species of bamboo was done in the year 2009, 2010 & 2011 for monitoring of carbon sequestration in the Himalayan region (Majhera & Sealdeh) through biomass production. Agriculture Research Station, Majhera is in district Nainital and Sealdeh is in district Almora of Uttarakhand state at an altitude of 905 and 1000m (a.s.l.) respectively.

Monitoring and analysis of Culm Dynamics, Biomass and Total Net Production

Growth parameters of *D. asper* plantation done at ARS, Majhera in the year 2009 were recorded on monthly basis for the estimation of carbon sequestration through above ground biomass production of two year old plantation.

Table 1. Carbon sequestered on the basis of above ground biomass produced in two year old plantation of *D. asper*

No. of plants	Above ground biomass produced in two years		Total Carbon sequestered(kg)	Biomass produced per plant on dry wt. basis (kg)	Carbon sequestered per plant (kg)
	On fresh wt. basis (kg)	On dry wt. basis (kg)			
23	350.84	254.52	127.26	11.06	5.53

- Estimation of above ground biomass production was done using regression equation developed by Agarwal & Purwar (2009).
- Estimation of carbon sequestration was done on the basis of 50 per cent of the total above ground biomass produced (Singh et al, 2011)

As per the data summarized in table 1, **biomass production and carbon sequestration** potential of *D. asper* **is 4.4 & 2.2 t ha^{-1}** respectively **in two year old plantation** in mid Himalayan region which is quite comparable with the report of Kao & Chang (1989). Maximum net annual production was estimated at 41.4 t/ha during the 8th yr in a *Dendrocalamus asper* plantation in Taiwan. Biomass production in bamboo increases in subsequent years.

Maximum height attained and number of total culms produced by the plantation of *D. asper* at ARS, Majhera is summarized in Fig.1 & 2.

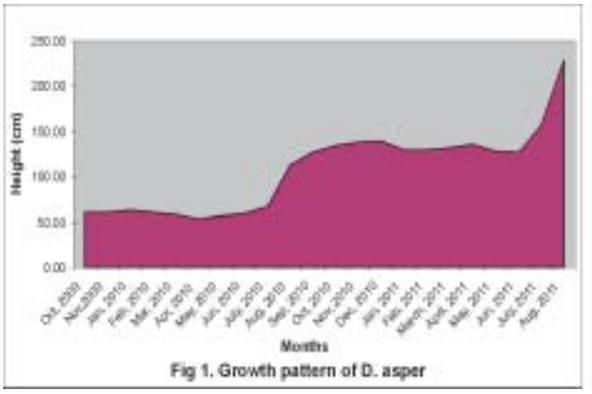


Fig 1. Growth pattern of D. asper

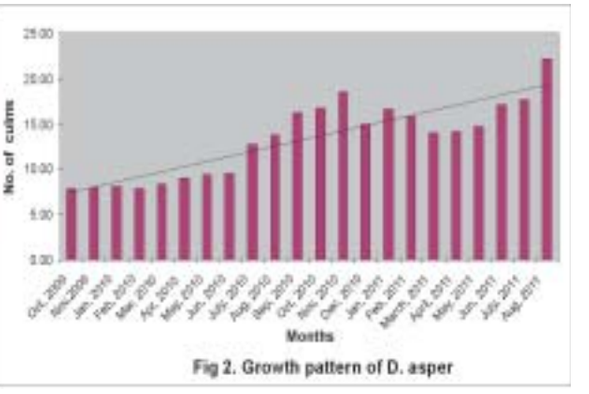


Fig 2. Growth pattern of D. asper

Fig. 4.24

Maximum height was attained by the plants in the month of August in both the years (2010 and 2011) whereas total number of culms showed an increasing trend in subsequent months.

Further, plantation of different species of bamboo has been carried out in Majhera and Sealdeh in the year 2010 and 2011. Details are summarized in table 2.

Table 2. Detail of bamboo plantation in the year 2010 and 2011

Species	Number of Plants	Place	Total Approx. area (ha)	Date of Plantation
D. apser	09	ARS, Majhera	0.11	August, 2010
D. hamiltonii	09			
Bambusa balcooa	09			
B. nutans	09			
B. tulda	09			
D. apser	150	Sealdeh(1000m Asl)	1.0	August, 2010
D. strictus	50			
D. hamiltonii	200			
D. asper	100		0.25	July, 2011

Growth pattern of different species of bamboo (*D.asper, D. hamiltonii, B. balcooa, B. tulda* and *B. nutans*) planted at ARS, Majhera in August 2010 indicated that, though all the species gained maximum height in the month of August but maximum height was gained by *B. nutans* (Fig 3).

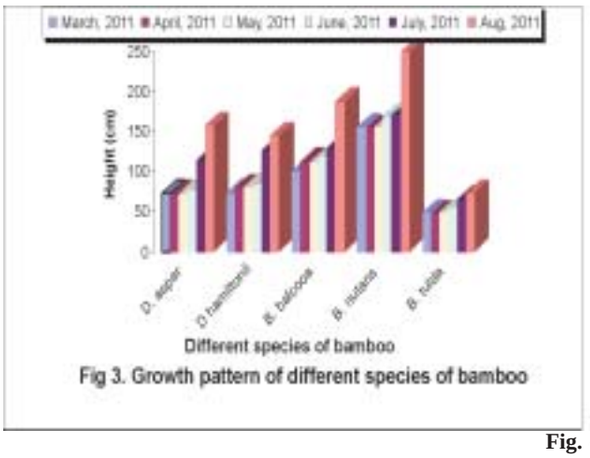


Fig 3. Growth pattern of different species of bamboo

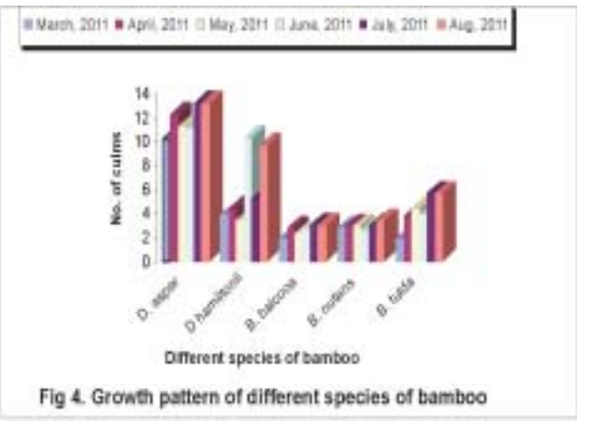


Fig 4. Growth pattern of different species of bamboo

Fig. 4.25

Maximum Number of culms was recorded in micropropagated *D. asper* followed by *D. hamiltonii* (Fig 4). Out of three species planted at Sealdeh (1000m asl), *D. strictus* showed the maximum height attained where as *D. hamiltonii* produced maximum no. of poles. Work on biomass production and carbon sequestration potential of these species is in progress and shall be estimated on the completion of two years.

No. of papers/patent filed etc.:

Research Paper

Agarwal A. and Purwar, J.P. 2011. Biomass production and carbon sequestration potential of various Bamboo species in the Mid Himalayan region of India. Communicated to IX World Bamboo Congress to be held in 2012.

Extended Abstract

Agarwal, A.; Purwar, J.P. 2010. Linear regression model for the estimation of above-ground biomass in various species of bamboo. In: 2010 INBAR Congress on Bamboo and Rattan Proceedings, 29.

New innovations towards technology development:

- Bamboo plantation using biotechnological technique (micropropagation) which quickly provides homogenous planting material for large scale plantation in the hill region for environment protection.
- Developed regression equation for biomass estimation without destruction

Deliverables /output after completion of the project

Year wise biomass estimation study in the Himalayan region shall be helpful in estimating the carbon sequestered by the stands of various species of bamboo. A well managed stand of *D. asper* shall be able to sequester **24 t ha^{-1} CO_2 in five years**.

- Very few studies have been performed in the hill region on bamboo. This study shall provide the opportunity of translating the knowledge to the field.
- Hill farmers and locals are developing interest and awareness on the multiple uses of bamboo and its very important role in environment correction which will result in substantial plantation in the hill region.

(v) **Title of the project:** Experimental & Simulation Studies of CO2 equestration using solar/ chemical methods

Implementing agency: National Institute of Technology, Tiruchirappali

Important achievements:

Lab details:

An exclusive lab for Bio sequestration was established. The lab consists of culture room, instrumentation room, inoculation room and analysis room. Instruments needed for analysis of microalgae were purchased, installed and being used.

Instruments purchased:

Gas chromatography, Microscope, PAR sensor, sonicator, CO_2 meter, Lux meter, Flow meters, Membrane filtration unit, Fabricated solar bio reactor, Culture racks, Laminar flow chamber, Weighing machine, autoclave, centrifuge, micropipettes, tubular reactor fabricated, open pond fabricated.

Experimental Details

Initially chlorella species was tested in open pond conditions it is observed that another species is able to grow at a faster rate than chlorella. This species is viewed in microscope and photographs sent for identification and confirmed from Kirshnamurthy Institute of Algology, Chennai that the species is ***Scenedesmus arcuatus var capitatus.*** Further studies are being carried out with this species.

S.No	Experimental Details	Justification	Variables	Results
1	20 cm dia tube is simulated for light distribution	Effect of dia on light intensity	Depth,	Light penetration is only upto 5 cm
2	4cm-9cm tubular photobioreactor were fabricated and tested	Effect of diameter on growth rate	Diameter, carbonation	4 cm gives higher growth rate even at high temperatures.Carbonated tubes give better growth than uncarbonated
3	Parallel plate fabrication with wetted surface	To reduce the pressure drop of CO_2 absorption column	Flow rate of water	Empirical relation obtained
4	Tray containing water is taken and saturated with CO_2. Different wind velocities were simulated and studied for CO_2 loss	To find the loss of CO_2 absorbed due to wind velocity	Wind velocity	Empirical relation obtained
5	Tray studies. Thin film of water is exposed to light and CO_2	To find the effect of surface area to volume ratio	Batch studies	Higher growth rate obtained compared with literature. is 1.09 g/L/day which is higher than literature (Morais & Costa, 2007) value for *S. obliquus* of 0.76 g/l/day with 12% CO_2.
6	Open pond with 0.3, 0.5 and 0.7 m with water simulated for light distribution	Effect of depth on light distribution	depth	Simulation results compared with cornet's model and are in agreement.
7	Open pond with different algal concentration. Simulated for light distribution for constant depth	Effect of light distribution on cell concentration	depth	Simulation results compared with cornet's model and experimental results. They are in agreement.
8	Incubating shaker is used to maintain different light intensity and different temperatures	Applicability of RSM technique for prediction of microalgal growth	Light intensity, temperature, carbonate concentration	Yield (mg/l) = -5.75006 +0.265188 × (T) + 0.0152625 × (L) -6.66250E-05 × (C) -0.00325500 × (T^2) -6.00000E-06 × (L^2) -2.17500E-07 × (C^2) -3.09000E-04 × (T) × (L) + 1.81000E-05 × (T) × (C) -1.30000E-07 × (L) × (C) Equation verified with experimental data. 10-15% error is resulted

Training programme: 3

Conference Details:

International conference: 3

National Conference: 7

Workshop: 7

Membership details:

International Solar Energy Society

International Society of Applied Phycology

Solar Energy Society of India

Phycological society of America

Future scope: A feasibility study is undertaken with NLC, Neyveli to test the CO_2 sequestration capability of Scenedesmus sp. Completion of this study will pave a standard method to arrive a biological solution for flue gas CO_2 emission.

(vi) **Title of the project:** CO_2 sequestration using microalgae – Efficient use of CO_2 from a bio-hydrogen production facility

Implementing agency: Shri AMM Murugappa, Chettiar Research Center, Chennai

(ii)	Brief objectives/goals	To evaluate the technical feasibility of biofixation of CO_2 from a bio-hydrogen plant using suitable microalgae and a cost effective media.
(iii)	Important highlights/ achievements of the work done during 2011-12 (i.e.01.04.2011 to 30th December, 2011)	• Optimized culture conditions and nutrient requirements for the growth of *Scenedesmus obliquus* in sugar industry effluent. • Growth evaluation of *Scenedesmus obliquus* supplemented with CO_2. • Use of *Scenedesmus obliquus* in biotreatment of sugar effluent treatment.
(iv)	No. of papers/patent filed etc.	Publications • Influence of carbon dioxide on the growth of microalga, *Spirulina sp*., (MCRC-a0003), in a tubular photo bioreactor", R. Ranjith Kumar, M. Sivakumar, and S. Seshadri. In: 7th Asia-Pacific Conference on Algal Biotechnology, Algal Biotechnology in the Asia-Pacific Region: New Challenges and Opportunities for the 21st Century, 1st – 4th December, 2009, New Delhi • Growth of Microalgae utilizing Carbon-dioxide, V. Shashirekha, M. Sivakumar, Beena B. Nair, and S. Seshadri, Internatiional Conference on Climate change and Carbon dioxide Management, Mitigation, Separation and utilization, February 2-3, 2012.Patents - Nil
(v)	New innovations towards technology development	Application of green algae, *Scenedesmus obliquus* in biotreatment of sugar effluent using CO_2. The treatment methodology involves oxidation followed by treatment using *Scenedesmus obliquus* in tank with air and CO_2 which runs on a sequential mode at pilot -scale under open conditions.
(vi)	Deliverables/output after completion of the project (very brief and specific)	Process for CO_2 sequestration using green algae, *Scenedesmus obliquus* and its growth in industrial effluent, the process that will not only use gaseous and liquid wastes from the Industry but also produced good amount of biomass for further use.

(vii) **Title of the Project**: Evolution of RuBisCO hypermorphs for enhanced CO_2 sequestration and its utilization for polymer production

Implementing agency: Bharathidasan University, Tiruchirappali

Brief objectives/goals:

1. Cloning and expression of Calvin cycle genes in *E. coli*
    - Cloning of *prkA* and *rbcL/S* genes by specific primers for these genes.
2. Random mutagenesis and genetic selection
    - Random mutation of the rbcL allele by standard PCR methods
    - Selection of double transformants carrying *prkA* and *rbcL/S* genes
    - DNA sequencing and identification of the RuBisCO hypermorphs
3. $^{14}CO_2$ incorporation assay
    - Cell extract $^{14}CO_2$ incorporation assay
    - Purification of the enzyme and $^{14}CO_2$ incorporation assay
4. Production of â-hydroxybutyric acid utilizing the fixed CO_2
    - Cloning of the best RuBisCO variants in *E. coli* XL1 blue (pSY104)
    - Large scale production of the polymer
    - Purification and characterization of the polymer by GC-MS analysis

Important highlights/achievements of the work done during 01.04.2011 to 12th December, 2011):

The Cyanobacterial strain *Synechococcus elongatus* PCC6301 is propagated in the laboratory at room temperature in MN medium under 12 hours of light and 12 hours of darkness (Fig.1). The genomic DNA was isolated from *Synechococcus elongatus* PCC6301 using the Smoker & Barnum method, 1988 (Fig. 2). The nucleotide sequence for the RuBisCO enzyme was downloaded from NCBI (Accession number: NC_006576.1). The forward primer with the restriction site of *NdeI* and the reverse primer with the restriction site of *XhoI* were designed using the software PRIMER2.

- Forward Primer (*NdeI*) : 5' - GGGCCCCATATGCCCAAGACGCAATCT – 3'
- Reverse Primer (*XhoI*) : 5' - CCCGGGCTCGAGAGGCTTTAGTAGCGG – 3'

(The restriction sites of NdeI and XhoI are highlighted)

The *rbcL/S* gene of *Synechococcus* was amplified using the above mentioned primers (Fig.3). The product of approximately 1800 bp was obtained with *NdeI* restriction site in the 5' region and the *XhoI* restriction site in the 3' region. The product was then digested with the restriction enzymes *NdeI* and *XhoI*. Simultaneous digestion of pET15b with *NdeI and XhoI* was also performed.

The digested *rbcL/S* gene and the vector pET15b were then ligated using the T_4 DNA ligase. This resulted in a construct of pET15b + *rbcL/S*. The constructs were then transformed to the $CaCl_2$ treated

competent cells of *E. coli* (BL21). The transformed colonies were then plated on to the selection medium containing the antibiotic ampicillin in the concentration of 100µg/ml. The colonies that grew were picked up and colony PCR and sequence analysis was performed to confirm the positive clones (carrying pET15b+*rbcLS*). The sequence result showed 99%

similarity to the NCBI sequence of RuBisCO (Accession number: NC_006576.1). The positive clones were then propagated and Expression of the RuBisCO protein in the positive clones of *E. coli* was induced with 0.5mM IPTG (Isopropyl â-D-1 thiogalactopyranoside) (Fig. 5). There was good expression of the enzyme RuBisCO in *E. coli* when induced with 0.5mM IPTG. The purification of the Protein is under process.

No. of papers/patent filed:

Nil

New innovations towards technology development:

The gene *rbcL/S* coding for the enzyme RuBisCO in *Synechococcus elongatus* is cloned into the expression vector pET15b and the gene is over-expressed (Fig. 5).

Deliverables/output after completion of the project

The proposed work aims at efficiently reducing the level of atmospheric CO_2 to prevent the deleterious effect of CO_2 in the atmosphere. The work also aims at producing biopolymers as an alternative to the non-degradable plastics. Thus it is a two way approach to provide an eco-friendly atmosphere.

TECHNOLOGY DEVELOPMENT BOARD

The Government of India constituted the Technology Development Board (TDB) in September 1996, under the provisions of the Technology Development Board Act, 1995. The mandate of the TDB is to provide financial assistance to the industrial concerns and other agencies attempting development and commercial application of indigenous technology or adapting imported technology for wider domestic application.

The financial assistance from TDB is available in the form of loan or equity; in exceptional cases, it may be grant. The loan assistance is provided up to 50 percent of the approved project cost and carries 5 percent simple rate of interest per annum. In the alternative, TDB may also subscribe by way of equity capital in a company, subject to maximum up to 25 percent of the approved project cost. The financial assistance is provided during the commencement, start-up or growth stages of an industrial concern. The website of TDB is www.tdb.gov.in.

In addition to the direct support to industries for commercialization of indigenous technologies, TDB continued to network with technology focused Venture Capital Fund (VCF) to support technologically innovative viable ventures with the objective to spread itself by providing support to early stage ventures for SMEs having innovation and innovative products/services.

TDB also took growth-oriented initiative and provided financial assistance to Technology Business Incubators (TBIs) and Science & Technology Entrepreneurs Parks (STEPs) under Seed Support System for Start-ups in Incubators to incubate technological ideas. The assistance is positioned to create techno-entrepreneurs apart from acting as a bridge between development and commercialization of the technologies.

The scheme has progressed well and is being continued. TDB has extended the scheme and supported 9 more incubators during 2011-12 (upto December, 2011) with grant assistance of Rs. 900 lakhs (Rs. 100 lakhs each). This scheme has benefited entrepreneurs from STEPs and Incubators in various fields.

Major Achievements

In the recent past TDB has provided financial support to commercialise following innovative technologies:-

High Security and surveillance based product

M/s Kritikal Securescan (P) Limited (KSS) has been provided financial assistance from TDB for setting up a facility for high security and Surveillance based product in Critical areas like air Port, VIP Zone, offices & Hotels through computer vision & image processing. KSS has developed two products Zen Scan: Advanced under vehicle scanning system and VehiScan : Automated number plate reading system.

Fig. 4.26

Remote Medical Diagnostics

M/s Neurosynaptic Communications Pvt. Limited has been provided financial assistance by TDB to set up facility to develop medical equipment that can record physical and clinical (medical) parameters i.e. ECG, Temperature, Oxygen, Saturation, and Blood Pressure, as well as real-time transmission of chest sound of the patient, captured using the Electronic Stethoscope and enable a doctor to offer the basic diagnosis remotely.

Fig. 4.27

Small Unmanned Ariel Vehicles (UAVs)

M/s Aurora Integrated Systems Private Limited, Bangalore has been provided loan assistance by TDB for development and commercialization of small Unmanned Ariel Vehicles (UAVs) for military surveillance (Sky-I Mk-I) and homeland security (Urban Surveillance System - Urban View and Airship)'. The company is promoted by group of technocrats from IIT, Kanpur.

Fig. 4.28

New Generation Automatic Cone Winding Machine (ACW)

M/s Veejay Lakshmi Engineering Works Limited, Coimbatore has been provided loan assistance by TDB for development and commercialization of New Generation Automatic Cone Winding Machine (ACW). The Automatic Cone Winder is used in Textile Spinning MNills for post spinning operation for winding yarn form bobbins to cone and the yarn faults are also identified and eliminated by both Electronic Yarn Clearer and Splicer. All the new Electronic yarn Clearers can be integrated with the new machine.

Fig. 4.29

Pro-active Role

Seed Support for STEP/TBIs

In 2005, Technology Development Board (TDB) took a growth-oriented proactive initiative by starting the Seed Support System for providing financial assistance for Start-ups in Incubators. The basic idea of the proposed financial assistance is to equip the STEP/ TBI with the much needed early stage financial assistance to be provided to deserving ideas/ technologies.

TDB decided to provide financial support to Technology Business Incubators (TBIs) and Science & Technology Entrepreneurs Parks (STEPs) to extend much needed early stage /start-up capital to young entrepreneurs to incubate and in bring out innovative technology venture ideas under development to fruition and finally to reach the market place. This would enable some of these innovative ideas/ technologies to graduate to a level where they can then be fit for seeking normal lending through TDB/ FI's route in their way to the successful commercialization process. Thus the proposed assistance is positioned to act as a bridge between development & commercialization of the technologies.

TDB provided financial assistance to the following 9 Technology Business Incubators (TBI's) and Science & Technology Entrepreneurs Parks (STEP's) under Seed Support System for Start-up in Incubators to incubate technological ideas during 2011-12.

S. No.	STEP/ TBIs
1.	TREC-STEP, Tiruchirappalli
2.	BITS, Pilani, Rajasthan
3.	eHealth, TBI, Bangalore
4.	EKTA Incubation Centre, Kolkata
5.	Science and Technology Park, University of Pune, Pune
6.	KIIT-TBI, Bhuwaneshwar
7.	Centre for Innovation Incubation and Entrepreneurship (CIIE), Ahmedabad
8.	MITCON Consultancy and Engineering Service Ltd., Pune
9.	Indian Angel Network (IAN), IAN Monitoring and Incubation Services, New Delhi

Technology Day Function and Presentation of Awards

The Technology Day Function 2010 celebrated on 11th May 2011 and former President of India Dr. A.P.J. Abdul Kalam was the Chief Guest. The first session of the function was devoted to the theme of "Changing India" as three prominent individuals who performed exceptionally well in the field of innovation, leadership and entrepreneurship addressed the gathering. Padam Sh. Prof. Ashok Jhunjhunwala of IIT Madras delivered a talk on Innovation, Ms. Chhavi Rajawat, an elected woman Sarpanch delivered the talk on leadership and Sh. Suhas Gopinath, Youngest CEO in the world delivered his talk on entrepreneurship.

In the second session, the Chief Guest in presence of Sh. Pawan Kumar Bansal , Minister of State, Science and Technology and Earth Sciences presented the National award for successfully commercialization of indigenous technology to the following winners on this occasion.

National Award 2011 of ' 10 lakhs for the successful commercialization of indigenous technology by an industrial concern was awarded to:

Reliance Industries Limited, Hazira Manufacturing Unit Surat, Gujrat

For the indigenous development & commercialization of Advance Donor RELD 1000 Technology for High Performance Raffia Grade Polypropylene product to be given to

Reliance Industries Limited, Hazira Manufacturing Unit, Surat, Gujrat.

Fig. 4.30: Dr. A.P.J. Abdul Kalam presenting the trophy for the National Award 2011 to M/S Hazira Manufacturing Unit Surat, Gujrat On 11th May 2011.

Award to SSI Unit 2011 of ' 5 lakhs for the successful commercialization of a technology based product was given to the following units:

Top Gear Transmission, Addl. MIDC Satara , Maharashtra

For developing and commercializing Top Gear Transmission Gear Boxes, Planetary Gear Boxes and a number of custom Built Gear Boxes with optimum design features using latest technology for improving the geometrical accuracy of the Gear Teeth Profile.

Fig. 4.31: Dr. A.P.J. Abdul Kalam presenting the trophy for the SSI unit 2011 to M/s Top Gear Transmissions, Addl. MIDC Satara, Maharashtra on 11th May 2011.

NUMAC, MIDC, HINGNA NAGPUR, MAHARASHTRA

For developing and commercializing Rotary Vane Assembly and Body Liners for XRP type Coal Mill to prevent frequent damages of the Assembly and to avoid outages and downtime of mills, thereby saving huge amount of power.

Fig. 4.32: Dr. A.P.J. Abdul Kalam presenting the trophy for the SSI unit 2011 to M/s NUMAC, MIDC, HINGNA, Maharashtra on 11th May 2011.

WATER TECHNOLOGY INITIATIVE

The objective of the scheme, initiated in August 2007 is to promote R&D activities aimed at 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. The programme activities thus include development of database to recognize and rank water purification technologies for decentralized applications; capacity building of indigenous R&D institutions and academics; development, field assessment & pilot testing of technology options for drinking water purification.

During the course of implementation of the programme, the activities of the programme have been broadened to conduct R&D activities and developing capacity for addressing issues related to water availability, water purification and water reuse and recycling.

Achievement of XI Plan

Around 330 proposals have been mobilized so far since the inception of the programme and 145 projects has been supported so far. The programme has outreach to all the state except Jammu and Kashmir The activities supported under the programme include Research and Development, Demonstration Upscaling & Replication, Scouting of Technologies, Evaluation of Technologies and Capacity Building

The specific achievements of the programme during XI Plan relate to technology options for stand alone drinking water purification systems for rural schools, field assessment of technological solutions for arsenic, fluoride, iron and desalination of brackish water as well as sea water, scientific evaluation of various indigenously developed water purification technologies in academic institutions, laboratories etc.

Some of the notable achievements as well as initiatives to address these issues are elaborated below:

I. Water Purification

1. Development of low cost household filter for arsenic and other pollutant-free drinking water using modified laterite

Natural Laterite with degree of lateritazation about 0.42 is found to be a good arsenic adsorber with adsorption capacity 0.54 and 0.26 mg/g for As (V) and As(III), respectively. An optimized acid-alkali treatment has been established that increases the arsenic adsorption capacity of laterite remarkably with adsorption capacity 24 and 8 mg/g for As (V) and As(III), respectively. 4.5 liter (5 kg) treated laterite can produce 12,500 liter (2500 bed volume) water with Arsenic less than 10 ppb. Filter of this design is installed in village Bamangachi, Barasat. Estimated cost of each filter is about Rs. 1000 and life is 434 days with 1.2 L/day flow rate.

2. Purification of Drinking Water by Combined Treatment with Natural Coagulants and Solar Disinfection

Using natural materials to clarify turbid water is a technique that has been practiced for centuries and the seed materials used have been found to be effective. From the present research 10 litre turbid water treatment unit for surface water having various turbidity has been designed. All the seven agro based seeds :Molinga oliefera (Drumstick), Strychnos potatorum (Nirmali), Zeemays (Maize), Coccinia Grandis (Dondakaya), Abelmoschus esculentus (Lady finger), Pisum sativum (Peas), Phaseolus vulgaris (Beans) are non-toxic and effective coagulant aids useful for removing turbidity and bacteria from water. The cost of solar disinfection is negligible as it is a natural source. The cost of seed treatment is very low, in some cases negligible.It is cheap and easy methods at house hold as well at community level for developing countries. The low volume of sludge precipitated was found biodegradable and hence environmentally not harmful.

3. Microbiological and chemical characterization of water before and after treatment with rice husk ash (RHA) filters of different quality

Rice husk ash obtained from rice husk stove can be used for treatment of water. It has been reported that absorption efficiency of RHA is 60%, 30% and 78% for iron, fluoride and microbial contaminant, respectively.

4. Phytoremediation based removal of heavy metal appropriate to Rural areas

Phytoremediation is an emerging, plant based technology for the removal of toxic contaminants from water and soil. The groundwater of the two districts in Kerala (Palakkad and Alleppy) shows high fluoride content. It has been reported that plants like Ramacham, Tamarind seed and clove were more efficient in the removal of fluoride. Phyto-remediation experiments were carried out using plant species such as *Amaranthus spinosus, Solanum torvum, Ludwigia peruviana, Pteris and Lactuca sativa* to test the efficiency of these plants in removing heavy metals from contaminated soils. The study confirmed the phyto-remediation efficiency of *Amaranthus spinosus* and *Ludwegia Peruviana* towards Lead Compared to *Amaranthus spinosus*, *Ludwegia peruviana* showed higher uptake of lead within a short period of time. The experiments indicated that *Ludwegia peruviana* and *Amaranthus spinosus* can be used for the cleaning up of hazardous metals from polluted soils.

5. Removal of Iron using manganese dioxide coated sand

Experiments using ungraded sand coated with manganese dioxide were carried out to study the efficiency of iron removal. For a simple and cost effective method to be adopted for domestic use, removal of iron using MnO_2 coated sand was found to be very effective. The filter unit can be set up easily and a suitable flow control system can be used for better design. This requires less maintenance except the regeneration of media with $KMnO_4$, which is easily available. Sand filter has shown better results for the removal of iron.

6. Development of Non- Chlorinated products to purify domestic water

A non-chlorinated product in the form of Magnesium Peroxide in composition with immobilized copper and silver nano particles has been developed for the purification of drinking water. The

developed product has been tested to inactivate pathogenic micro-organism like coliform, salmonella and shigella and for the removal of iron and arsenic from drinking water.

7. Low cost water purification systems

Household filter and community filter for iron removal (IRP) based on river sand as filter media were developed for rural applications. 108 House hold filters and 36 community Iron removal plant have been installed in 3 Gram Panchayats of Kumarapuram, Thakazhy and Puunnapura. Local women were trained in water sample collection, water quality testing using field test kit and monitoring of the filter performance and community acceptances. One woman each from 24 households, where the filters were installed for study, were given training in filter operation, maintenance and washing of filter materials.

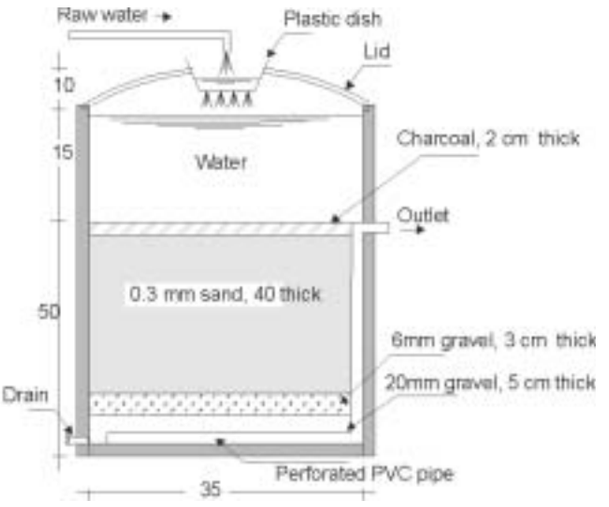


Fig. 4.33: ***Household level Filter***

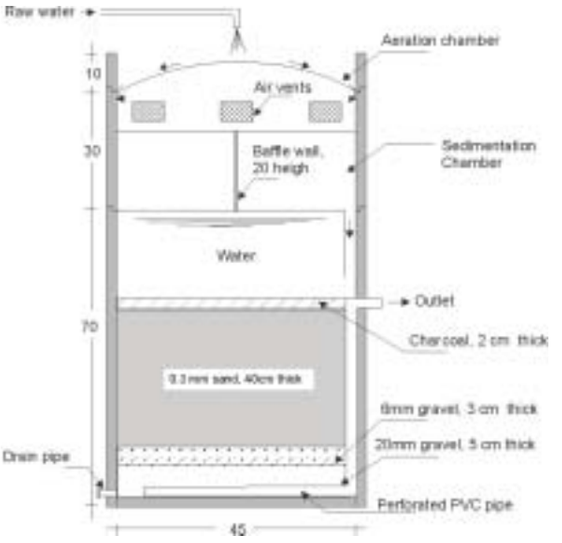


Fig. 4.34: ***Iron removal plant (IRP)***

II. Water Availability

Scientific studies have been supported for optimum utilization of traditional structures for rainwater harvesting and rejuvenation of tanks for water conservation. The project besides making sustainable intervention following scientific practices would also scientifically document impact of intervention and extent to which the intervention could augment the water need.

i) **Use of Temple tanks for Artificial recharge-** A case study of Arulmegu Marundeeswarar Temple tank in Thriruvanmiyur, Chennai has concluded that huge potential for recharge exist by diverting additional storm runoff. The study has suggested that borewells may be drilled penetrating the clay layer and bores may be used to recharge. However, the risks associated with such system need to be taken care. Also enhancing the catchments areas on recharge was an important factor.

ii) **Amrit Jalam Pariyojna- Addressing water scarcity challenge in Chirawa**- Technical solutions have been implemented in four Villages of Kishorepura, Kyamsar, Solana and Mehrampur in chirawa block. Progress is underway for other 8 villages of Chirawa block in Rajasthan covering 20,000 people to address the problem of scarcity of potable water through innovative water conservation techniques.

III. Water Quality Monitoring

Department has supported few research projects for assessing water quality for intended use.

i) A prototype Wireless Sensor Network based water quality monitoring system based on the Dissolved Oxygen (DO), pH value and TDS has been achieved in lab scale. The system can continuously collect the data through sensors deployed at water body and send it to the central server through wireless communication in an intelligent and energy saving mode. The central server will monitor the data for unusual events and raise alerts in terms of SMS to the concerned user.

ii) Assessment of groundwater quality along the Nandesari effluent channel area of central Gujarat. The base line data generated from the study would be useful to Gujarat Water Supply & Sewerage Board (GWSSB), Water and Sanitation Management Organization, (WASMO), Govt. of Gujarat Association of Chemical Industries and other related organizations and industries in the Nandesari area as well as the effluent channel area to take future preventive and remedial measures in protecting the ground water quality.

iii) Prototype development of Wireless Sensor Network based Adaptive Water Quality Monitoring System. The interface modules for Wireless Sensor for measuring fluctuation of pH, Dissolve Oxygen (DO), Total Dissolve Solids (TDS) and Fluoride have been setup. The system was working well within 30 m. The networked system is being further tested.

iv) Development of multi pass liquid cell for the study of water contamination: The project aims at development of detection technique for ultra low and low concentration of contaminants. Design and fabrication of special types of quartz cuvettes of different dimensions with anti reflection coating have been completed. Fringes showing Empty Multi-Pass Liquid Cell (MLC) and MLC filled with higher concentration of Arsenic were also recorded.

IV. Initiatives during the Year.

i) Increasing Water Availability

- Project initiated for Gingee Town, Tamil Nadu. TWAD Board and other local agencies are being associated in the project.
- Social Enterprise Model of RWH and Agriculture of low water demanding economically important plant has been initiated with academia-panchayat –private partnership to fine tune the models of sustainability of rain water harvesting structures in arid zone
- Rainwater harvesting resource centre being developed, at Allahabad for wider dissemination of methods and technologies to conserve Rain Water. The local populace would be trained for the innovative and scientific ways to harvest and conserve rain water. Inter institutional linkages is being promoted to deploy field solutions.

ii) Water Quality Monitoring and Management

- Sustainable water quality management for Greater Visakhapatnam Municipal Corporation (GVMC) area, Andhra Pradesh has been initiated taking into account current water supply system, catchments area industrial waste discharge points, existing industries and their discharge. Greater Visakhapatnam Municipal Corporation has been enrolled in the project.
- Development of low cost electrochemical nanobiosensor for detection of Enterobacteriaceae in drinking water

iii) Water Purification

- Development of ion-exchange membranes and mixed bed resign based electro-deionization process for fluoride removal from ground water
- Development of ceramic membrane based contactor for enhanced arsenic and iron oxidation for potential application in arsenic and iron removal plants
- Community pond based safe drinking water system in Manipur
- Formulation and validation of arsenic removal studies from contaminated drinking water
- Bacteria Free Water for Drinking by Silver Treatment (BFWDST)

iv) Waste Water Recycling and Reuse

- Development of plant prototype for removal of ammonia, arsenic and odorous compounds from water/wastewater by ozone micro bubbles
- Development of Grey-Water Treatment Unit for Residential/ Commercial-Low grade Water needs

Recognizing the fact that there remains an untapped opportunity for India to develop affordable innovations for applications in both emerging and developing economies with income disparities, 12th Plan Vision intends to tap India-specific opportunity which relates to Solutions for '*water on the go*' so that consumers can use portable devices that can upgrade poor quality water to potable water and other similar

innovative options. Further, Development of Technology Platforms in a consortium mode by private-public partnerships (PPP) consisting of innovative business models through which several institutions possessing the know-how and the knowledge will be able to collaborate with small and medium enterprises as well as major companies for designing solutions to the challenges in the water sector. Two such identified Technology Platforms are:

i) Test beds to take forward indigenous membrane technologies and build up capability in *"Membrane as technology platform"*

ii) Nanotechnology based sensors including biosensors for real time field analysis of water contaminants such as microbes, fluoride, arsenic, chromium, heavy metal ions, etc.

WINNING, AUGMENTATION AND RENOVATION (WAR) FOR WATER

Access to Water has emerged a major challenge to many people in the country. The Supreme Court of India passed an order in March 2009 that the water problem in the country must be solved using best of recourse to technology. The Secretary Science and Technology has been assigned the task of addressing water challenges using the best of technologies in the world. Technology Mission: Winning, Augmentation and Renovation (WAR) for Water has been launched with a budget of Rs. 145 crore.

On the directions of Hon'ble Apex Court, A Technical Expert Committee (TEC), with Secretary, DST as Chairman, has been formed. TEC has listed total of 26 types of water challenges in the country and also submitted an action Plan for addressing the problem to Hon'ble Supreme Court.

On the invitation of DST, all the States and Union Territories identified dominant water challenges and 5 locations (a village or group of contiguous villages having 10,000 population) facing such problems. Based on the feedback obtained, 89 clusters have been selected for technological interventions to address these water challenges.

Expression of Interest was sought from solution providers and those eligible were invited to submit detailed technical and financial proposals contracts have been issued to such solution providers offering technological solutions. On evaluation of these proposals, by a panel of experts, 13 projects, spread over Andhra Pradesh, Gujarat, Kerala, Rajasthan, Tamil Nadu and Tripura were sanctioned implementation by Enterprises and NGOs.

3 water plants, one each at Mansapuram (Tamilnadu), Thiruppattur (Tamilnadu), and Buja Buja (Andhra Pradesh), addressing 10 water challenges, have been established, meeting the drinking water needs of 80,000 people and their livestock. The waste water generated within these villages is treated and the same is being used for irrigating the lands within these villages. 10 more projects, addressing 7 more water challenges, are being implemented to meet the drinking water needs of nearly 1,25,000 people and livestock, covering in 21 villages across Gujarat, Kerala, Rajasthan and Tripura.

During the year, the spillover activity for setting up of water treatment plants at the recommended clusters, involving academic/research institute, NGO and industry as consortia approach, has been initiated. On the request of DST, the Union Ministry of Earth Sciences agreed to address the water challenge related to quality deficit of available water specified uses faced in Island territories, viz, Car Nicrobar in Andaman and Nicobar, with the use of Low Temperature Thermal Desalination technology.

The mission is expected to prove technical, social and financial viabilities of some integrated and total

solutions for different water challenges in the country. Appropriate research packages are expected to be delivered to line ministries dealing with water for multiplication and penetration.

Research proposals on Sea Water Intrusion, particularly in the West coast of India will be solicited from the Universities and other institutes. Research Packages on Development of Transparent Criteria, Least cost and best Revenue model of Technology solution, sizing of economy of scale and scoping for least cost solutions, Site neutrality of selected solutions, Hybrid options of technology solutions will be prepared. Under seawater farming and seawater intrusion, 15 research proposals to study various aspects of seawater ingress and augmentation of seawater as resource for productive purpose by cultivating salt resistant crops is being studied by different institutions/organizations.

Fig. 4.35: ***Water Purification Unit at Mamsapuram (Tamilnadu):***

Fig. 4.36: ***Water Pre-treatment Unit at Mamsapuram (Tamilnadu)***

Fig. 4.37: ***Water Purification Unit at Thiruppattur (Tamilnadu***

SOLAR ENERGY RESEARCH INITIATIVE (SERI)

Initiated in 2008-09, Solar Energy Research Initiative (SERI) is aimed at improving efficiency of devices, systems and sub-systems, to promote innovative R&D based demonstration projects for 24x7 off grid power supply. In addition to demonstration of hybrid solar power systems integrated on various R&D pathways and multiple technology alternatives for distributed energy use to validate their viability to meet rural energy needs and associated societal development, development of innovative materials, devices, coatings, etc., for solar based system are pursued. The programme targets to promote indigenous research capacity to drive the costs of delivered solar energy by 25% from the current levels through technology innovations and create at least 100 PhDs and MTechs in solar energy research area within the next five years.

DST in recent times has made foray in the area of solar energy through various parallel independent initiatives. DST's initiative on Solar Energy is positioned upstream with thrust on enabling knowledge based R&D activities for entire gamut of solar technologies including balance of systems. Solar energy utilization for applications both for power as well as other than power generation with a view to provide convergent technology solutions under real-life conditions are being explored and assessed. During the 11th Plan, DST has already embarked on a solar energy initiative aimed at achieving practical solar energy devices and systems that are scalable. Some of the illustrative achievements of current year are given below:

1) S&T Inputs for Policy Formulation

The first of its kind demonstration plant of the country under the Public-Private-Community Partnership (PPCP) mode and operating 24x7, has been commissioned in December, 2011. The plant has totally indigenous design for rural decentralized power using solar energy and biomass, reducing cost of solar-biomass hybrid option and work out viability gap. Under this project, done in association with M/s. Thermax Ltd, a 256 kW Plant at Village Shive in Khed Taluka of Pune district, has been set up. Thermax has been collaborating with national technology and scientific institutions like IIT Bombay,

IIT Madras, CGCRI Calcutta, University of Pune, ARCI Hyderabad etc to adopt cutting edge technology.

Fig. 4.38:Parabolic Trough erection & alignment completed at village Shive, Pune

Efforts have also been focused in performance testing and ORC integration. Three generation of parabolic troughs has been developed with each parabolic trough being the improvised version of the earlier generation with improved coatings. The plant could be utilized as the live laboratory for research work as performance of this modular plant can be analyzed for different configurations. It is also expected that the cost of parabolic trough could be 1/3rd of the imported system when taken up for large scale manufacturing. Besides contributing to the development of indigenous technologies which would bring cost effectiveness, the performance data generated from this plant would enable scientific assessment of viability gap for setting up such plants in yet to be electrified villages as well as villages facing electricity shortage.

2) Precompetitive Research & Technology Upgradation

The PAN IIT initiative aims at developing pre-competitive research capacity and further improving current status of technology in Solar Power generation at the MW level grid synchronized technologies and focuses on cost reduction through technology paradigm. In this endeavour, PAN IIT partners intend to capacity building through development of knowledge network of elite institutions by focusing on technology innovations to drive the costs of delivered power from solar energy plants for supplementing the efforts of National Solar Energy Mission in driving the costs down through scaling up. So far, few projects have been supported with limited funding focused on lab scale development for smart grid. These are :

- ❖ Re-synchronizable Autonomous Grid: Active Power Filters
- ❖ R-synchronizable autonomous grid: DC-DC conversion for Solar PV including MPPT and battery charge controller

3) Basic Research led Disruptive Technologies

As stated earlier, as part of pro-active effort of DST to promote indigenous capacity in Solar Energy Research, DST has shaped a PAN-IIT Initiative. A knowledge network of about 40 faculties from 6

IITs have emerged. This initiative of DST aims to promote basic research led disruptive technology options through ideas generated by PAN IIT Group initially and to expand to other institutions subsequently. DST has adopted request for proposals models for promoting cutting edge science in Solar Energy research in the country. It is now proposed to expand this initiative for other public funded R&D institutions to promote innovations which could leapfrog current state-of-art. During the year 9 projects have been approved for establishing '*proof of concept*'.

4) Enabling R&D for Solar Technologies

It has emerged that supporting enabling R&D is essential for advancement of Solar Technologies in the country. This initiative takes thematic area based research in the area of solar energy and quantifiable targets are set as yardstick. The areas for the themes identified are energy storage, battery technology, micro grid, newer materials and availability of low cost silicon etc. Accordingly, promotion of enabling R&D for solar energy by various academics/ institution with focus on advancement of technologies, devices and technological capabilities is being pursued. Some of the important initiatives in this direction are given below:

❖ **Solar Energy Hub at Bengal Engineering & Science University, Kolkata**

The consortium of institutions has been formed up to set up a Solar Energy Hub at Bengal Engineering & Science University, Kolkata for development of next generation Solar Cell Technologies like Plasmonics and nano-structured solar cells. The Hub is in advanced Stages of establishment and the experimental work in these facilities is expected to be started during the current year.

❖ **Development of large areas coating systems**

The need for development of cost effective reactors and components to bring down the cost of coatings in PV fabrication is felt. The organizations that have generated significant in-house capability in developing crystalline and amorphous silicon photovoltaic technology on a pre-commercial scale needs to be mapped and supported in the efforts to bring down the cost of indigenous modules. A project "**Development of textured ZnO thin films for solar cells front contact applications using sputtering technique and the demonstration of its performance in silicon thin film solar cells**' has been initiated to develop improved transparent conducting oxide coating on large areas through further R&D and testing.

5) International Cooperation

DST has also leveraged International Cooperation for furthering Solar Energy Research. A Joint Initiative has been taken up in partnership with UK for collaborative R&D for technology trade and industrial partnership. The initiative is based on Intellectual Property Right (IPR) sharing on reciprocity and parity principle. Initiative in partnership with EU on the other hand aims at enabling Indian science systems achieves global benchmarks.

6) Solar Technologies for Non-Power Applications

DST has supported a project to develop and demonstrate a solar thermal desalination plant which harnesses solar energy, concentrates it and produces steam which in turn is used for desalination of sea water. This Multi Effect Distillation (MED) with Thermo Vapour Compressor (TVC) desalination

system consists of a Linear Fresnel Reflector (LFR). KG Design Services (KGDS), Coimbatore and National Institute of Ocean Technology (NIOT) is implementing the project. This plant will produce desalinated water at the rate of 6000 liters/ hr.

Fig. 4.39:Newly designed and developed MED

Fig. 4.40:Existing solar collector system in coimbatore

In the trial run, the plant has been successful in bringing down salinity from 26000 ppm to 2 ppm. Land has been identified in Kuthiraimozhi village near Narippaiyur, Ramanathapuram. After successful trial run at Coimbatore, the MED plant will be setup at the identified site.

Projects supported during the current year with industrial collaborators

- Development of large area, high efficiency (19%) Passivated Interface Heterojunction (PIHJ) solar cells
- Development of amorphous silicon crystalline silicon Heterojunction solar cells with efficiency 17-20%
- Development of nano material and optically enabled, front surface and back contact tailored, enhanced efficiency amorphous silicon solar cells
- Improved efficiency c-Si cells-Fabrication and characterization wit industry Collaboration

Project supported to research labs and academic organization

- Inkjet printing of inorganic thin films for Solar Photovoltaics
- Solar Energy based multifunctional device with integrated holographic, photovoltaic and photo-electro-chemical components to produce electricity and clean environment
- Development of Thermal Energy Storage System for Solar Thermal Power Plant
- High throughput a-Si:H/nc-Si:H based Tandem solar cells on low cost flexible substrates
- Si/Ge Nanostructure Sensitized & Hybrid Solar Cells
- Analysis of Hybrid storage based solar PV systems
- Photo electrochemical water splitting using photo electrodes having non-native nanostructures and selective surface terminations

- Solar Cooling and production of potable water with two stage silica gel-water adsorption system
- Development of CdS/CdTe thin film solar cells by electrochemical technique using indigenously produced starting materials
- Iron Disilicide Heterojunction Solar Cells

During the 12th Plan, it is envisaged to focus on Development of convergent technology solutions as well as to build institutional research capacity. The convergent technological solutions will be sought primarily in the area of off-grid solar energy solutions, solar cooling and desalination of sea water. Promotion of public-private-partnership for developing solar energy based solutions will be vigorously perused.

The plan for the next five years would be to focus and intensify technology development efforts in certain priority areas of national importance. These will include:

i) Cost-effective distributed solar phototovoltaic technologies for homes, schools, community facilities and micro-enterprises in the context of the National Solar Mission

i) Cost effective Solar Thermal Power technologies and systems for rural and urban applications in tune with the objectives of the National Solar Mission

COGNITIVE SCIENCE RESEARCH INITIATIVE

Under Cognitive Science Research Initiative, Department provides support for basic science, infrastructure development and human resource development. Department has supported 33 individual projects from various fields such as Psychology, Linguistics, Social Engineering, Education, Neurology, Bio Engineering, Biotech, Computer Technology and Artificial Intelligence worth **8 Crore**. Department has also received 146 individual research proposals. In order to encourage young researchers to pursue research and make career in this emerging field Department supports "Post Doctoral Fellowship" in Cognitive Sciences. In 2011 Department supported 13 fellowships under this scheme. In addition to this, Department also supported an International conference focused on Cognitive Science related streams of sciences entitled "Looking with interdisciplinary approaches to consciousness" organized by National Institute of Advanced Studies.

In one of the project under CSI entitled "Screening for Dyslexia Phenotypes and their Molecular Genetic Analysis" the new application potential came up which would help to understand the manifestation of dyslexia across orthographies (Kannada and English). These finding will help to understand the mode of inheritance of risk in the family and will also help in understanding the association of gross chromosomal anomalies. The study is useful to understand the correlation between significantly associated Single-Nucleotide Polymorphisms (SNPs) with particular sub-phenotype of dyslexia. In another project entitled "Cognitive activation studies of Language and memory as a preoperative evaluation in Patients with intractable" - the study helped in understanding the mechanism and plasticity of language and memory adjustment and transfer in persons undergoing temporal lobectomy for drug refractory epilepsy. Functional MRI language and memory study in preoperative intractable epilepsy can be successful in surgery planning. It is able to determine the functionality of the neuronal areas adjacent to the area of surgery, and hence helps in preserving functional area for memory processing, activations were found in medial temporal lobe and proved that fMRI could definitions of eloquent areas with the objective of minimizing the adverse cognitive sequelae. New Innovation in another project "Social Cognition and Semantic memory in the context of Indian normal and neurologically diseased patients" was a semantic memory test and social cognition test are being

developed for literate and illiterate Telugu/Hindi speaking subjects in the Indian context. Application Potential of this lies in exploring biological basis of semantic memory and social cognition and studying impact of education and culture on their organization. It will also lead to development of tests of Semantic memory and social cognition in Indian normal literate and illiterate healthy controls. New Innovation in the project "Language, Emotion and Culture" devised a method of making short 30-second coded "snips" from a much larger and richer video database that is amenable to statistical analysis (ANOVA). Developed a system tested for reliability, norms to code touch and emotion in early mother child interaction. Another innovation in which a robust system to linguistically distinguish, with special reference to the grammatical features and quantum of emotion words and intensifiers between patient non-epileptic seizures and epileptic seizures was developed. Thus, research in cognitive science areas has enormous importance.

INNOVATION CLUSTERS

Initiatives under Innovation Clusters are ongoing in six clusters; three of them are foundry clusters of Faridabad, Samalakha & Kaithal; two are Pharmaceutical Clusters of Ahmedabad and Hyderabad and one is Information & Communication technology (ICT) industry cluster at Delhi-NCR. The highlights of the initiatives in the three sectors are given below.

The foundry clusters' initiatives have infused improved technology, fresh knowledge inflows and better operational practices to at least 100 cupola based foundries out of the universe of about 200 foundry units in the three clusters. Cluster based associations have been revived and strengthened to sustain initiatives in the areas of technology up-gradation (conversion of single blast cupolas to divided blast cupolas, better operating practices); new product development (newly designed chaff cutter based on market inputs, product improvements etc); waste recycling (brick making from cupola waste); market development initiatives (engaging market development service providers in select Gujarat market); leveraging development initiatives (Design Clinic scheme by DC-MSME, GIZ project on CSR in foundry units etc.). It is noteworthy that energy efficiency by better practices and better technology has led to savings of 4300 Tons of coal per annum in these bottom of the pyramid units while the total savings to the enterprises are estimated to be Rs. Five crores per annum. Moreover, the project activities are proposed to be upscaled by Foundation for MSME Clusters (FMC) to another 500 enterprises across 4 clusters by leveraging upon 1.6 million Euro (Rs. 10 Crores) of funding from European Commission in collaboration with two international agencies (GIZ, GRI), a UN body (UNIDO), Indian Institute of Corporate Affairs and a development bank SIDBI during the years 2012-15.

Cluster approach based Innovation promotion initiatives at Pharmaceutical cluster of Ahmedabad have resulted in institutionalization of a one year, partially self funded Techno-Bio-preneur program for mentoring aspiring life science technology based entrepreneurs. This is first such programme in the country among Entrepreneurship Development Institute of India, Gujarat State Bio Technology Mission and Foundation for MSME Clusters. The project has also strengthened a physical facility for preservation of new chemical molecules at Rajkot university. It has been connected to 10 universities and has collected 2500 indigenously made molecules of which 1500 have been screened and a select few already sold commercially leading it to sustainability. Two innovators have got partial funding support and have been connected to other resource agencies. Besides, to promote and celebrate creativity & entrepreneurship in the cluster, innovation recognition awards like best M. Pharma Thesis Award (pan India) and Sushruta Innovation Award for medical devices have been conducted and institutionalized locally. Besides more than 100 proven ready to commercialize technologies from private and public technology sources have been identified and disseminated among innovation led entrepreneurship through road shows among various

Pharma clusters. Training programs on Intellectual properties, new drug delivery systems (NDDS) etc. have been undertaken for awareness creation. These initiatives have also led to formation of interconnections among relevant stakeholders.

In Hyderabad Pharma cluster a unique business plan competition on ready to market technologies, branded 'Metamorphosis', has been institutionalized involving IKP Knowledge Park and Indian School of Business (ISB). Metamorphosis is now in its second year and this year its scope has been widened to involve Information and Communication Technologies in Life science segment apart from Life science technologies. Innovation awards for MSMEs with local industry association will be organized during the year. Local institutions have been assisted in executing MoUs for technology transfers with institutions like IPRD, LTN- South Africa, Evolution Bioscience-UK, Steinbeis Technology Transfer India, Russian Union of Innovation & Technology Centre- Moscow (RUITC), Yet2.com etc. Apart from above, two academic institutions have been strengthened for a strong interface with local industries that has resulted in at least 7 faculty members and 50 students to work directly on the industry related projects.

Information and Communication Technology (ICT) cluster initiatives at Delhi-NCR has been able to induce a regional (or cluster) level innovation network led by entrepreneurs. Network of ICT Entrepreneurs and Enterprises (NITEE) with its 100 paid members is probably the country's first regional level membership based business organization in ICT domain. A cluster portal www.nitee.org to showcase and share information among cluster stakeholders, facilitate on line and offline communications, experience and leads sharings among entrepreneurs and relevant stakeholders on various verticals & domains has been developed by the budding entrepreneurs and is functional now. On knowledge dissemination, NITEE has organized more than 55 learning workshops, NCR-IT Innovation Expo (1st such buyer-seller meet in North India), several regularly held one to one handholding & mentoring sessions between experts and entrepreneurs, first general body meeting, collective participation by 12 entrepreneurs in India International Trade Fair' 12 at Pragati Maidan illustratively since April 2011 have added to the vibrancy of Delhi-NCR based ICT cluster. NITEE has emerged as a regional level innovation network on bottom up approach under the PIC program and as a membership based organization represents interest of more than 4000 ICT MSMEs in the cluster. As a result of the above mentioned initiatives, more than 100 ventures have significantly benefitted in their scaling up endeavours.

TECHNOLOGY SYSTEMS DEVELOPMENT (TSD) PROGRAMME

Technology Systems Development (TSD) Programme supports activities aimed at developing and integrating technologies to evolve technology systems both in the advanced/emerging areas and in traditional sectors/areas. Under the Programme, feasibility of fresh ideas/ concepts is assessed for their potential conversion into useful technology/product. Applications of R&D for socio-economic benefits are consciously promoted under this programme. The focus is on inter-disciplinary, multi-institutional technology feasibility and development of technologies in certain identified areas. The specific objectives of the Programme are to:

- develop and integrate technologies following a holistic approach in identified areas;
- promote application of modern/advanced technologies to socio-economic problem solving;
- promote modernization of traditional technologies, tools and skills;
- facilitate enhancing quality and performance of the traditional/non-traditional items;

- encourage developments in application of R&D activities; and
- promote activities aimed at improving technology, technique, material, methods and other appropriate activities conducive for development of technology status in identified areas.

Around 150 projects have been supported through this scheme during the 11th FIVE YEAR PLAN (2007-12) in the following focus areas:

- **Water Purification**

  The focus is primarily on removal of arsenic, fluoride, salinity and iron. Ceramic Membrane reverse osmosis based iron removal plant has been installed at Howrah, Defluoridation, desalination plant at Andhra Pradesh.

- **Alternate Fuels**

  The focus of activities under this programme is mainly on technology related applications and system integration in bio-fuels e.g. from Karanja oils, vegetable oils, etc. The main projects include Straight Vegetable Oils for stationary and transport use, setting up state-of-art bio-diesel testing facility, field trials of indigenous technologies for utilization of bio fuels, Utilization of Bio-products to develop value added chemicals.

- **Information & Communication Technology (ICT) Systems**

  This area promotes application of information technologies for the benefit of general masses, especially rural people, primarily working on telemedicine facility in Ophthalmology, wireless sensor network based automated feed uptake and animal development monitoring scheme for semi-rural dairy operations, soil nutrient analysis through Image Processing of Chromatograms.

- **Surface Engineering modification and rejuvenation of Traditional Crafts**

  This program focuses to explore the application of advanced surface engineering technologies to improve the traditional crafts & techniques, tools and skills with a view to enhance export capabilities and performance of traditional and non-traditional items. A plasma polymerization system has been set up at Moradabad to deposit protective barrier SiOx coating on brass articles. Hank processing machines which reduce hazards faced by workers are placed at Solapur (Maharashtra) and Rabkavi-Banhatti (Kamataka).

- **Innovative Civil Infrastructure Technology Systems**

  Projects on Industrialized building system for affordable quality housing, distress diagnostic, performance evaluation, development of Magnesia Hercynite bricks, management system for concrete bridges, development of semi actively controlled structures and devices for seismic protection using smart materials and development of a critical infrastructure information system in GIS environment for maintenance of bridges on national & state highways were started.

- **Glass Technology Upgradation**

  This programme aims at technology upgradation and development in the areas of optical glass, ophthalmic glass and unorganized small sector glass industry like development of contemporary design for small scale Firozabad Glass Cluster. Also the area aims at developing preventive, diagnostic and curative technologies for eye-related diseases.

- **Bio-molecular & Conducting Polymers Devices including Platform Technologies**

  Under this sub-area, technology feasibility and development projects in the area of Bio-Molecular Electronics, Conducting Polymer Electronics and Bio-sensors are catalyzed, self-assembled monolayers, Languir-Blodgett films and their device applications in the flexible electronic structure, organic LEDs, organic solar cells, energy storage devices, electrochromic materials and biosensors.

- **Waste utilization, recycling and Management**

  This area aims to develop technologies and processes which not only dispose off the waste but are also equally effective in value recovery from the Electronic, Hospital and Plastic waste.

- **Biodegradable Bio-medical Polymers**

  Biodegradable/ biomedical polymers are increasingly used in household, transport, industrial, agricultural fields and are also used as artificial organ and transplant in various biomedical applications. Project proposals to catalyze research and technology development are being supported.

- **Ceramic Technology Upgradation**

  Projects were initiated on the basis of the needs of the society and in each and every project, industry is involved.

- **Development of Microwave based systems**

  Projects like "Development of High Power microwave system for tea processing" and "Design & Development of 42 GHz, 200 kW/CW/Long Pulse Gyrotron" were reviewed this year.

- **Miscellaneous Technologies**

  Development of rare earth Permanent Motor Steeper Motor, Process Analytical Technology development for standardization in pharmaceutical industry and enhanced prosthetic hand for Transhumeral Amputees, development of advanced technologies based cost effective systems offering end to end solution of the problems related to environment protection, water contamination and waste management, generation of hydrogen using solar energy are some of the new projects in this area. DST has funded a major project on setting up of test bed for integrated production of 0.75 TPD (Tone per Day) SOP (Sulphate of potash) from seawater bittern-based mixed salt through patented process to Central Salt & Marine Chemicals Research Institute (CSMCRI), Bhavnagar.

Summary of the progress made in some of the important areas during 2011-12, which were taken up for technology development is given below:

1. **Bio-degradable/Bio-medical Polymers and Water Purification** :

   These polymers, due to their outstanding characteristics, are finding increasing applications in household, transport, industrial and agricultural fields. They are also increasingly used as artificial organ and transplant in various biomedical applications. One of the solutions is to use biodegradable polymers based on microbial/agricultural/forest resources. This technology is recent one and is being fervently pursued in every part of the world. Following projects were sponsored during the year:

   - Amphoteric xanthan gum (AXG): Synthesis, characterization and application as a novel polymeric flocculent for the treatment of industrial wastewater.

- Project entitled "Polymer electrolyte membranes: A critical evaluation on the viability for medium temperature fuel cells" was sponsored at Laboratory for Advanced Research in Polyhmeric Materials (LARPM), Centre Institute of Plastics Engineering & Technology (CIPET Bhubaneswar.

- **TECHNOLOGY DEVELOPMENT OF BIO-DEGRADABLE ADDITIVES AND PERFORMANCE EVALUATION OF BIODEGRADATION WITH VARIOUS PLASTICS**

  A new class of photo and biodegradable multi functional additives (MFA) comprising transition metal salts such as ferrous 12-hydroxy oleate (Fe-MFA) and nickel 12-hydroxy oleate (Ni-MFA) were synthesized and characterized by Fourier Transform Infrared Spectroscopy (FT-IR). Fe-MFA and Ni-MFA act as photodegradable as well as biodegradable additives as they have been synthesized from fatty acid. MFA consists of three functional groups namely a double bond between the 9^{th} and 10^{th} carbon atoms, a hydroxyl group at 12^{th} carbon atom, and a metal carboxylate. In addition, the long alkyl chain of hydroxyl oleic acid imparts compatibility with polyolefins. The metal carboxylate acts as an activator to induce photodegradation in the polymer. Therefore, these metal carboxylate additives play multiple roles such as compatibilizer, photo/biodegradation activator and plasticizer.

2. Alternate Fuels:

The department has carved out a niche area to address various technological aspects related to bio-fuels. The focus of activities under this programme is mainly on technology related applications and system integration in bio-fuels. Department has initially focused on potential and problems related to the application of Straight Vegetable Oils (SVOs). The department has the mandate to support R&D related to development, demonstration and field trials of various technologies related to bio-fuel for various applications and activities to promote the use of bio-fuels and utilization of their by-products to produce value added chemicals. Following projects were supported in this area during the year:

- A technology for the production of ethanol from spent biomass of seaweeds and identification of the byproducts for suitable applications.
- Development of 100% biofuelled tractor.
- Detoxification of Karanja (Pongamia Glabra) Seed Cake and its Utilization in broiler and layer Chicken Diets.
- Development of an economically viable process technology for detoxification of jatropha de-oiled cake and simultaneous fuel gas production.
- Screening and improving biomass production, lipid accumulation and oil recovery of microalgae from estuary region (Khambhat, Gujarat) by conventional and modern approaches.
- Corrosion behavior of a few industrial metals in selected biodiesels.
- Thermo Chemical Characterization of Non-Edible Seedcake for Gasification.
- Analysis and improvement of oxidation behavior of biodiesel.

a). A Project entitled "Production and utilization of biodiesel blends in Stationary and automotive engines to assess their suitability to meet emerging fuel quality and emission standards" was sponsored at IIT-Delhi during the year. The major objective of the project is to investigate and assess the feasibility of producing diesel-biodiesel blends in appropriate proportion for meeting emerging specifications of diesel fuel and the effect of blending on fuel properties with special emphasis on lubricity. It is also proposed to evaluate performance of these blends in stationary as well as automotive engines on test bed and also to conduct on road performance evaluation and emissions assessment for conformity/ deviation to Bharat III/ Bharat IV norms.

Several non-edible feed stocks are available in different parts of the country from which biodiesel can be developed. Figures 1, 2, 3 given below indicate the R&D activities in IIT Delhi on the production and utilization of biodiesel. The present project aims at a very meaningful topic in using the three prospective ones in Indian context. It is proposed to prepare alkyl esters from Jatropha Karanja and Castor by transesterification and study the subsequent physico-chemical properties. Special emphasis is proposed to be put on the lubricity of biodiesel from Castor oil using methanol and ethanol and establishing feasibility of utilisation of biodiesel blends both as a fuel as well as lubricant to meet emerging fuel requirement and emission standards.

Fig. 1 GM sponsored Tavera vehicle fueled with B20

Fig. 2. Biodiesel plant for process optimization (one Liter capacity)

Fig.3. Fifty liter Batch capacity-Biodiesel Pilot Plant at IIT Delhi

Fig. 4.41

3. Information & Communication Technology (ICT) Systems:

Under this area, the focus is on developing technologies, which promote application of information technologies for the benefit of general masses especially rural people. Following projects were completed/supported in this area during the year:

- Development of Non-Intrusive system for Real-Time Monitoring and Prediction of Driver Fatigue and Drowsiness.
- Internet Multimedia Search Engine for information retrieval in distributed environment.
- Development of Agricultural Decision support system software.

4. Surface Engineering modification and rejuvenation of Traditional Crafts:

The main objective of this program was to explore the possibility of application of advanced Surface Engineering technologies to improve value addition of traditional crafts and modernization of traditional techniques, tools and skills with a view to enhance export capabilities and performance of traditional and non-traditional items. Few Brainstorming meetings for formulation of proposals were organized during the meeting. Project entitled "Setting up of an Indistrial scale atmospheric pressure plasma system for Kullu region to improve Angora Wool Processing" was supported during the year.

The following technologies were successfully demonstrated at user sites:

ii) The plasma polymerization system designed and developed at FCIPT to deposit SiOx coating on brass articles using radio frequency (13.56 MHz) power source. Si containing precursor molecules get fragmented in plasma and get deposited in the form of polymer coating on brass articles. The coating protects brass articles from corrosion as well as the process is environment friendly. The plasma polymerization system developed at FCIPT has been installed and comissioned at MHSC, Moradabad. The SiOx coating is deposited in eco-friendly manner. Field trials were conducted for doing systematic studies on the developed system.

The plasma system installed at MHSC, Moradabad

Coated brass articles

Fig. 4.42

ii) FCIPT, Gandhinagar developed 15kg/hr plasma pyrolysis system **(Green Technology)** for the safe disposal of hospital and plastic waste. 4 prototype plasma systems was developed and demonstrated at various locations in India. Out of 4 systems one plasma pyrolysis system of 15kg/hr capacity was successfully commissioned at GCRI-Ahmedabad, for the disposal of actual medical waste. The emission measurements were carried out on this system by VIMTA Lab, Hyderabad. The emission results are shown in table1:

Biomedical Waste Category 6 & 7 Disposed

Parameters measured	CPCB Norms (As per the Gazette of India 26th June 2008)	Actual Emission in Plasma Pyrolysis system
Sulphur dioxide	200 mg/Nm^3	90.6 mg/Nm^3
Oxides of Nitrogen	400 mg/Nm^3	261.5 mg/Nm^3
Particulate matter	50 mg/Nm^3	26.7 mg/Nm^3
Chlorine as Hcl	50 mg/Nm^3	26.7 mg/Nm^3
Chlorine as cl2	——	23.4 mg/Nm^3
Dioxins & Furans	0.1 mg/Nm^3	0.0032 mg/Nm^3

Fig. 4.43: Plasma Pyrolysis System (Green Technology)installed at GCRI, Ahmedabad

5. Innovative Civil Infrastructure Technology Systems:

Civil Engineering infrastructure comprises buildings, roads, bridges, road interchanges flyovers, tunnels, railway tracks, dams, irrigation works, transmission towers, stadiums, etc. They are the backbone of national economy; they influence the quality of life and sustain developments in agriculture, industry, commerce, power, transportation and communication.

To optimize the utilization of resources committed for this rapid growth, innovative, efficient and new technologies are required to be developed through well designed and concerted national R&D programmes. These technologies must be sustainable, eco-friendly and in conformity with the national priorities and in harmony with the Indian milieu.

Following are the thrust areas of this core-group:

(1) the housing sector which will lead to speedy construction of energy efficient, environment friendly, material conserving, comfortable and economical dwellings in urban and rural areas;

(2) Road transportation sector with a focus on performance, durability, maintenance interventions, construction materials and binders and life-cycle cost;

(3) Bridge, interchange and fly over structures which are economical, durable and aesthetically appealing; and

(4) Civil engineering construction materials to provide options for the use of new materials, substitute materials, waste materials, innovative materials and eco-friendly materials.

6. Glass and Ceramic Technology Upgradation Programme:

Under this programme, projects aiming at technology upgradation and development have been initiated in the areas of optical glass, ophthalmic glass and unorganized small sector glass industry of consumer items (Firozabad glass industry). The objective of this programme is **t**o develop commercially viable technologies of interest to either existing industries or start-up companies. A few identified thrust areas for submission of the project proposals for funding from DST are:

Following projects were supported during the year:

- Development of production technology for protective coated precision plastic bi-aspheric lenses for indirect ophthalmoscopy.
- Development of improved quality Glass, compatible lamp torch and high surface finish dies and moulds for glass beads.
- Design and development of gas fired glass re-melting furnace for glass beads.
- Development of new designs and new products based on the indigenous materials, skills and infrastructure of Purdilnagar bead cluster.
- Low temperature healing photo catalytic self cleaning coatings for solar cell covers and glass surfaces.
- Development and Pilot production of high permittivity and low loss ceramic filled PTTE substrates for microwave circuit applications.
- Development and Pilot production of nano-ZnO for electronics and deep-desulphurisation catalyst applications.

i) **Developmental Aspect of Double Fired wall Tiles by Suitable Substitution of Various Ceramic Waste for it's Gainful Utilization in Body, Engobe and Glaze.**

With the increase in production of vitrified tiles in India, there are growing concern about the huge generation of tile polishing sludge. This waste materials are siliceous in nature and contains lot of impurities restricting its utility in any industries. This lead to dumping of large quantities of these sludge waste in the factory premises causing environment pollution. CGCRI, Naroda Centre took initiatives to find its gainful use by incorporating in ceramic formulations. Thus, an attempt is made to explore possible use of waste materials in the traditional ceramic industries to solve not only the waste disposal problem for the vitrified floor tile units but it also encompasses the larger benefit to the wall tile industries towards cost reduction and energy saving.

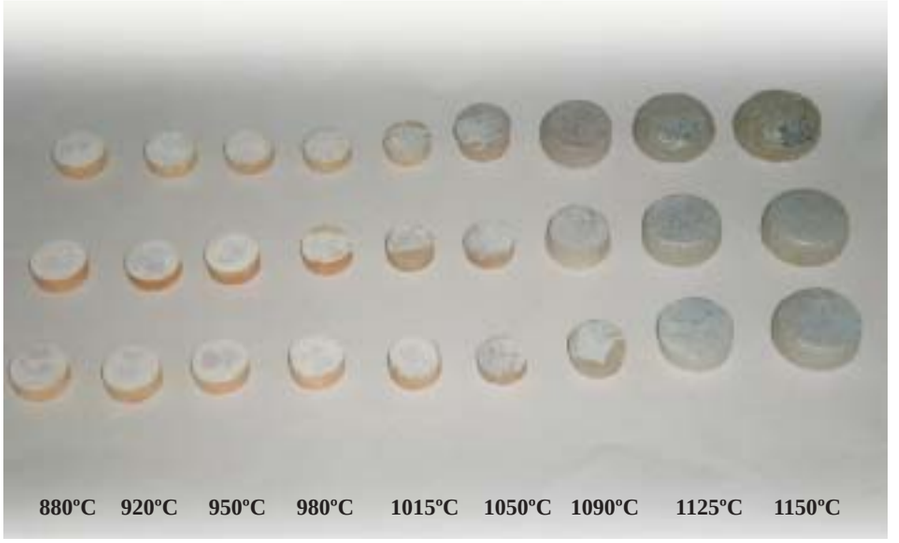


Fig. 4.44

Tile polishing sludge samples behavior after firing at different temperatures

Above figure shows firing nature of the sludge samples. In this case, there is a deformation with swelling has been observed for sludge samples fired beyond 1050°C. This could be attributed to the evolution of gases as well as oxidation of silicon carbide and other organoceous material present in this sludge. The research project is expected to explore the gainful use of waste in ceramic industries.

ii) **Development of manufacturing technology of SiAlON cutting tools**

In this project, an in-situ combination of multiphase ceramic composite based on different α-β SiAlON materials has been developed. The oxynitride compositional plane, which is actually a subsection of the plane Si_3N_4-YN.3AlN-Al_2O_3.AlN, in the system Si_3N_4-SiO_2-AlN-Al_2O_3-Y_2O_3-YN has been considered. Different phase combinations produced an excellent tailorable combination of fracture toughness and hardness of the cutting inserts compatible for wide varieties of work piece materials under different cutting operations.

Salient features of the project:

- Patented compositions and processes were reproduced at CGCRI;
- á- & â- were selected as the combination of phases for insert preparation;
- Starting powder batches suitable to prepare cutting inserts were supplied to collaborating partner from CGCRI;
- Collaborating partner could reproduce right combination of phases at plant;
- Collaborating partner could reproduce by using the proposed route of MPIM as well as another route done by CGCRI through CIPing of samples;
- All insert shapes, square, 80° rhombos, equilateral triangles were produced;

- Process parameters were optimized and the manufacturing technology has been established.

iii) **Technology for self cleaning titanium oxide nano coatings on ceramic and glass surfaces.**

This project was carried out by National Institute for Interdisciplinary Science & Technology (CSIR), Trivandrum jointly with M/s KAP India Tiles, Thrissur. The objective of the project was to develop on demonstration levels, suitable compositions of 25-30 nano meter size photo active titanium oxide and coatings on glass and ceramic surfaces.

As the first step, nano titania coating precursor sol having particle size in the range, 25-30 nm was synthesized through aqueous sol-gel route starting from titanyl sulphate. The titania compositions were characterized for properties including photoactivity. Transparent coatings were then prepared over commercially available glass, glazed ceramic tiles and terracotta tiles by dip coating and spray coating technique. The coated tiles were annealed at 400-800 ^{o}C, depending on the nature of substrate. Optimum quantity of additives was arrived at after investigating in detail, the influence of additives on the phase transition and grain growth of nanotitania on the increased photoactivity of the composite system. As a result, compositions which provide enhanced photoactivity under exposure to sunlight as well as certain hydrophobicity could be developed. A production plant for manufacture of functional nano particles and sols of rare earth phosphates was set up under a parallel project in Indian Rare Earths Ltd. Kollam, Kerala which is capable to also produce titanium oxide in kilogram quantities.

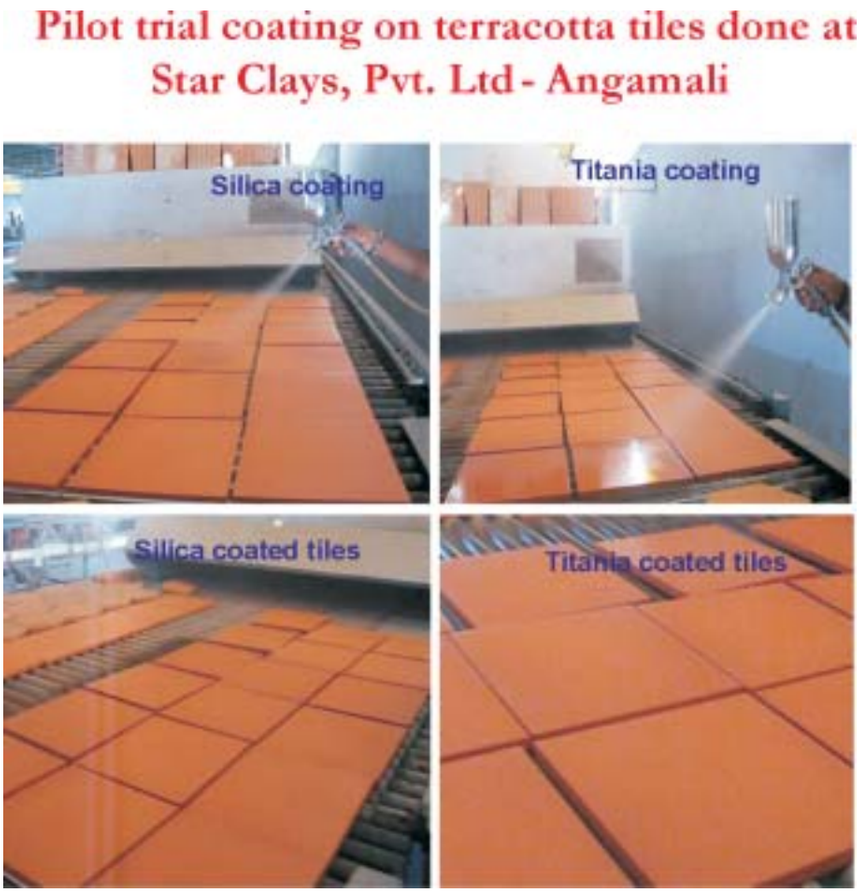
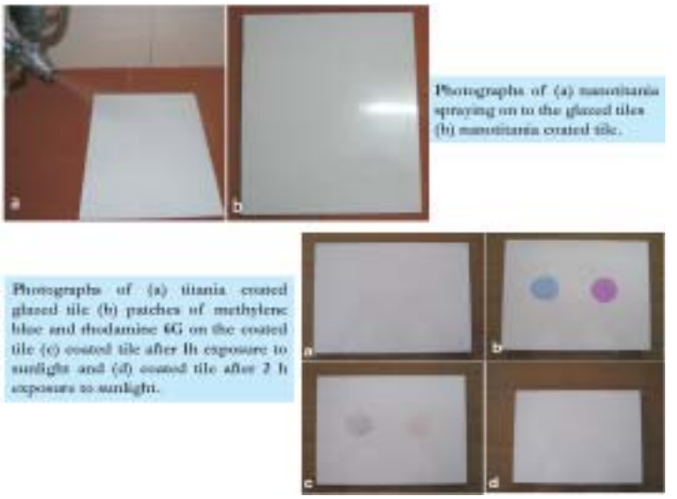


Fig. 4.45



Photographs of (a) nanotitania spraying on to the glazed tiles (b) nanotitania coated tile.

Photographs of (a) titania coated glazed tile (b) patches of methylene blue and rhodamine 6G on the coated tile (c) coated tile after 1h exposure to sunlight and (d) coated tile after 2 h exposure to sunlight.

Fig. 4.46

7. Molecular Electronics, conducting polymers and Non-invasive and other biosensors program:

The Molecular electronics is a fast emerging area of nanotechnology which is concerned with the electronic and optoelectronic properties exhibited by several class of organic molecules, fullerenes, carbon nanotubes, graphene, conducting polymers and biological materials such as proteins and nucleic acids. Biomolecular electronics is a sub-area which integrates the biomolecules with the electronics through a transducer. A major outcome of research in biomolecular electronics is the development of biosensors for health care diagnostics especially of non-invasive type.

Following projects were sanctioned during the year:

i) Design and synthesis of low band gap conjugated polymers and the fabricationof inverted polymer Solar Cells.

ii) Field test and commercialization of polymer gel based Pbo2-AC ultracapacitor system for rural lighting and ride through in power conversion applications.

iii) Biosensor for analysis of phenolic compounds in textile industry effluent.

iv) Development of a biosensor for estimation of polyphenols in apple juice.

v) Developing Hydrogen Gas sensor based on conducting polymer nano-composite materials.

vi) Ion Conducting Polymer-Metal Nano-composite (ICMPN) Based electrochemical sensors for Biological Fluids.

vii) Validation of auto range capacitance measurement instrumentation as clinical biochemical analyser.

viii) Design and Development of a rapid diagnosis test for early detection of HIV infection.

ix) New Materials and methods for the efficient organic photovoltaic devices.

x) Molecualr Characterization of soil bacterium for plastic degradation.

xi) Design and characterization of electrochromic rear view mirrors using conducting polymers.

xii) Design and development of multi level inverters for power quality improvement in renewable energy sources

xiii) Corrole-based sensors for halide ion recognition.

xiv) Design and Fabrication of a Conducting Polymer Ceramic Nanocomposites Gas Sensor.

xv) Fluorometric sensor for cadmium in drinking water.

xvi) Development of recombinant DNA based Biosensor device for detection of arsenic in water samples.

xvii) Nanostructured oxide materials for application in electrochemical biosensors.

xviii) Development of electrochemical hybrid supercapacitors based on conducting polymer electrodes and polymer electrolytes for energy storage.

xix) Studies on high efficient nano-Tungsten oxide solid state electro-chromic devices for possible applications to Helmets.

xx) Nanosensor Array based on Conducting Polymer Functionalized SWNTs for Real-Time Monitoring of Toxic Air.

Progress of all the projects sanctioned under this Core-group were reviewed during the year.

- ***Preparation of Bacteriorhodopsin :***

Photoactive biomolecules are in great demand for the development of optical and electro-optical sensors. In this regard, Rhodopsins which are proteins and vital to animal and human vision are particularly important owing to their sensitivity to light and optical capabilities unmatched by synthetic molecules. Ability to make and manufacture rhodopsin based photonic components for device applications go a long way in establishing technological supremacy in the areas of Molecular electronics devices. The program has two major objectives. (a) To prepare BR molecules from purple bacteria (b) simultaneously develop photonic devices based on the already established properties and to use available films for the high-end applications**.** The focused efforts in this direction with optimal funding are yielding rich dividends as evidenced by success in isolating and purification of BR in small quantities. The aim is not only prepare the BR in larger quantities but also to produce films for device applications.

The following project funded for large scale BR preparation of homogeneous BR protein from halobacterium has progressed to the level of isolating small quantities of BR protein from.

➢ **Process development for production of bacteriorhodopsin by halobacterium species for application in nano-device development**

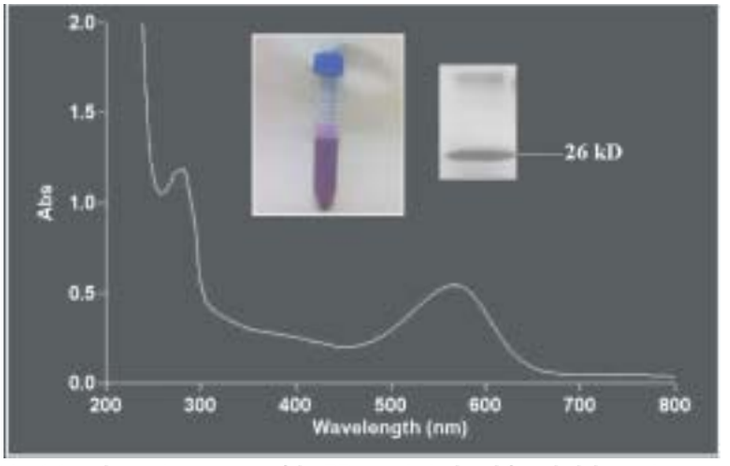


Fig. 4.47: *Absorption spectra of the BR protein isolated from halobacterium sp. With BR protein sample and gel electrophoresis (in the inset).*

The other projects funded under this programme and progressing well are:

- **Development of Halobacterial variants for enhanced Bacteriorhodopsin (BR) protein production**
- **Optimization of Bacterioehordipsin (BR) Protein production from Halobacterium Species**
- **Development of photo chromic thin film of bacteriorhodopsin**

Capacitance and conductance based sensor :

- **Capacitance and conductance based sensor Instrumentation for biochemical Characterization**

Reagent less measurement of reactions is close to the ideal situation in analytical chemistry and biochemistry. Measurement of many enzymatic biochemical reactions, including those of great clinical relevance, are not amenable for the conventional and currently popular spectrophotometric methods, which in many cases require external reagents to produce colour, fluorescence etc. However, many such reactions undergo changes in the charge status during the reaction depending on the charge associated with the substrates and products, which could be measured as changes in capacitance. This inherent property was exploited in this new approach using an indigenously made auto-range capacitance meter capable of measuring capacitance in the range of microfarads to tens of picofarads. The enzymatic reactions causing capacitance changes have been successfully studied and showed to be comparable to the spectrophotometric analysis.

Fig. 4.48: Portable auto-range capacitance meter for reagent less measurement of enzymatic reactions (left : capacitance meter ; right : Measurement set-up with reaction cuvette)

❖ **Conducting polymer based rechargeable battery:**

➢ **Development on conducting polymer rechargeable battery for consumer applications**

Under this project, a polyaniline (PANI) based rechargeable battery was developed, fabricated and tested. The battery shows very desirable features such as good cycle ability, high capacity and quick charge retention. The doped PANI electrode based battery is expected to be of low cost, eco-friendly and lighter weight than the conventional dry cell batteries in the market. The performance of the battery has been tested under laboratory conditions and found to be capable of meeting the requirements of portable electronic devices. The battery has been demonstrated in Industry interaction meeting at Ambala which invited keen interest from Industries. Further field trials and up scaling studies would establish its potential for commercialization.

8. **Development of Microwave based systems:**

- **Design and Development of 42 GHz, 200 kW CW/Long Pulse Gyrotron**

A multi-institutional project titled "Design and development of a 42 GHz, 200 kW CW/Long Pulse Gyrotron", has been sponsored by Department of Science and Technology (DST). CEERI is the Nodal Centre and the participating institutions are BHU, Varanasi; IIT(R), Roorkee; SAMEER, Mumbai; and IPR, Gandhinagar. The total budget of the project is Rs 2316.35 Lakh which has been distributed amongst the institutions participating in the project. The IPR, Gandhinagar is the user of gyrotrons for plasma heating applications.

Till now, in this project many milestones have been achieved and the major achievements are listed below.

✓ Design of different components of 42 GHz, 200 kW gyrotron with peripheral systems have been completed.

✓ Infra-structure for design of 42 GHz, 200 kW gyrotron has been established.

✓ First time a leak tight Magnetron Injection Gun (MIG) of 42 GHz, 200 KW gyrotron has been successfully fabricated with the help of Bharat Electronics Limited (BEL), Bangalore, CEERI workshop and M/s Kamal Engineering Works (a local vendor) based on indigenous design (Fig. below). The MIG with dummy collector has been vacuum processed and cathode breakdown test has been performed.

✓ Tapered cavity made up of OFHC copper has been fabricated with the help of CEERI workshop based on indigenous design and has been also cold tested successfully. The tested results have matched with the design and are within the tolerance range. The dimensions have been freezed after repetitive fabrication and testing.

✓ Two trial nonlinear tapers (NLT) with alternate materials have already been fabricated with reasonable success.

✓ Design of mounting arrangement of whole gyrotron with peripheral systems has been completed.

✓ Novel cooling duct design has been completed to handle thermal loading on the collector, NLT and cavity with desired flow rate of water.

✓ RF characterization and high voltage testing lab have been developed.

Fig. 4.49: MIG of the 42 GHz, 200 kW Gyrotron

9. Miscellaneous Technologies:

PRODUCTION OF POTASH FROM SEA WATER

DST has funded a major project on setting up of test bed for integrated production of 0.75 TPD (Tone per Day) SOP (Sulphate of potash) from seawater bittern-based mixed salt through patented process. The project has taken up by the Central Salt & Marine Chemicals Research Institute (CSMCRI), Bhavnagar. This project has three main deliverables:

i) A test bed for production of 0.75 TPD of SOP, 0.75 TPD of ammonium sulphate and 0.3 TPD of magnesia.

ii) Scale up the process for the production of ammonium sulphate and calcium carbonate using byproduct gypsum in the SOP process, use of cabon dioxide produced during calcinations of calcium carbonate in the reaction to produce ammonium sulphate, and use of lime in the preparation of magnesia and calciumchloride. The process will be scaled up and its integration with SOP process will be demonstrated.

iii) Scale up of ammonia based process for production of ultra pure magnesia. The ammonia is recovered by reaction with lime that will be recycled. The scaled up of the technology and integration of the same with SOP process will be demonstrated.

Given that all the potash consumed in the country is imported, and given that the country produces about 18 million tones of salt, based on bittern produced in salt works, about 0.35 million tons of potash can be produced. Further, there is potential source of naturally occurring bittern in Greater Rann of Kutchh in Gujarat which can be utilized for the production of potash.

Vision for the 12th Plan:

In addition to above mentioned programmes, new areas of technologically important for country have been identified by the expert groups such as Solar Hydrogen, Ferro Magnetic Fluids, Civil Infrastructure, Special Thrust on Technology needs for North Eastern States, Technology convergence for the production of Sulphate of Potash (SOP) and in any other area deemed to be necessary for enhancing the technological prowess of the country and not being included in other major national initiatives would be initiated for development of technologies/technology convergence. These may include specific product/process/ application related to material development, health related, microwave based, electronics related technology systems, waste recycling and management, energy harvesting technology and technological interventions in traditional sectors etc.

CHAPTER 5

S&T AND SOCIO-ECONOMIC DEVELOPMENT

The Department of Science and Technology (DST) has been playing a major role for socio-economic development through science and technology applications. DST has been implementing a range of schemes and programmes for connecting S&T with society. The review of on-going societal programmes of 11th plan indicates satisfactory outputs for investments made. Long term core support to 20 science based voluntary organizations; S&T innovations for supporting the elderly, physically challenged, weaker segments of the society including tribal and SC population; and some women component programmes have been implemented through the **Science for Equity, Empowerment and Equity division** involving field level agencies and S & T institutions. Technology up-scaling and demonstration projects undertaken through such programmes have shown potential for improved quality of life and livelihoods gain at pilot scale. To foster technology based and knowledge driven entrepreneurship among S&T persons, **National Entrepreneurship Board (NEB)** of DST has been actively engaged in establishing technology business incubators and Science and Technology Entrepreneurship Parks and participating in Innovation clusters. NEB has been engaged in enlarging the scope for setting up of more Innovation and Entrepreneurship Development Centres in academic institutions to foster growth of innovation and entrepreneurship amongst the faculty and student, and Technology Based Entrepreneurship Development Programme to promote entrepreneurial temper and motivating unemployed youth for establishing micro enterprise based on innovative skills and technology. NEB is also planning to step up activities relating to the establishment of Research Parks in the formal innovation system and New Emerging Technology (NET) Skills project by creating sustainable models of NET Skill Packages.

Under Societal programme, several important initiatives for science communication related activities have been undertaken by DST during the year through **National Council for Science & Technology Communication (NCSTC)**. Science Express is one the flagship and successful mobile programmes of DST to reveal the relevance of science in everyday life and generates interest about burning issues & challenges of S&T amongst the visitors. This flagship venture of NCSTC also strives to showcase new exhibits on Climate Change and Biodiversity and take modern research and state-of-the-art out of laboratory to school & college students in particular in order to encourage them to pursue higher studies and careers in science. Children Science Congress organized at Jaipur National University, Jaipur through NCSTC network has been a major event in the country. About 700 projects were presented by child scientists from urban and rural areas both from different states, apart from the participation from ASEAN countries as well. To promote R&D in emerging areas of Geo Information Science and Technology, DST has been implementing National Resource mapping related activities under **NRDMS** division. Studies have been completed in areas like Cartographic Generalization and Disaster Management (floods and landslides). Fresh studies have been initiated in areas like Spatio-temporal Data Analysis, Sensor Web Enablement, Marine GIS, Digital Heritage, and Hyper Spectral Remote Sensing. The division has been engaged actively in the preparation of some policy papers for sharing of data among the arms of the Government of India and other important aspects of national security related issues in recent times.

While such role towards contracting Science and Technology for Social Good should be continued to be played by DST, in 12th plan, new mechanisms and operational methodologies are being developed for enlarging and enriching theses activities/programmes through institutional strengthening and human capacity building for making visible socio economic impact of technology changes. In this process, new programmes and schemes for promoting the role of Women in Science and S&T interventions for improving women and child health are envisaged for implementation during the 12th plan period.

SCIENCE FOR EQUITY, EMPOWERMENT & DEVELOPMENT (SEED)

The Department has been playing a important role in promotion of science and technology to address the issue of socio-economic development in the country. Social Equity principles demand special attention and careful intervention to facilitate rural community and deprived section of the society in their developmental by developing need based programmes/schemes focused on enabling their emerging need for livelihood as well as food security. Equal emphasis has been given in this programme to take into account both empathy and sensitivity backed up by the use of adequate resources and capacity building through appropriate application of science and technology. In this direction, Science for Equity, Empowerment and Development(SEED) Programme of the Department supports S&T based voluntary organization/ institutions/ Colleges/Universities throughout the country to take up field oriented action projects at the grassroots level with S & T applications. In this endeavor, focus under this SEED programme of the department is to create S & T based potential models/packages at the pilot scale to facilitate not only better employment opportunities, but also to engage community in establishing micro-enterprises at local level for better quality of life. Schemes operational under SEED program have been able to design and implement variety of demonstration projects for technological solutions to location-specific problems through technology modulation of appropriate scale, field testing and transfer. Major achievements made under various schemes during the year as well as in 11th plan period are listed below:

1. Science and Society Programme (SSP): This programme aims at facilitating development of promising S & T based field groups and innovative technologies for addressing societal needs. Schemes operational under this programme are:

I.1 Long Term Core Support: Technological Advancement for Rural Areas (TARA)

Through Long Term Core Support scheme, S&T based VOs are supported by the department on long-term basis to remain active in adaptive R & D having application for rural areas. Under this unique programme of the department, core support was extended to twenty science based voluntary organizations working in different parts of the rural India to address local problems through need based S&T solutions. The core support is being utilized by each field group to nurture and sustain scientific manpower to take up challenges to work on issues/problems related to sustainable rural livelihoods both in farm as well as non farm sector. These groups have major focus to innovate and disseminate location specific rural technologies in respective geographical coverage area to train and empower local community. With systems management approach involving PRA, each group is also engaged to strengthen local skills and knowledge to revive traditional occupations like pottery, black smithy and other rural engineering sectors to improve the working and efficiency of local production system with reduced drudgery by exploring proper linkages and support from S & T Institutions/Labs. Such interventions are not only need based, but also improve working conditions and bring environmental as well as livelihoods benefits at the community level as described in **Box 5.1 to 5.3.**

Box 5.1. Scalable Solution: Technology Innovations, Incubation & Dissemination

Perspective

DST's **Long Term Core support** to Development Alternatives (DA), Delhi is to scale up available technologies and develop/source new technologies which would strengthen the commercial entities and community groups towards creating sustainable livelihoods in large numbers. The major emphasis was to produce goods and services for the local market and bring the poor and downtrodden, the women and the marginalized, into the mainstream. In collaboration with Technology and Action for Rural Advancement (TARA) the commercial arm of DA, large scale technology based enterprises and livelihoods creation are being pursued covering the full spectrum of:

- **Innovation** with emphasis on sourcing and collaborative R&D for product/technology customization
- **Incubation,** primarily enterprise development with focus on livelihood opportunities, and
- **Dissemination** of technologies with focus on business models for enterprises community based models with S&T applicationWhile implementing core activities in Bundelkhand region, this approach is coupled with capacity building of village institutions and initiate community managed development processes.

Technology Intervention Made: Utilization of Fly ash in Brick making.

As a joint effort, DA and TARA teams have worked out a total solution package for utilization of fly ash in brick making. The Package consists of required testing of fly ash and its suitability in brick making with cost benefit analysis compared to available building materials in the region. The service package consists of process design and composition with training of workers at site on benchmark operating practices. The hardware package consists of semi mechanized and automatic machines of various capacities to suit various needs. Technology has been transferred and is now being marketed commercially through TARA Machines and Tech Services Pvt. Ltd. To ease decision making, finalization of a fly ash database has also been initiated. This is an interactive and easy-to-use tool through which a first time entrepreneur can base his decision on adopting a fly ash business in his area of operation.There was a strong demand from the fired clay brick sector for a low cost, easy to use brick moulding machine. Thus two types of machines with varied capacities were sourced and adapted to field conditions with development of various accessories. These technology packages are expected to benefit small scale enterprises besides assisting the existing enterprises to diversify. Through training of vendors and entrepreneurs, commercial dissemination is being undertaken. Already more than 20 machines (TARA Brick Mek) have been sold with increasing demand for more.

Pre-cast Toilet technology package has also been developed for production of pre-cast concrete panels for construction of toilets. The package includes a set of moulds for manual production of panels and a production manual for training of entrepreneurs. A Pre-cast Door/window Frame technology package has been completed for production of pre-cast door frames. Training to TARA Karigar Mandal (Mason Guild), and community groups has also been done to facilitate replication.

As part of **Enterprise incubation** efforts, provision of safe drinking water through enterprise mode has been tested in 5 locations in the Bundelkhand region and Rajasthan. Draft business plan along with a delivery model has been worked out also. The Energy team and TARA Nirman Kendra have successfully demonstrated the **Rural Entrepreneurship Zones (REZ)** at Datia, Jhansi which has resulted in the economic growth of concrete building enterprises cluster. Production has improved significantly because of skill development and inter-unit coordination. Till date around 28,000 units have been generated providing reliable power to 12 enterprises.

Fig 5.1: Semi mechanized fly ash block making machine

Fig 5.2: Automatic fly ash block making machine

Fig 5.3: Soft mud moulding machine with conveyer feeding developed for clay brick enterprises

Box 5. 2. Scalable Solution : Innovative Technology for Easy Fishing

Introduction

Mitraniketan based in Thiruvananthapuram is one of the development organizations in Kerala established in the year 1956. **Long term Core support** project of Mitraniketan is targeting small and marginal farmers, women, and youth for their development through S&T based farm and non farm activities. Promotion of Homestead farms by utilizing available resources to its maximum for ensuring food and nutrition security is one of the major focuses of the Core Support project.

Similarly the technical staff is also working among fisher folk engaged in fishing in backwaters. Core team has developed a technology for easy fishing using Chinese fishing net is an innovation to be projected during the current year.

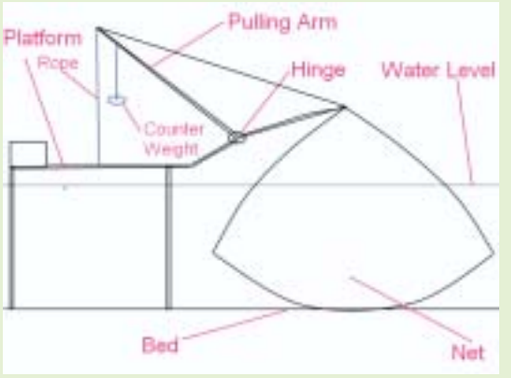


Fig. 5.4: Schematic diagram of Chinese fishing net installation

Technology: Motorized Winch for Chinese Fishing Net

Chinese fishing nets locally known as "Cheena-Vala" are a common feature in the backwaters of Kerala. Chinese Fishing Nets are fixed land installations, shore operated lift nets. These are large wooden contraptions used to lower a net into the water to trap fish and prawns and raise it to extract the catch. It takes 3 to 6 men to operate the mechanism depending on the size of the net. Once the net is raised, one of the operator walks up to the hinge point along a catwalk and using a pre-attached line to the centre of the net pulls it in to recover the catch.This fishing technique is popular in coastal regions of Kollam, Aleppey, & Cochin in the state of Kerala. The primary focus area is Azheekkal of Kollam District in Kerala State.

Technology intervention Made

Due to the shortage of workers and increase in labor cost, this form of fishing is in decline. This technology makes it possible for a single person to operate the mechanism by the use of a motor powered winch to pull the rope. This machine is an addition on to the existing mechanism and can be easily retrofitted to existing rigs.

An electric motor rotates the winch drum about its axle through a transmission comprising of a first stage belt drive and a second stage gear reduction. The machine can be driven by 0.5Hp or 1Hp electric motor. So a single operator can use the rig to fish continuously without any exertion.

The cost of the machine is reported Rs. 13,500/- for 0.5 Hp, and 16,250/- for 1Hp version. Field trials in Azheekkal back water area in Kollam & Alleppy districts has indicated that catch has increased to 300% compared to the conventional fishing.

Fig. 5.5: Conventional Chinese Fishing rig

Fig. 5.6: The motorized winch installed on Chinese fishing rig.

Box 5.3. Scalable Solution: Technologies and Systems for Sustainable Pro-poor Rural Enterprises

The Society for Economic & Social Studies, New Delhi through its Centre for Technology & Development (SESS/CTD) with field Station in Dehradun focuses on development and dissemination of technologies and systems for sustainable pro-poor rural enterprises, and has demonstrated replicable models in Leather including Carcass Utilization, Pottery, Fruit Processing and Non-Edible Oils. Under **Long Term Core Support**, CTD is making efforts to develop technologies for rural enterprises in new areas such as Natural Plant-based Fibres, Plant Extracts for Cosmetics/Toiletries and some SHG-based Enterprises. While these models would aim to meet local felt needs, they would also aim at sectoral development and all-India application.

Technology Intervention Made : Multi-Fibre Extraction Machine

During the reporting period, CTD developed an improved Prototype of a Multi-Fibre Extraction Machine designed for operation at village-level near the source of such raw material, as part of efforts at developing a complete technology package and field model for networked or distributed enterprises covering natural plant based fibres extraction, treatment, blends or composites, and manufacture of higher-end products based on assessment of available technologies and market analysis. The technology aims to replace traditional retting methods that are increasingly proving unsustainable due to water shortage and pollution problems, and be capable of handling several different fibre-bearing plant materials. Based on extensive field surveys and ethno-botany studies, work was undertaken on 3 priority plants namely Bhimal *(Grewia optiva*), Bhang or industrial hemp (C*annabis sativa*) and Himalayan Nettle *(Urtica dioica).* Prototype #2 developed during 2010-11, an improvement over the first year's design, has speed control, adjustments for handling materials of different thickness and rotor with differently serrated blades. The machine has demonstrated good results with all 3 fibre-bearing plants as shown by tests conducted at the Northern India Textile Research Association, Ghaziabad. Currently, protocols for extraction of fibres from these different plants are being optimized. Simultaneously, processes and protocols for softening of the fibres and obtaining desired properties of lustre, breaking strength etc are also being developed and optimized with very promising results so far.

Fig. 5.7: Multi-Fibre Extraction Machine Prototype & Mechanically extracted Fibres of *Grewia optiva*

1.2 Technology Interventions For Addressing Societal Needs (TIASN)

Main objective of the scheme is to develop and facilitate innovative research and application of S&T based solutions to identified problems and societal needs in different parts of the country.

- Under a project, a low cost high efficiency gas furnace with accessories for melting bell metal to be used by rural artisans has been developed by IIT Delhi based on CFD models of the modified design and simulation results where desired temperatures are achievable, and the design is more ergonomic than the existing one.
- In another project, technology has been developed using Recycle paper mill waste for making light weight building blocks as per IS and ASTM codes for low cost housing options.

Fig 5.8: Recycle paper mill waste

Fig 5.9: Sun drying of bricks

Fig 5.10: Making of bricks using hand operated machine

- Under a project "*Development and Dissemination of location specific protocol for integrated management of diseases of pomegranate in mid hills of Himachal Pradesh*" by Dr. YS Parmar University of Horticulture and Forestry, Regional Horticultural Research Station Bajaura, Distt. Kullu, survey of pomegranate growing pockets of Kullu and Mandi districts and Bilaspur and Hamirpur districts was done and different pomegranate varieties according to their relative reaction against different diseases has been evaluated and categorized. Isolation and identification of pathogens and evaluation of different fungicides and plant extracts against important pathogens was also carried out.

Fig. 5.11: Pathogenecity Tests (Fruit Rot- *Coniella granati)*

- A project entitled, "*Artificial Glacier Technology*" in Leh, is in operation being executed by Leh Nutrition Project, Leh, J&K. The project area covered are - Two blocks of Leh & Kharu [i.e Villages of Saboo (Leh Block) - Area 214 ha, Nang (Area 105 ha), Sakti (Kharu Block) Area 650

ha. The aim is to address the issue of this water scarcity by harnessing and conserving glacially melt water at high altitude during winter months when all agricultural activities ceases and all plant species go into dormancy due to intense cold and conserve, manage and sustainable use of water and land resources for livelihood by creating adequate irrigation potential to convert land holdings into source of adequate income for the rural mountain population.

Fig. 5.12: Artificial Glacier, Saboo village (Summer)

Fig. 5.13: Artificial Glacier, Saboo village (Winter)

Fig. 5.14: Formation Stage of Artificial Glacier Saboo

Programme for Technology Interventions for Elderly (TIE)

Major emphasis under this umbrella programme is to promote research, development and adaptation of technology for improving quality of life for benefit of elderly population in the country. During the year, about 20 new projects have been supported under this programme. Salient achievements under some projects are:-

- In a project being implemented up by PGIMER, Chandigarh, quality care audit of old Age Homes of Chandigarh was undertaken and comparative efficacy of intervention for inmates and for community based bedsore prevention and management of bed-ridden Elderly was carried out.
- In another project Design and development of Hip Protective Device for Elderly people to prevent fractures has been undertaken at IIT Delhi.

Fig. 5.15: Design & Development of Hip protective Device for Elderly

- Under another project entitled, "*Mobility enhancement for the Elderly*" a wheel chair with features of vision based obstacle detection, geo-referencing based navigation and speech command based human machine interactions has been developed.
- A project supported to University of Delhi has led to awareness creation about lifestyle modification and development of radio messages/jingles for prevention and management of chronic degenerative diseases among the Elderly group.

1.3 Scheme for Young Scientists and Technologists (SYST)

Main objective pf the scheme is to encourage motivated young scientists and technologists to work and apply their expertise to problems in the rural areas through socially relevant action research projects. During the year, two sensitization workshops were conducted to create awareness about the scheme. Salient achievements made under some projects are:-

- Under a project on **"Identification of alternative animal health delivery through folkloric claims"** *by* National Innovation Foundation, Ahmedabad more than 80 traditional healers were identified during the period and more than 70 technologies were filed for patent application. On farm testing of three technologies were carried out for -Medication for curing Ephemeral fever, Medication for curing bacterial mastitis and Enhancing milk production potential for which linkages have been created with Veterinary dispensaries and dairy cooperative in the regions of Anand, Dahod and Panachmahal.
- A suitable Intelligent Systems for Tourism Industry for Kumaon Region of Uttarakhand has been developed at BIAS, Bhimtal and for which details are available on a portal www.indiasignposts.com. The system includes identified and categorized socio-economic activities of tourist interest and options for planning travel in a specified time period.
- In another project handled by MNIT, Allahabad, a process has been developed for Bioremediation of industrial grease and oil waste where about 73% degradation of grease waste with bacterial consortium of mix culture has been achieved. Optimization of culture condition being done to enhance the percentage of degradation.

Fig. 5.16: Development of bioprocess for the biodegradation of grease waste (pure cultures and mixed populations)

- In a project entitled" **Biodiversity of Macrofungi in Andaman and Nicobar Islands (ANI): prospective approach in isolation and characterization of mycopigment"** being implemented by University of madras, forest areas of North and Middle Andaman and Rut island were covered for collection of macrofungi. About 30 no. of macrofungi were collected. Of the 30 dry specimens, 20 either fails to produce pigment or negligible amount pigment was produced. Three isolates viz., K2-8, K2-10 and R1-6 produced yellow pigment, isolate K2-6 produced dull brown pigment and isolate M2-8 produced red pigment and these myco-pigments have potential application for dying the cotton fabric.

Daldinia concentrica MA2-1

Heterobasidion sp. F2-14

Isolate K2-10

Isolate K2-8

Fugilo sp. MAK2-4

Fig. 5.17: Macrofungi screened for myco-pigment characterization in Andaman and Nicobar Islands

Science and Society Programme: Major Achievements during 11th Plan Period

- Continuation of Long Term Core Support to 20 S&T based field groups for innovative and adaptive research to address rural livelihood needs.
- A Mobile Elderly Unit to meet elderly health needs for promotion of health care and wellness activities by screening and providing medical facilities at their door step. Launching of a web portal covering information on issues related to S&T interventions for elderly populations.
- Model mechanism for registration of farmers' varieties for rice and millets from Uttarakhand, and development of modular cost effective drier suitable for vegetable drying in hilly region.
- Development of technology packages like Operation of fruit processing unit using upgraded water mill for mountain areas, Energy-Efficient Rural Jaggery-making Systems, briquetting technology package using invasive biomass for energy needs and fuel efficient Tava stove with reduced fuel wood consumption.
- Development of location specific low carbon technology models and institutional mechanism of distributed energy to address small energy needs (e.g. for lighting) and linking it with micro-enterprise generation in10 non-grid villages.

- Establishment of common facility centre for Seabuckthorn processing and making value added product involving community in Leh region.
- Village-level enterprise model for gainful utilization of Non-Edible Oils (NEO) bearing plants involving 10 VOs.

2. Science & Technology for Women

The Science and Technology for Women is one of the earliest initiative of Department of Science & Technology with a vision to promote research, development and adaptation of technologies to enhance the overall social status of the women and augment their to science and technology development, especially in rural areas. The main objective of the program is to involve/network/support R&D Institutions, Scientific Institutions, Universities, Colleges and S&T based field groups (NGOs) in developing appropriate technology packages for women.

Besides individual projects for technology development, up gradation, modulation and replication, the scheme also focuses on All India Coordinated Programmes (AICP), Women Technology Parks (WTP), Scholarship Schemes and National Awards for Women's Development through application of Science and Technology. Salient achievements made under some Co-ordinated programmes/individual projects are:-

Coordinated Program on Biomass Dryers

The coordinated program was initiated during the year 2010-2011 for economic upliftment and empowerment of livelihoods of women through food processing involving biomass based tray dryers in North and North-East India. The project is being implemented in the states of Himachal Pradesh, Uttarakhand and Assam involving TIDE, Bangalore as a co-ordinating agency. Drying protocols were developed for a range of horticultural products. Trial production and test marketing demonstrated that biomass based drying is a viable enterprise for rural women.

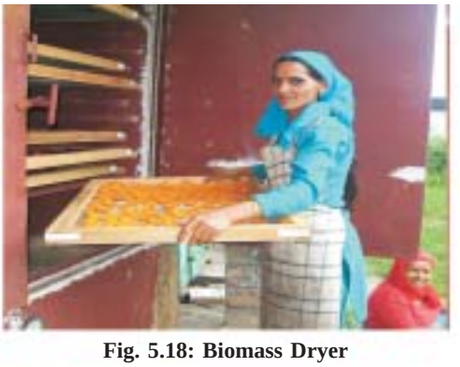


Fig. 5.18: Biomass Dryer

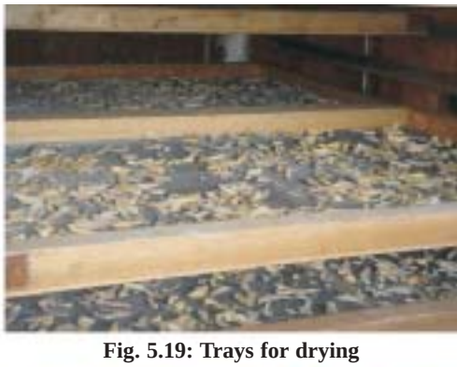


Fig. 5.19: Trays for drying

Fig. 5.20: Different Dried Products

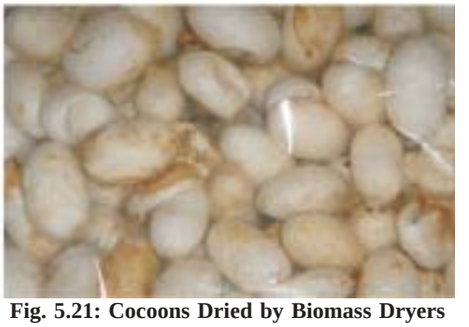


Fig. 5.21: Cocoons Dried by Biomass Dryers

During the 12th Five Year Plan, the programme is slated for an expansion to other geographical areas like Lakshadweep Islands, Andaman & Nicobar Islands, Onion belt of Karnataka/Southern Maharashtra and Hilly areas of Tamil Nadu and Kerala by developing a business plan for women's enterprises in dried products and networking with NABARD for further collaborative work.

Coordinated Programme on Large Scale Employment Generation in Coastal India through Sustainable Utilization of Marine Bio-resources

A coordinated programme on "**Large scale employment generation in coastal India through sustainable utilization of marine bio-resources"** is initiated not only as an alternate source of livelihood but also as an environmentally friendly technology for biomass supply to the seaweed industry. The focus of the programme being implemented at eight locations in the country being co-ordinated by Delhi University is on potential cultivation, processing and value addition of seaweeds with direct benefits for coastal women on priority species keeping in view of environmental considerations and socio-economics aspects as well. The programme has been launched at 6 different coastal locations of the country.

The colossal success of the this coordinated programme resulted in expansion to the second phase during the 12th Five year plan with major thrust on carbon sequestration studies, medicinal properties/ nutritional potentiality, biofertilizers, biofuels, development of low sodium salts and extension of the project to other coastal areas for sustainable livelihood for the coastal communities by creating viable and scalable business models, whilst operating in a manner that is environmentally responsible and beneficial to society on the whole.

Fig. 5.22: Women involved in Cultivation and Collection of Sea weeds

Fig. 5.23: Post Harvest Processing of Seaweeds by Women SHG's at Mandapam, TN.

Fig. 5.24: Development of Mineral Salt (Low Sodium Salt) from Sea Weeds, Mandapam, TN

Outreach Impact: Individual Projects

Agriculture & Animal Husbandry

In a project "**Technology transfer of Good Agricultural practices (GAP) management to improve profitability, sustainability and income from rain fed farming in Rangareddy district of Andhra Pradesh"** being implemented by CRIDA, Hyderabad improved technologies in Maize and Pigeonpea intercropping system were identified for technology transfer. Effective soil management practices, soil test based fertilizer application was introduced. Utility and use of Bio-fertilizer was promoted as GAP intervention. PSB, a bio-fertilizer substituted inorganic 'P' in soil. PSB, bio-fertilizer mixed with FYM @ 8kg PSB per quintal of FYM and about 40kg of PSB applied to 50% of demonstration plots. The figure showing microbial count in field treated with PSB and untreated with PSB is given below.

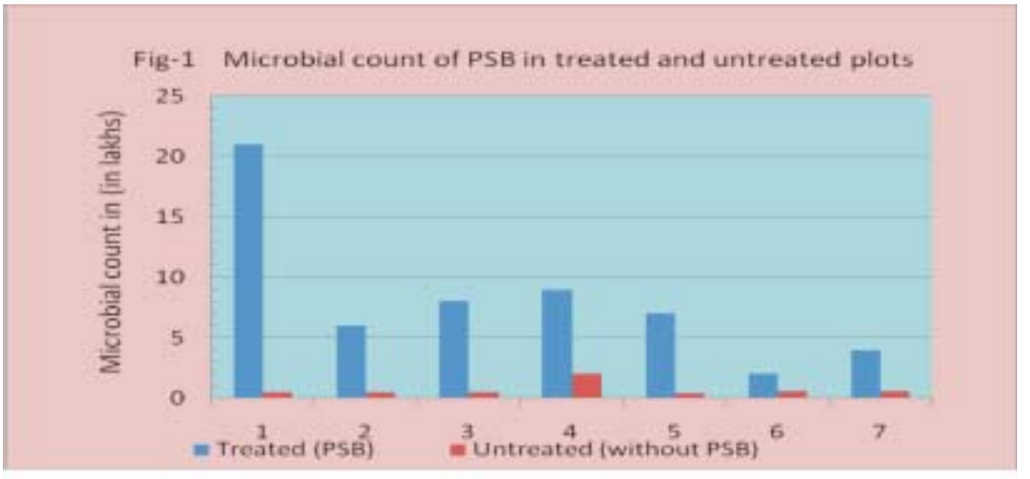


Fig. 5.25

In Horticulture, rain fed tomato, brinjal and chillies are promising vegetables of the region. Pro- trays were utilized for nursery seedling establishment in vegetables. Benefits derived from are time saving in nursery duration, production of healthy seedlings causing less damage to seedlings while removing from trays during transplanting in main field. A pre-season training programme, benefiting women beneficiaries was organized during monsoon season.

Numerous projects were conceived by the division in order to empower rural women socio-economically in the filed of animal husbandry. A project "*Backward poultry and duck production as a tool to sustainable livelihood for rural women of Khurda district of Orissa"* was taken up by Central Avian Research Institute, Bhubneshwar to impart sustainable technology of backyard poultry and duck rearing for both nutritional security and economic gain to the adopted women farmers through training and demonstration at the farmers door step establishing linkages with market for disposal of product and entrepreneurs for supply of inputs in Khurda district of Odisha State. A project "*Breeding and management strategies in dairy animals for socio- economic up-liftment of rural women*" was taken up by Sher-E-Kashmir University in R. S. Pura block of Jammu, J&K State to reduce inter-calving period and enhance fecundity rate of dairy animals in rural areas by using biotechnological tools of reproduction. Oestrus synchronisation and fixed time Artificial Insemination technique was used to reduce intercalving period in dairy animals. Efforts were made to make farmers aware about the economical losses due to delayed intercalving period. Oestrus synchronisation and fixed time AI was performed in a group of 10-15 animals at a time. Women farmers were given training and demonstrations on various aspects of estrous detection, feeding and management

Post Harvest Technologies

Value addition to food products has assumed vital importance in our country due to diversity in socio-economic conditions, industrial growth, urbanization and globalization. Importance of Post-harvest technology lies in the fact that it has the capability to meet food requirement of growing population by eliminating losses making more nutritive food items from raw commodities by proper processing and fortification.

A project titled "**Standardization and commercialization of Post Harvest Management of White button mushrooms"** has been taken up by Y. S. Parmar University in Solan district of Himachal Pradesh to develop the protocol for the post harvest management of mushrooms. After harvesting, mushrooms were brought to the laboratory for analysis and further treatments. Mushrooms were analyzed for different physio-chemical characteristics. Different washing treatments were given in lieu of different quality characteristics. After giving the different treatments, mushrooms were air dried and further analyzed to check the effect of washing treatments on different quality parameters and functional properties of mushrooms. Data was statistically analyzed and best treatments were further applied to mushrooms before standardizing the packaging material.

Fig. 5.26: Color variation in white button mushrooms after various washing treatments

Non-enzymatic Browning (NeB) of white button mushrooms was considered as the key indicator for the evaluation of washing treatments. The above figure clearly shows treatment T7 (0.5 % Citric acid + 0.5 % KMS solution) was recorded with minimum NeB followed by T15 (0.5 % KMS + 0.5 % salt + 0.5 % CaCl2 solution). However, other quality and functional properties were also taken into consideration for the evaluation of washing treatments. After treatment, the mushrooms were also analyzed for their quality and functional and characteristics. The results are given below.

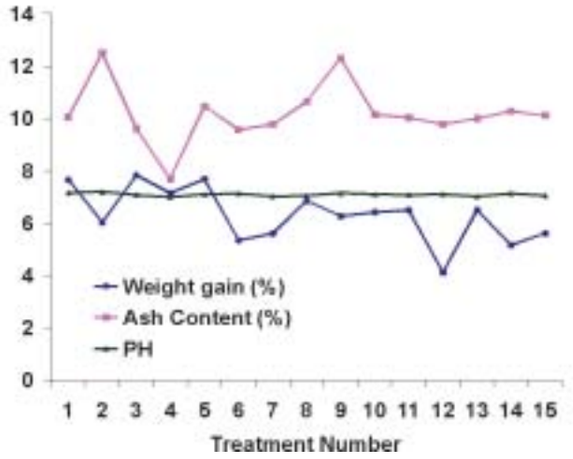


Fig. 5.27: Variation in quality parameters

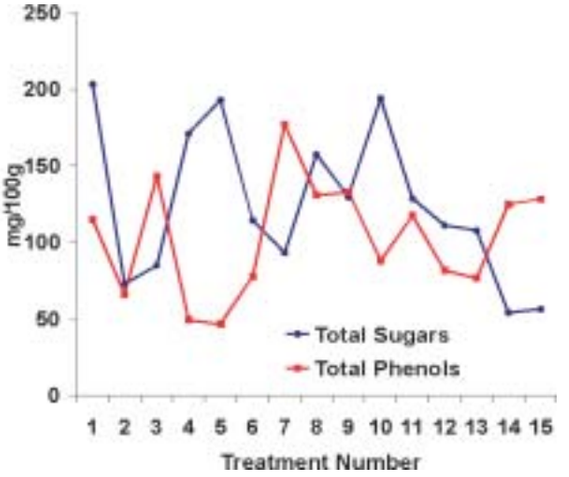


Fig. 5.28: Variation in functional parameters

It has been observed that Slight weight gain was noticed in mushrooms after washing treatments however there was a non-significant gain in all the treatments. Ash content on dry weight basis was found in the range of 9.57-12.50 %. However the maximum ash content was recorded in T2 followed by T9 which were significantly higher than other treatments. The pH range was found to be 7.00 to 7.20 among different washing treatments. The maximum total sugar content was recorded as 202.83 mg/100 g in control which was at par with T4 (170.83 mg/100g), T5 (192.7 mg/100g) and T10 (193.75 mg/100g). The total phenols were in the range of 46.59-176.89 mg/100g. The highest phenolic content was recorded in mushrooms washed with 0.55 citric acid + 0.5% KMS solution (T_7) while minimum phenolic content was recorded as 46.59 mg/100 g (T_5) followed by 49.24 mg/100 g (T_4) and 65.91 mg/100 g (T_2).

Fodder and Forage Crops

There is an acute shortage of fodder in almost all villages of Himalayan regions. Mostly the local people, depending on their fodder requirement, practice lopping of the trees. Most of the fodder tree species are under stress because of unplanned defoliation. Screening and selection of some good indigenous fodder species and establishment of field germplasm bank successfully will be of great help in conserving the genetic wealth and availability of good quality fodder near villages saving energy and time of the village women.

Keeping in view the above state of affair a project "**Creation of Field Germplasm bank of *Grewia optiva* and *Quercus leucotrichophora*"** was taken up with Forest Research Institute, Dehradun, to conserve the existing variability of two important indigenous fodder species by establishing the germplasm bank of these two species. The survey for identification of suitable land for establishing field germplasm bank in collaboration with Uttarakhand Forest Department has been taken up in addition to collection of

seeds from 41 selected trees of *Quercus leucotrichophora* and 70 selected trees of *Grewia optiva* from entire Uttarakhand state.

Standard methods of drying, cleaning and storage were followed by collection of seeds from parent trees. The farmers/women were also trained for various activities related to nursery management, plant propagation, establishment and maintenance of germplasm bank.

Fig. 5.29: Seed Drying and Seed Germination of *Quercus leucotrichophora*

Apart from the above, continuous effort is being laid to economically empower women by providing better work environment and setting up small enterprises trough a variety of projects. A project **"Development of effluent treatment plant for Natural Dyeing Unit & Conversion of waste into commercial products** " has been taken to set up appropriate effluent recycling and disposal system for small-scale natural dyeing unit in Magan Sangrahalaya Samiti, Wardha, that will assists in optimum utilization of waste water, organic materials and mineral mordents; cut the waste to minimum; reduce environmental hazards; convert the organic waste into value added products; and give healthy and hygienic work environment to the workers.

Fig. 5.30: Prototype Effluent Filter, Mosquito Coil Moulding Machine and *Terminalia bellerica* oil developed in the project being implemented at Wardha, Maharashtra.

A New filter to clean dye effluent water for treatment of liquid effluents, Mosquito Coil Machine and Dhoop Batti hand moulds for treatment of semisolid effluents and *terminalia bellerica* seed decorticator for treatment of solid wastes have been developed. The effluent plant will assist in annually saving and reusing more than 2, 00, 000 litres of waste water. Mosquito coil, Dhoop Batti, Holi colours, Behda powder, Behda oil units will give gainful employment to 20 women in 10 villages. The Construction of efficient effluent disposal system and effective drainage structure will provide healthy and hygienic work environment to the workers working in the Natural Dyeing Unit.

Science & Technology for Women: Major Achievements during 11th Plan Period

- Implementation of a coordinated programme on Green leafy vegetables in partnership with Home science colleges, NIN, Agharkar Research Institute, Voluntary Organizations at 16 different agro-climatic regions of the country to tackle the wide spread problem of anemia prevalent in adolescent girls and young women.

- Technology package developed specifically for women viz production of low cost sanitary napkin will be widely disseminated in different parts of the country by setting up of production units/common facility centre. 9 Low cost sanitary napkin production units have been set up.

- Women Technology Parks (WTPs) set up in Karnataka and Gujarat which act as windows for providing information, creating awareness, giving training for appropriate technologies leading to skill up gradation and also possibly to establish important forward and backward linkages for income generation through micro enterprises for women. Total 14 WTPs are operational.

- Implementation of coordinated programme on "Large scale employment generation in coastal India through sustainable utilization of marine bio-resources" at six centres in coastal India not only as an alternate source of livelihood but also as an environmentally friendly technology for biomass supply to the seaweed industry.

3. Tribal Sub-Plan – Technological Intervention for Tribal's Empowerment (TITE)

The Scheme TITE under "Tribal Sub Plan" of the Department of Science & Technology aims at improving living conditions of Scheduled tribes based on sustainable science and technology activities. Under this Scheme, location specific and need-based projects were supported for socio-economic upliftment of tribal communities. Salient achievements made under some Co-ordinated programme/projects are:-

Coordinated program for the Development of Angora Wool Sector to Enhance Income and Employment Generation Opportunities in Tribal Areas of Five Districts of Uttarakhand

This local area multi-locational programme is being implemented in 13 Blocks of 5 Districts of Uttarakhand State with the involvement of 13 science based partner voluntary organizations. This programme Co-ordinated by HIFEED, Dehradun a science based voluntary organization is essentially to benefit Schedule Tribe families from border districts of Uttarakhand by engaging them in entire value chain for development of Angora wools sector as potential micro-enterprise in the higher region of the hills (between 5000 to 7000 feet above sea level) with need based technological interventions. Highlights of the programme in terms of outcome and deliverables may be seen in **Box. 5.4.**

Box 5. 4. Coordinated Programme for the Development of Angora Wool Sector to enhance Income and Employment Generation Opportunities in Tribal areas of Five Districts of Uttarakhand (A HIFEED-SEED, DST Initiative)

RATIONAL & OBJECTIVES: Angora rabbit breeding and rearing has emerged as an important income generating enterprise in the hilly regions of India. This livestock system has been viewed to provide a sustainable source of income under small or zero agriculture land holding. Thus, programme was conceived at the pilot scale to introduce Angora rabbit rearing as an viable income supplementing activity in mountain tribal families of Uttarakhand.



AREA OF OPERATION AND BENEFICIARIES: This program is being implemented in 13 Blocks of 5 border Districts of Uttarakhand State with the network of 13 Partner VOs to benefit and involve Schedule Tribe families.

TECHNOLOGICAL INTERVENTIONS

- Technology inputs provided for designing low cost shelter design and caging systems.
- Demonstration of vermi composting by rabbit faecal matter at the farmer's field.
- Development and designing of quality products (angora yarn, shawls, sweaters, scarves, mufflers, socks, caps etc.) both for local use (blended with merino and local sheep wool) and upper end use (with designed inputs).
- Modified Bageshwari charkha by installing electrical motor to enhance the production capacity.
- Development of portable electrical charkha for spinning purpose and manual mini carder for carding and blending of wool at the household level.




OUTCOMES OF THE PROJECT

- Establishment of total 1170 units (390 angora, 390 spinning and 390 weaving and designing units) within a time period of 3 years through Partner VOs. Average increase in household income to Rs. 3,000.00 to 5,000.00/month.
- Development of cost effective rabbit feed formulation based on locally available raw material.
- Buy-back facility for angora wool, yarn and end products.
- Marketing tie-ups with TRIFED, THDC, Department of Tourism and Department of Industries (HIMADRI) and other marketing agencies.
- Products are being sold under a common brand name i.e. "MONAL"

Outreach impact: Individual Projects

Integrated Duck, Fish Farming along with Horticultural crops through Intervention of Appropriate Technologies for Socio-economic Development of Rural Tribal People of Ziro, Lower Subansiri District, Arunachal Pradesh

This project is being implemented by Take Bogo Multipurpose Co-operative Society Limited located at Ziro with the basic objective for improving the socio economic status of rural Apatani populace of Take Bogo area of Ziro through intervention of integrated farming of Duck, Fish and Horticulture Crops.

Fig. 5.31: View of plantation of Kiwi fruit taken up at Ziro, Arunachal Pradesh in the horticultural garden of project area

Through this project it is has been tried to maximize optimum use of the available land through integrated scientific farming of duck, fish culture along with cultivation of horticulture crops, vegetables to uplift the economic conditions of the rural people of the project area. All the three aspects in integration have been tried and plantation of 160 nos. plant cuttings of Kiwi fruit and around 500 nos. plant cuttings of different varieties of Apples. Cuttings of local varieties of Plums were also planted. Seasonal crops like capsicum, chilli, gourd, brinjal etc. are also being cultivated. This project has been able to draw participation of the villagers, self help groups, un-employed youths as it provides scopes for income generation through maximum utilization of land available by integrated farming of Duck, Fish and Horticulture Crops.

Technological Intervention on available resources for developing feed package for sustainable management of pig farming and improving the socio-economic condition of tribal farmers in the Sonitpur district of Assam.

Under this project being implemented by IIRM, Dispur, Guwahati, a low cost feed package has been developed from locally available feed material in consultation with NRC on Pig, Rani, Guwahati. Trainings have been provided to local tribal community on scientific feeding and management aspects of pig rearing at different stages of growth leading towards better income.

Income generation for rural women through production of high value paper and paper products from banana stem fibres

Under this project implemented by Dharamitra in select villages of Wardha and Yeotmal Dist. of Maharashtra , three types of activities were undertaken i.e. (i) extraction of fibre from banana stem waste, (ii)production of high quality paper from banana fibre and (iii) conservation of banana paper into different utility products. Through these interventions, 6 SHG's of women (about 50 women) came into existence for sustainable income generation in project operation.

Fig. 5.32: Training in preparation of some paper based products from Banana stem fibres

Conservation Avenues for Sustainable Utilization of Minor Forest Produce for Ecological & Economical Benefit of Tribal

In this project being implemented by Centre of Science for Villages, 25 groups of tribal are organized in scientific and sustainable collection, drying, preservation, product diversification with value addition, packaging and storing of MFP covering four blocks located in the northern side of Wardha district, Maharashtra. These trained groups are now engaged in trades related with 1) Gum 2) Food and Beverages 3) Medicine (Herbal) 4) Natural dye and 5) Lac Shellac leading towards livelihood security at local level.

Enhancing the income of resource poor farmers through introduction and expansion of improved crop production technologies (ICPT) of chickpea and other crops in rainfed rice fallow lands (RRFL) in Jharkhand

This project is being implemented by ICRISAT, Hyderabd in collaboration with Birsa Agricultural University, Ranchi to provide **research backstopping** for further improvement of **chickpea and traditional crops varieties traits** and improved crop production technologies of **chickpea** and traditional crops **(lentil, field-peas, mustard & linseed)** in rainfed rice fallow lands **(RRFL)** in participation with farmers from 60 villages of Ranchi and Palamu district.

Collection, Conservation, Characterization and Registration of Farmers' Varieties and Capacity building of the Farmers on the Legislation of PPV FRA

In this innovative project being implemented by MSSRF, Chennai, focus has been given towards awareness and capacity building programme for local farmers on registration of farmers varieties of cereals, small millets-Finger millet (*Eleusine coracana);* Foxtail millet *(Setaria italica), and* Little millet *(Panicum sumatrense),* oil seeds - Niger (*Guizotia abyssinica)* from different agro climatic regions and facilitating

registration of farmers' varieties for the protection of their rights by involving Grampanchayats and villages in Koraput, Kalahandi, Rayagada, Nawarangpur Districts of Orissa. Seed samples of all farmers' varieties have been deposited in the MSSRF Community Gene Bank and local Village Seed Banks for further study like characterization and their profiling as per the DUS guidelines of PPVFR Authority.

Technological Intervention for Tribal's Empowerment: Major Achievements during 11th Plan Period

- Implementation of coordinated programme at 8 locations on demonstration and training in sustainable agricultural technologies and related entrepreneurship development in NE India with technical and co-ordination support of G.B. Pant Institute of Himalayan Environment and Development, Itanagar Unit in partnership with seven VOs. Programme has benefited total 1540 lead farmers in 49 villages covering six states. Total 69 SHGs have been formed involving 11 tribal communities from North-East.
- Implementation of another coordinated programme on sustainable livelihood of tribal around protected area (PAs)/National Parks - a Joint initiative of the SEED, DST and WWF-India around PAs. More than 2000 tribal households have been involved directly around 12 project locations through S & T based activities for MFP Value Addition, Nursery Raising, Medicinal Plant Cultivation, Floriculture, Composting, Millet, Pulse, Cereal and Oilseed Processing etc. Overall, this programme has engaged with over 66 existing village level institutions and created around 40 new groups/institutions at local level.
- Dairy cattle improvement through scientific breeding plan and artificial insemination at Block level in Uttarakhand.
- Cost effective design & development of a manually driven washer pump to lift water from open water sources in Ranchi, Jharkahancd.
- Setting up of incubation support centre of technology skill up-gradation and design development on woolen garment at Ziro, lower Subansiri district, Arunachal Pradesh.
- Local area coordination project on system of Rice Intensification in Jharkhand tribal villages.

4. Scheduled Caste Sub-Plan for the Development of Scheduled Caste Population (SCSP)

Department of Science and Technology has been implementing a Scheme, viz Scheduled Castes Sub Plan (SCSP) with a view to empower SC population through the input of Science and Technology, since 1992. Over the years, the scheme SCSP has achieved significant breakthroughs in developing and demonstrating technology packages in several sectors with the association of S&T based field groups and S&T institutions for improving the quality of life of the economically weaker sections of scheduled castes in urban/rural areas.

Twenty seven projects were sanctioned during the year in the technology areas such as skill improvement and efficiency of traditional occupations, introduction of alternative vocation and entrepreneurial skill development for artisans, products from agro-processing / horticultural produce, production of non-traditional fiber composite, production on recycled material –waste utilization , introduction of non-traditional high value crops for small farmers, value addition in ceramic / pottery wares, solid waste management / vermi-composting, etc. Some of the programme / projects which have made visible impact on the well being of the poor Scheduled Caste population are as under.

Coordinated Programme on Resource Management and Development for the Empowerment of Scheduled Castes in different parts of the country

The programme has been initiated through an orientation workshop to hundreds of NGOs from the twelve states of country in 2007, 2008 and 2009. This has led to the study on the current status of development in 60-65 selected villages where SC communities are predominantly residing.

These projects are located in Andhra Pradesh, Gujarat, Himachal Pradesh, Jammu & Kashmir, Kerala, Madhya Pradesh, Maharashtra, Rajasthan, Tamil Nadu and Uttarakhand where the selected SC communities are mostly engaged in unskilled seasonal labour. The target area includes coastal villages, hilly areas, and plain/drought areas.

Project intervention of the organizations at their respective villages started with mobilizing the community towards a common goal of empowering the community through the application of science & technology leading to reduction in poverty, unemployment and improvement in the basic facilities of living. Participation of the community in planning and implementing the programs are ensured from pre project activities onwards. In addition, a person in the community is made as a project staff and Co PI of the project so as to ensure their ownership of the programme.

The programme component mainly includes addressing of social issues, adoption of technologies in the field of water, sanitation, livelihood development, and micro enterprise development by utilizing local resources. In brief, the programme could build people's institutions either new ones or strengthening the existing ones in the target villages. Involvement of the community in this way reduced the obstacles to intervention from the part of the agency. These initiatives have motivated the community and created ownership among them. In addition, these activities are being contributed to the enthusiasm of SC women and youth towards self help activities

Based on the progress of the first three phases of projects, SEED, division DST is now initiating the this programme in the States of Bihar, Orissa and West Bengal covering about 14 locations.

Outreach Impact: Individual Projects

- A project on "**Utilization of homestead derelict water bodies through culture of air breathing fishes for nutritional security and economic development of SC community**" has been taken up by Vidhan Chandra Krishi Vishwavidyalaya in selected villages under Soguna Gram Panchayat, Block Chakdah, district Nadia, West Bengal. 20 SC families are practicing this method for aquaculture and earning their livelihood.
- In a project being implemented by Uttaranchal Jan Vikas Samiti at Uttarkashi, sustainable livelihood activities were taken up for SC Community of Village Dhunkra, Gram Panchayat Nagihal, Block Purola. Under this project, three types of activities are being undertaken i.e. animal husbandry, apiary and poultry. 63 SC families benefited under this project.
- Another project on " **Demonstration and market link of non chemical method of cultivation of haldi and arrowroot to the SC population as additional livelihood means in Dehrikalan village of Phanda block of Bhopal district**" is being undertaken by Society for Human Welfare and Environmental Furtherance in a cluster of ten villages in an around Bhopal targeting 62 SC families. Training programmes were conducted to beneficiaries and planting materials were distributed.
- In a project being implemented by a field level agenacy at Agastheeswaram block namely Suchindram and Pichaikudiyiruppu of Kanyakumari District, the poor unemployed women of SC population were trained in waste paper recycling technology for sustainable livelihood. Totally 40 women were

trained in the waste paper recycling technology. Two units are being established in two villages involving community and the self help group women. Project has ensured assured market for the paper produced by the community.

- In a project at Pachiappas College, Chennai, Tamil Nadu *in vitro* propagation of *Rosa bourboniana* was standardized in identified rural areas (outskirts of Chennai) by organic cultivation techniques. It was initiated to mass multiply the elite plants of *Rosa bourboniana* through *in vitro* propagation techniques in a cost effective and time consuming manner. Fifteen SC beneficiaries were trained *in vitro* propagation of *Rosa bourboniana* cultivation in Gummidipoondi Panchayat, Thiruvallur district and 5 families are now engaged in the acivities. Five families are practicing rose cultivation using organic farming methods.

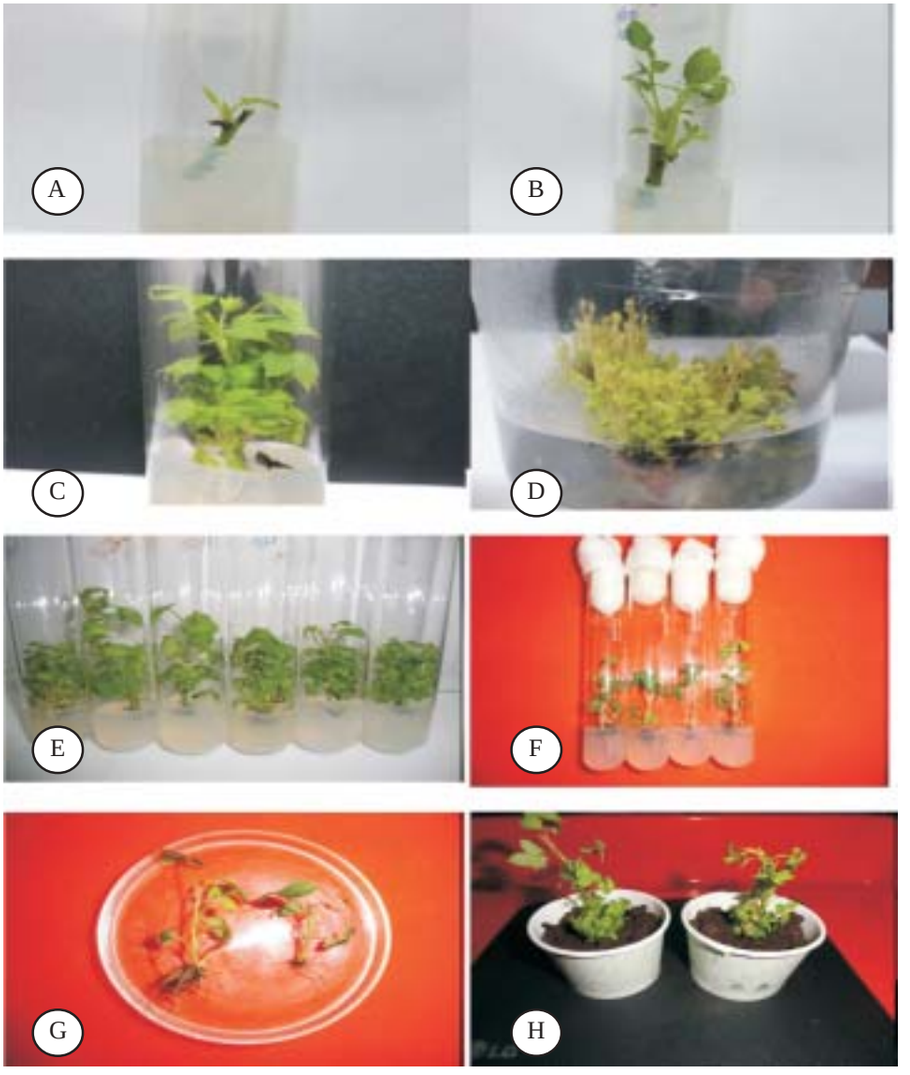


Fig. 5.33: *In vitro* direct shoot regeneration from nodal explants of *Rosa Bourboniana*

A – 7 days old shoot initiated explants in MS medium supplemented with 1.00 mg/l BAP; B & C – Elongation of initiated shoots; D – Multiplication of elongated shoots; E – six weeks old regenerated plants; F & G – Well rooted shoots for hardening; H - *in vitro* grown plantlets were transferred to plastic cups with soil rite and compost mixture for acclimatization

- Number of projects are being implemented in different parts of the country (in the States of Madhya Pradesh, Uttarkhand, Kerala and Tamil Nadu) to improve livelihood of Scheduled Caste population by production and application of bio-fertilizer (Azolla) and organic manure (vermi-compost). Around 500 SC families are benefited under this programmes.

Fig. 5.34: Preparation of vermi-compost at trial field of Pachaiyappas College Campus, Chennai

A – Preparation of vermicompost B and C - staffs (Project scientist and SC women technician are interacting with the beneficiary farmers of rose cultivation in three villages of Gummidipoondi Panchayat; D – Innoculum of earthworms; E and F – preparation of vermicompost

Integrated Mission on S&T-Driven Sustainable Development of Scheduled Caste Populations

- DST envisages taking up An Integrated Mission on S&T-driven Sustainable Development of Scheduled Caste (SC) Population in the top eight SC-populated states in the country. The states are: Andhra Pradesh, Bihar, Haryana, Madhya Pradesh, Orissa, Rajasthan, Tamil Nadu and Uttar Pradesh. This

Mission aims at taking up an all encompassing S&T-driven development of the Scheduled Caste populations in 136 exclusive/nearly exclusive SC clusters (villages/helmets/urban wards) in 36 districts in the above states.

- To gather appropriate inputs for this Mission, the DST sponsored a study, developed a comprehensive inventory of the developmental needs of the Scheduled Caste Populations in the clusters (villages/ helmets/urban wards) in the above states. The study, based on the perceptions of the target SC beneficiaries, local voluntary organizations and field investigation, has identified a comprehensive package of S&T interventions for each of the 136 clusters for meeting their developmental needs and promoting sustainable development of Scheduled Castes in the sponsored project mode along with the appropriate S&T delivery system (technology developers and technology/skill disseminators) for each S&T intervention.

Scheduled Caste Sub-Plan: Major Achievements during 11th Plan Period

- Implementation of coordinated programme on Resource Management and Development for the Empowerment of Scheduled Castes in Coastal & South India and Central and Arid Zone in a cluster of Thirty villages each in 25 locations at Andhra Pradesh, Kerala, Tamil Nadu, Gujarat, M.P., Maharashtra and Rajasthan. In all locations, special emphasis have been given on health and sanitation, food processing, animal husbandry, low cost construction with locally available material and safe drinking water as well as strategic needs such as contract farming system, local resources as new source of livelihood, skill up-gradation for better output and empowerment.
- Supported individual projects for research, design and development in the traditional vocations for socio-economic upliftment and improving the quality of life of scheduled tribes, and area specific S&T based development plan for SC dominated regions.

5. SEED Programme: New Initiatives for 12th Plan Period

During the 12th Plan period for eliciting the social contract of S & T, under the various schemes of SEED programme, it is being planned to take up major programmes on societal intervention in a consortia mode on select themes. These programmes will be designed and implemented in collaboration with technical institution / university and field level voluntary organizations to make visible outreach of the programme. Such theme oriented programmes will have focus on encouraging rural enterprise and production systems; innovations for better quality of life; R & D initiatives for women and child health; encouraging SC/ST youths in development process as technology entrepreneurs ensuring also suitable delivery systems for the S & T interventions. In this process, SEED, DST has taken initial Initiatives to develop multi-locational network programme for Arid and Semi-Arid Regions (ASAR); Hot and Cold Desert Regions; and to expand ongoing programme to provide alternative livelihoods to tribal around protected areas etc. with a focus on research, development and adaptation of need based appropriate/innovative technologies in the areas of Habitat, energy, water, livelihood, etc.

Besides above, during the 12th plan period, women /rural technology parks as multi-sectoral and integrated capacity building model projects, and new inter-disciplinary & location specific projects are likely to be taken up on technology development and piloting and subsequently, extension and delivery in different critical areas of the country to improve traditional skills and livelihoods of the local community. These projects will involve using / augmenting the local resource base, and apply new scientific knowledge to the traditional knowledge of communities. During 12th plan period department will also encourage Public -Private – Community partnership models to evolve and sustain innovation driven entrepreneurship

for livelihoods enhancement.

Department has also constituted Council for Science & Technology for Rural India to develop new mechanisms and operational changes for effective outreach of societal programme in Rural India. S & T interventions to bridge the rural-urban divides in the country promoting equity and improved access to development choices to people will be accorded priority.

S&T ENTREPRENEURSHIP DEVELOPMENT

National Science and Technology Entrepreneurship Development Board (NSTEDB) aims to foster technology based and knowledge driven entrepreneurship among S&T persons through its programmes and activities. Achievements in brief are described below:-

Technology Business Incubators (TBIs): Coupling Knowledge to Wealth Creation

Business Incubation has been globally recognized as an important tool for economic development, job and wealth creation. Technology Business Incubator (TBI) is a flagship programme of NSTEDB and it helps in incubating knowledge based start-ups into sustainable businesses by providing expert guidance, specialized support services, early stage financing, networking among stake holders etc.

Following new TBIs have been sanctioned and are being established in the F.Y.2011-12:

1. **Indian Telecom Innovation Hub** - A Technology Business Incubator (ITIH-TBI) under PPP Model at Koratty, Kerala has been sanctioned for establishment by MobME Wireless Solutions Private Limited in partnership with Technopark TBI (T-TBI). The TBI will focus on start-ups and entrepreneurs on Mobile based value added services and applications with a target of nurturing 100 start-ups in 5 years.
2. **TBI by Agnel Charities, Verna, South Goa** in the area of Clean/Green technology and mixed technology.
3. **TBI at BITS Pilani, Hyderabad campus** focusing on Biotechnology & Information and Communications Technology.
4. **TBI at Adhiyamaan College of Engineering, Hosur** in the area of Information Communications Technology & GPS based systems.
5. **TBI at Technovate India Innovations, Bengaluru**: A virtual TBI in collaboration with Imperial Innovations, India is being hosted in 'Technovate India Innovations', Bengaluru. The thrust area of the TBI is on Clean & Health care technologies and other potential market/applications that leverages from unique Indian demographics.

The rate of incubator formation which was a trickle in the 80s and 90s has gained momentum in the current decade. During last three years, new Incubators have been set up and now the number has grown to over 60. Various efforts are underway to create an appropriate ecosystem to nurture and cultivate techno-entrepreneurship in the country for tapping the existing and futuristic market opportunities across various sectors.

Seed Support System for Incubators and Incubatees

During F.Y. 2011-2012, seed support has been extended to the following TBIs/STEPs:

1. PSG-STEP, Coimbatore.
2. Kongu Engineering College-TBI, Erode
3. TBI at National Chemical Laboratory, Pune.

New Initiatives

1. NET Skills

It is now important to align the growth aspirations of the backward regions, especially that of its youth and adolescents with the basic growth requirement and provide immediate, viable and vibrant employment and career growth, addressing the knowledge and development connectivity requirements, for future growth and prosperity. This challenge is being addressed by the New Emerging Technology (NET) Skills project by creating sustainable models of NET Skill Packages. The Project is being supported by DST and co-funded by EU, to disseminate new knowledge based skills training though New Emerging Technology Skills (NETS) Nodal centres, to marginalized and vulnerable youth, in the backward regions of the 3 states of Tamil Nadu, Maharashtra and West Bengal. The project is being implemented by three partners i.e. STP, Pune and VIB, Nimpith and TREC-STEP, Trichy.

2. DST INTEL Asia Pacific Challenge 2011

An event based platform organised in September 2011 in Bangalore is jointly sponsored by DST and INTEL focusing on identifying 20 technology innovations from Asian countries. The programme is being implemented by PSG-STEP Coimbatore, which is secretariat of Asia Pacific Incubator Network (APIN). The programme aims to provide a platform and roadmap to incubators from 10 countries from Asia Pacific Region to identify and tap potential business plans having good market potential through a systematically structured time bound mechanism.

International Initiatives

India Innovation Growth Programme-A collaborative project of NSTEDB and Lockheed Martin Global Inc.:

Fig. 5.35: Dr.T.Ramasami, Secretary, DST conferring Awards to the winners of the India Innovation Growth Programme in April 2011

India Innovation Growth Programme (IIGP) is a joint initiative of the Department of Science and Technology, Lockheed Martin Corporation, Indo-US Science and Technology Forum, Federation of Indian Chambers of Commerce and Industry and the University of Texas at Austin.

The programme aims to identify innovative technologies from across the country with commercial potential and transform laboratory knowledge into commercial products, services and processes for the benefit at large. The prime endeavour of the programme is to bridge the gap between the mind and the market.

So far, advanced training in Technology Commercialization Strategies, Venture Formation, Venture Finance, Technology Marketing, Competitive Technical Strategies and Presentation Skills by subject matter experts has been provided to 170 Innovators and approx. 200 agreements have been signed between the innovators and the industry partners for commercialization of the selected technologies. The programme has successfully completed five years and has been very well received both by the scientific and industrial fraternity.

Sectoral Analysis of the Selected Technologies in IIGP 2011

Programme 2011 witnessed a phenomenal rise in the number of applications received, indicating success of the programme in the past years in providing support and guidance to the innovators for ways to market their technologies and ideas at domestic and global level. During this programme, the number of applications received rose to 881. These applications underwent the initial screening in which 50 technologies were selected based on the innovativeness and their ability to solve complex challenges faced in the respective end user industries.

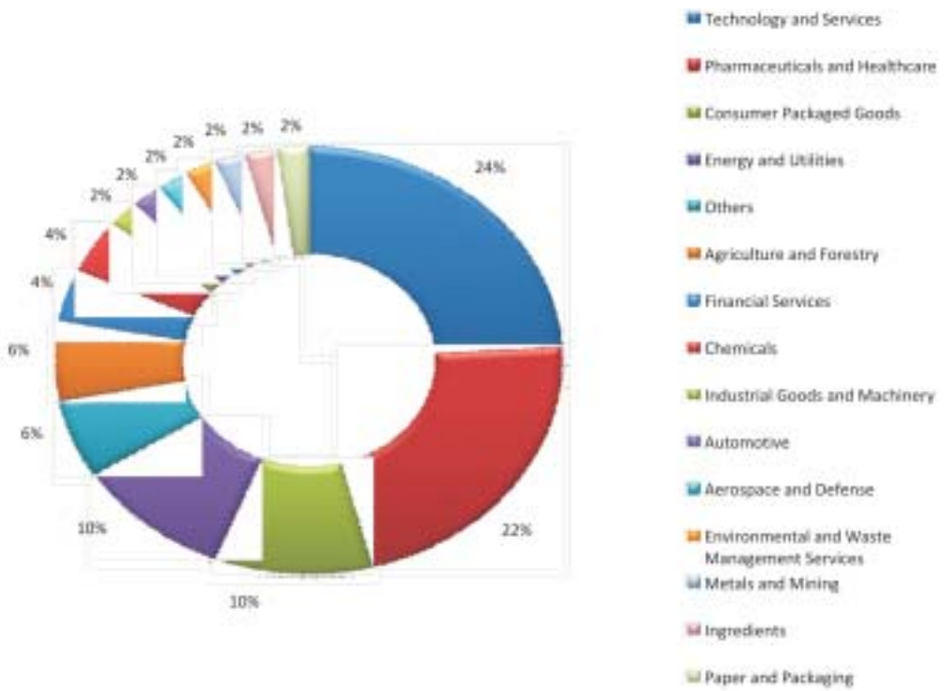


Fig. 5.36: IIGP 2011: End-User Industrial Classification of Selected Technologies

The analysis based on type of organizations that developed the selected technologies during IIGP 2011 is given below:

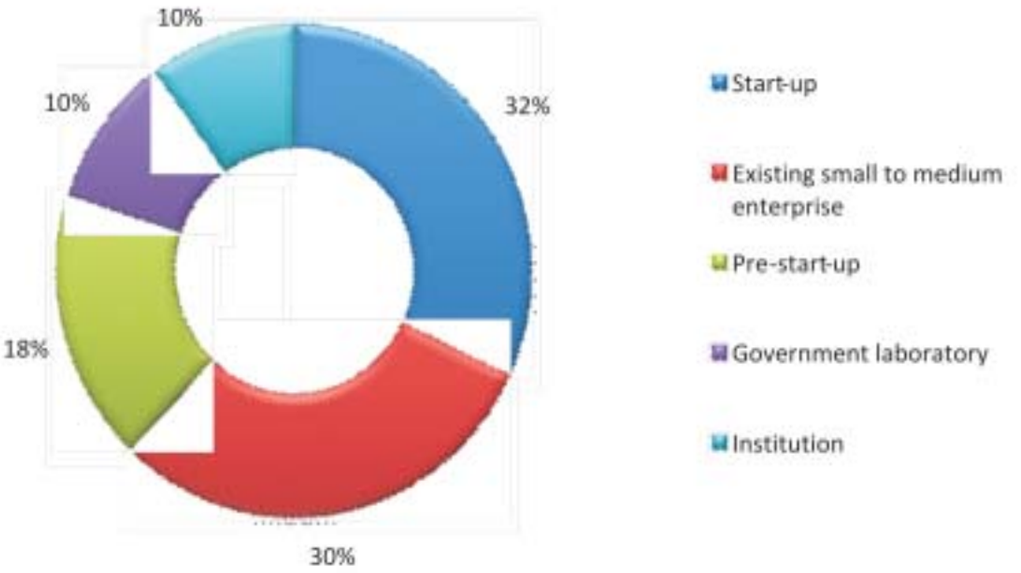


Fig. 5.37: IIGP 2011: Selected Technologies by Organization Type

This year Technology Expo's and road shows were added initiatives of IIGP 2011with very successful Trivandrum and Mumbai chapters.

Fig. 5.38: Mr.H.K.Mittal, Head, NSTEDB at the Mumbai Technology Expo in December 2011 (L) and Trivandrum Technology Expo in September 2011 (R)

Next Big Idea Programme-Intel-NSTEDB and IIM Bengaluru Joint Initiative:

NSTEDB in partnership with *Intel* implemented the Next Big Idea programme in collaboration with IIM, Bengaluru. The main objective is to identify innovations among the student community and build an ecosystem for innovation promotion in academic institution. Under this programme, a training workshop was organised for imparting necessary organisational skills for conducting Business Plan competitions at Institute level. Nearly 29 institutes participated in the event this year. Three week long workshops were

conducted and the workshops included interactive mentoring sessions with experts followed by elevator pitch coaching sessions to polish their presentation skills. Top three finalists were selected and further fine tuned through 1:1 mentoring sessions. Out of which top two have been sponsored to participate at the *Intel*-UC Berkeley Technology Entrepreneurship Challenge at the global platform in November 2011.

Entrepreneurship and Innovation Programmes

Innovation and Entrepreneurship Development Centres (IEDCs):

Innovation and Entrepreneurship Development Centre (IEDC) have been promoted in educational institutions to develop institutional mechanism to develop entrepreneurial culture in academic institutions to foster growth of innovation and entrepreneurship amongst the faculty and students. The IEDCs aim to promote innovation amongst the students of S&T. The students are encouraged to take up innovative projects as a part of their curriculum and are support to developed a working prototype. During the year 3 new IEDCs have been supported once each at Hyderabad, Chennai and Agartala. Support to 15 existing IEDCs continued during the year. About 75 innovative projects were developed by the students during the year. Students are being motivated to take up this project on a commercial basis and go for their start-ups.

Entrepreneurship Development Cell (EDC):

EDCs have been promoted by NSTEDB in educational institutions and institutions of higher learning to create entrepreneurial culture in the parent institution and other institutions in the region and to act as an institutional mechanism for providing information and assistance to budding S&T entrepreneurs. About 15 EDCs are currently operational.

Science & Technology Entrepreneurship Development (STED) Project:

STED project aims to bring socio-economic development in a region by promoting entrepreneurial temper and motivating unemployed youth for establishing micro enterprise based on innovative skills and technology. With the support to 55 STED Projects in the current financial year 2011-12, it is expected to establish more than 3000 micro-enterprises / units all over the country.

12 new STED projects have been initiated for implementation at the following locations in 2011-12:

- Panchmahal, Gujarat,
- Ranchi, Jharkhand
- Idukki, Kerala
- Morena Dist., Madhya Pradesh
- Vangar, Rajasthan
- Ranipool, Gangtok, Sikkim
- Vellore, Tamil Nadu.
- Barabanki Dist., Uttar Pradesh

- Khushinagar, Uttar Pradesh
- Bijnaur, Uttar Pradesh.
- Gonda, Uttar Pradesh.
- Mayanguri, Jalpaiguri, West Bengal

Skill Development Training through S&T (STST) aims at demonstrating the effectiveness of short term market oriented technical skill training in empowering unemployed youth to earn a sustainable livelihood. 96 new STST proposals are being supported in 2011-12 and more than 10,000 youth are expected to be trained during current financial year.

Entrepreneurship Awareness Camp (EAC):

With a view to expose students as well as faculty of academic institutions, offering degree/diploma courses in S&T, to entrepreneurship as an alternative career, Entrepreneurship Awareness Camps (EACs) are conducted by nodal agencies in each State/Union Territory of the country. The implementing agency is usually either an educational institution or a professional body specializing in entrepreneurship development. Each Camp, of 3 days duration, is conducted in the premises of an academic institution and aims at creating awareness among students about various facets of entrepreneurship while highlighting the merits of pursuing such a career option.

During the year 2011-12, total **867 EACs** have been organized at various educational institutions in the country.

Entrepreneurship Development Programme (EDP):

An Entrepreneurship Development Programme (EDP) aims at training the S&T graduates and the diploma holders in the essentials of conceiving, planning, initiating and launching an economic activity or an enterprise successfully. Duration of the programme is of 6-8 weeks.

During the year 2011-12, total **87 EDPs** have been organized at various locations.

Women Entrepreneurship Development Programme (WEDP):

Women Entrepreneurship Development Programme (WEDP) aims at training potential women entrepreneurs having S&T background for setting up an economic activity or an enterprise successfully. Duration of the programme is of 6-8 weeks. During the year 2011-12, total **63 WEDPs** have been organized at various locations.

Technology Based Entrepreneurship Development Programme (TEDP):

A Technology Based EDP primarily focuses on training and development need of S&T entrepreneurs in a specific technology area of commercial viability. The participants are provided with hands-on training in indigenous technologies developed by R&D institutions that are available for commercial exploitation. In each TEDP, 20-25 persons, having a degree/diploma in S&T are trained through a structured training programme of about 6 weeks duration. During the year 2011-12, total **189 TEDPs** have been organized at various locations.

Faculty Development Programme (FDP):

A Faculty Development Programme (FDP) is designed to train and develop professionals in entrepreneurship development so that they can act as resource persons in guiding and motivating young S&T persons to take up entrepreneurship as a career. Through each FDP, about 20-25 faculty members of Science and Engineering colleges, Polytechnics and Entrepreneurship Development Organizations are trained for duration of 2-3 weeks. During the year 2011-12, total **135 FDPs** have been organized at various locations.

NATIONAL COUNCIL FOR SCIENCE & TECHNOLOGY COMMUNICATION (NCSTC)

The National Council for Science & Technology Communication (NCSTC) is mandated to communicate science & technology (S&T) to masses, stimulate scientific and technological temper and coordinate & orchestrate such efforts throughout the country. The programmes of the Council also aim at building capacity for informed decision making and promote rational thinking in the community. It is contributing to societal upliftment through dissemination of scientific knowledge in an informal manner and builds programmes with the help of different media which percolate down to every nook and corner of the country.

Science Express

'Science Express' is a unique & innovative mobile science exhibition, mounted on a customized 16 coach AC rake especially fabricated for DST by Rail Coach Factory Kapurthala. The goal of this world's largest mobile classroom-on-wheels is to nurture curiosity amongst our youth and create an awakening through fun-filled learning. This flagship venture of NCSTC also strives to take modern research and state-of-the-art out of laboratory and showcase it to school & college students in particular in order to encourage them to pursue higher studies and careers in science. Further, it endeavors to reveal the relevance of science in everyday life and generates interest about burning issues & challenges of S&T amongst the visitors.

The Exhibition

'Science Express' initially contained about 300 large-format visual images, over 150 video clips and multimedia exhibits, which dealt extensively with cutting-edge research. Majority of the exhibits displayed in 11 coaches were developed by Noble laureates from Max Planck Society, Germany while another coach was devoted to portray Indian legacy in Science besides hosting a lab in which students were encouraged to perform experiments in Chemistry, Physics, Mathematics and Biology. About 20 indigenous exhibits too were displayed. Through these, the visitors were exposed to a wide gamut of issues in science including mysteries of our world, groundbreaking discoveries, emerging issues, etc. in a fascinating manner.

A dedicated coach on 'Climate Change', sponsored by HSBC Bank, was introduced in Phase-3 which was updated in Phase-4 based on its popularity. Panels on Indian scientists and their contribution in various disciplines of science too were added. To celebrate 'International Year of Chemistry–2011' each Element of Periodic Table, its properties, uses, etc. was prominently displayed on exterior of each window pane. Petroleum Conservation Research Association (PCRA) too has used the train to distribute material

on 'Energy Conservation' among masses. In addition, an interesting & informative exhibition on 'Water' sponsored by Nestle & Swiss Embassy was also put up in Phase-4 which was highly appreciated. The programme got extensive coverage in Media while dedicated website www.sciencexpress.in has become very popular.

Achievements in XI Plan

The inaugural edition of 'Science Express' was flagged off from Delhi Safdarjung on 30 October 2007 by Hon'ble Prime Minister of India and Chancellor of Germany. Since then, it has been showcased across India in 4 phases of 6-7 months duration each year (Figure 5.39). Phase-IV of this iconic exhibition was launched on 4 December 2011 and culminated on 16 June 2011 at Gandhinagar. At each of the locations, the train usually halted for 2-4 days during which students and public thronged the exhibition. It received overwhelming response at most of the halts with over 63 lakh people, mostly students & teacher. They enjoyed learning about cutting-edge research in science, explained through interesting & informative audio-visual exhibits and interactive tools. An overview of Achievements in XI Plan is given in the **Table-1.**

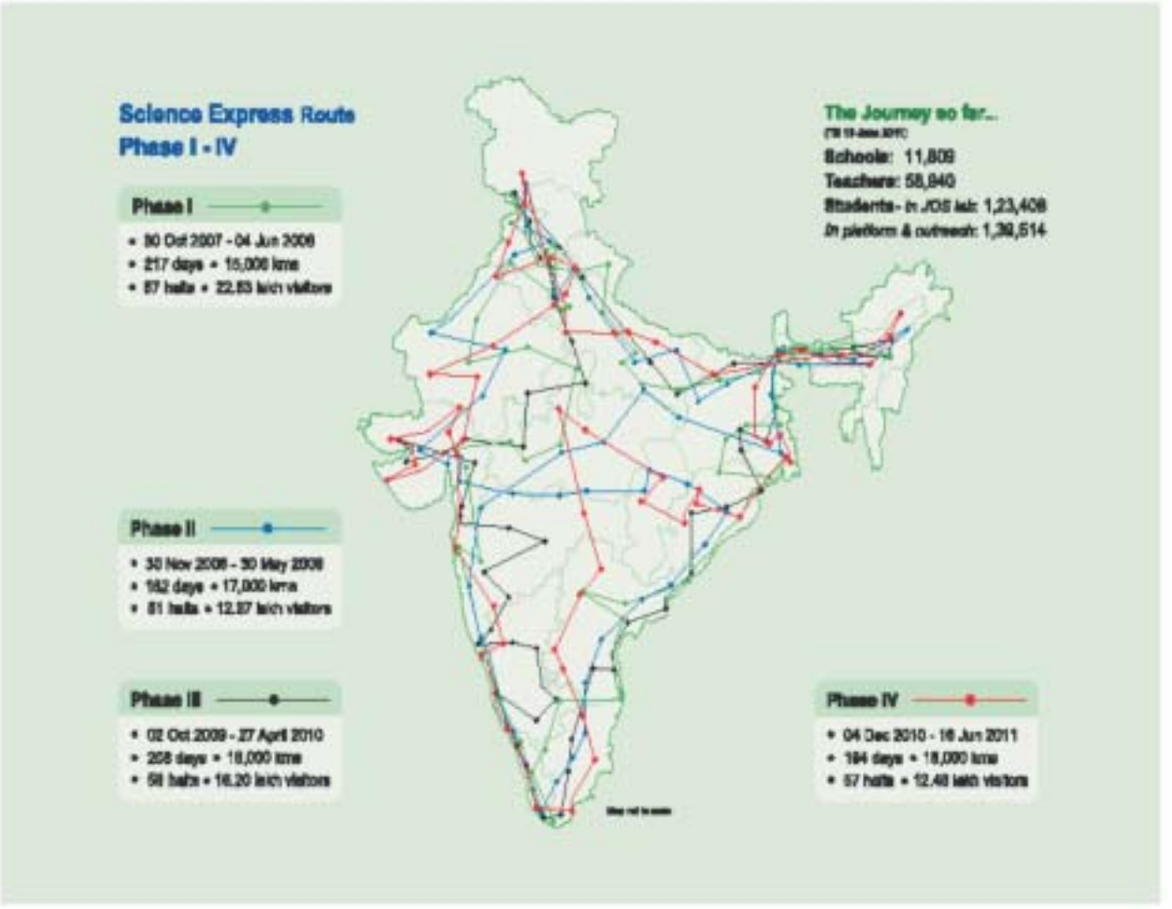


Fig. 5.39

Table 1: Science Express – Achievements

Duration From…To	**No. of Schools/ Colleges**	**No. of Students** (visited with prior appointment	**No. of Teachers** (visited with prior appointment	**No. of General Public** (includes about 30% students who visited with parents or on their own)	**No. who performed Joy-of-Science (JOS) Lab** (Students & Teachers)	**No. of students who performed On-Platform Climate Change Activities**	**No. of Students Counseled about Careers**	**Other Activity** (include Out-reach in schools near halts)	**Total No. of visitors**
Phase I 30 Oct 2007- 3 June 2008	3,129	2,19,395	16,134	20,04,687	15,372 *(Kids' Lab of BASF)*	n/a	n/a	n/a	**22,55,588**
Phase II 30 Nov 2008- 30 May 2009	2,420	2,14,014	12,283	9,81,095	17,333	n/a	Reported as part of 'Other Activity'	13,257	**12,37,982**
Phase III 2 Oct 2009- 27 Apr 2010	4,098	4,76,468	19,855	10,10,597	46,253	34,846	9,128	23,113	**16,20,260**
Phase IV 4 Dec 2010 – 16 June 2011	1,162	2,32,201	10,668	9.01,737	44,450	26,329	4,730	27,053	**12,48,226**
Total (801 days)	***11,809***	***11,42,078***	***58,940***	***48,98,116***	***1,23,408***	***62,233***	***13,858***	***63,423***	***63,62,056***

Operations of 'Science Express'

Vikram A Sarabhai Community Science Centre (VASCSC), Ahmedabad was entrusted by DST with the task of day-to-day operations of the 'Science Express' right since its inception. Buoyed by the on-board success of Kids' Lab of BASF Ltd. in Phase-1, VASCSC mounted 'Joy-of-Science' lab in Phase-2, in which over 1.25 lakh students have conducted exciting & easy-to-perform experiments & activities in Physics, Chemistry, Biology, Maths and Electronics.

Future of 'Science Express' in XII Plan

NCSTC plans to dismantle the existing exhibits as these have been effectively showcased across the country and put up new exhibits on some of the burning issues of S&T in XII Plan so as to create an awakening amongst masses, in general and students, in particular about their various aspects. Union Ministry of Environment & Forests has evinced interest in putting up a new exhibition in 8 coaches dedicated to the theme 'Biodiversity' as the current decade (2010-2020) has been declared as the United Nations Decade on Biodiversity. DST will display exhibits on 'Climate Change' to highlight its causes & effects and ways & means of mitigation. HSBC, Nestle, Swiss Embassy and PCRA have once again come on-board with new exhibits on Climate Change in rest of the coaches of this 'Biodiversity Special' besides DST & VASCSC putting up a new version of Joy-of-Science lab with a thrust on experiments & activities on focal themes.

'Science Express-Biodiversity Special' will be showcased for two years at about 100 locations on the Broad Gauge Railway network across the length & breadth of the country in at two phases. It is planned to be launched on 9 April 2012 from Delhi to coincide with the meeting of Inter-governmental Committee for Nagoya Protocol on ABS under the United Nations Convention on Biodiversity (UN-CBD) and culminate at Hyderabad in October 2012 where over 5000 delegates from about 200 countries

will assemble to attend UNCBD- Conference of Parties (COP-11). Later, it is proposed to utilize this unique medium to showcase many other stimulating exhibitions on issues like Natural Resources, Innovation, Space Programme, and so on.

National Science Day

National Science Day (NSD) is celebrated every year on 28 February to commemorate the discovery of the 'Raman Effect'. The theme of NSD-2012 was 'Clean Energy Options & Nuclear Safety'. NCSTC supported various programme countrywide by giving grants to its State S&T Councils & Departments for organization of lectures, quizzes, open houses, etc.

Eco- Wash Awareness & Literacy

The programme has led to development of a specialty of Development Science Communication as applied to communication of traditional and modern knowledge and practices related to Eco Literacy & WaSH (Water, Sanitation & Hygiene) Literacy for-

- Ecological efficiency, innovation, inherited knowledge & wisdom: for better WaSH Practices
- Eco-water resources & environmental sciences
- Water conservation, purification, re-use, recycling solutions
- Watershed management, harnessing water cycle- land & sea water: Inherited knowledge, wisdom & S&T advances (community informatics, hydro-geomorphology, imaging, mapping, & scenario building, etc.)
- Eco-sanitation & eco-tech, liquid waste & waste-water treatment
- Sanitation & hygiene support solutions

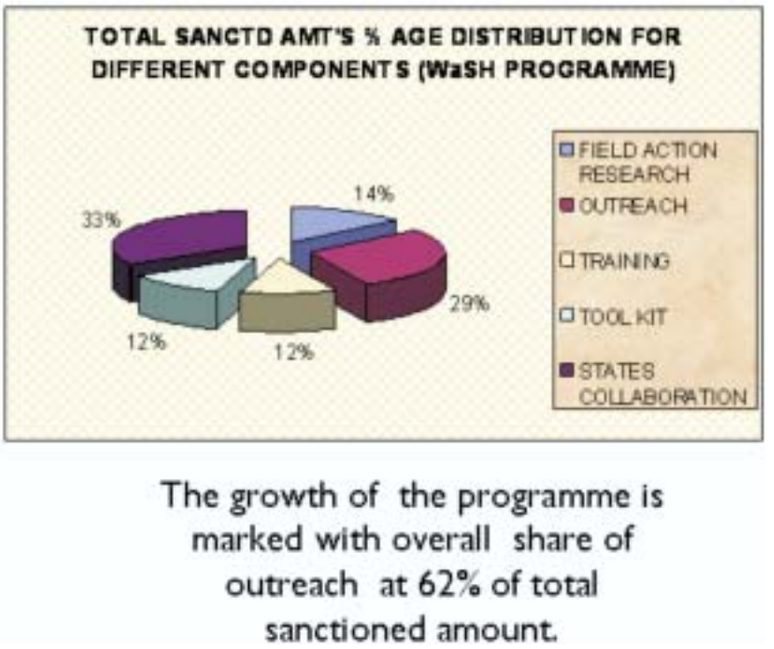


Fig. 5.40

Thrust Areas

For promoting a multifaceted and multilevel approach to behavioural change, based on field action research, the following thrust areas have been promoted:

(a) Research & S&T Communication Software

(b) Trainings & Demonstrative Communication- Best practices in protecting eco-systems, preserving & restoring watersheds, water bodies & water quality, water conservation, etc.

(c) Outreach: Outreach models for inaccessible & remote areas (Eco-zonation based target areas); Institutional Capacity Building through various media & institutional innovations- *Jal Saksharta Kendras*, *Jal Chaupals*, Watershed Watch & Care Groups, *Paani Panchayats*/Water User Associations, *Swachhta Chaupals*, *Swachhata Vigyan Sarathis & Sahkarita*, Complementing IWRM & TSC in States).

Up-scalable Models of Outreach

Projects have yielded scores of models for scale up e.g. IIT, Delhi's action with Navodaya Schools in Rajasthan, Haryana, U.P villages; *Jal Chaupals* and Water Clinics in Shankargarh block, Allahabad; Trainings of rural youth in Water Literacy in Bharatpur (Rajasthan), Science Communication using Water Audit in 5 districts of M.P. Under various projects, as model interventions with S&T communication, the community has been mobilized for taking action at local level, which notably includes formation of *Mahila Paani Panchayat Samooh* (Uttarakhand), Student Volunteer networks (Delhi, Uttarakhand), Orientation & trainings of students & community representatives and Community volunteers (Rajasthan & West Bengal), Schools–community interactions for water conservation and water quality monitoring, amongst others. S&T Communication Trainings for Water Educators have been supported. Trainings for prospective members of Paani Panchayats have been organized in Rajasthan and Uttar Pradesh.

A resource book in Hindi for Science Communicators, "*Paani Ki Bat-Vigyan ke Saath*" has been brought out and disseminated. The communicative guidance on water quality monitoring has been enriched with development of quality assurance protocols for comparative evaluation of water testing kits and also lab methods in respect of Fluoride, Iron & Nitrate. Projects were formulated with IIT Delhi & Shriram Institute for Industrial Research, Delhi. The initiatives and outcome has been reviewed and assistive guidelines provided to project teams. Consequently, relative utility of test kits and lab methods is being brought out for reinforcing the integrity of scientific knowledge, skills and practice at the time of training of young scientists in water quality monitoring with participation of communities.

Following the meeting of Technical Advisory Committee, a state level sensitization was organized in Odisha on November 2, 2011.

Role of State S&T Councils has been enlarged under six month long special package on 'Networking for WaSH'. Karnataka, Tamil Nadu, Andhra Pradesh, Gujarat, Tripura, Manipur and Punjab have come forward for the package.

Achievements during XI Plan

- Large no. of participants (Outreach, Field Action Research, & Trainings)
- Contributions to resolution of location specific developmental/socio-scientific problems

- Improvement of quality-of-life of specific target groups
- Implementation of needs analysis and evaluation mechanisms within the communication process.
- Capacity building of implementing agencies in science communication practices (about 45 groups, apart from State S&T Councils)
- Research sustainability by the implementing agencies

The share of outreach has consistently been on a rising trajectory as shown in Fig. 5.41 and 5.42.

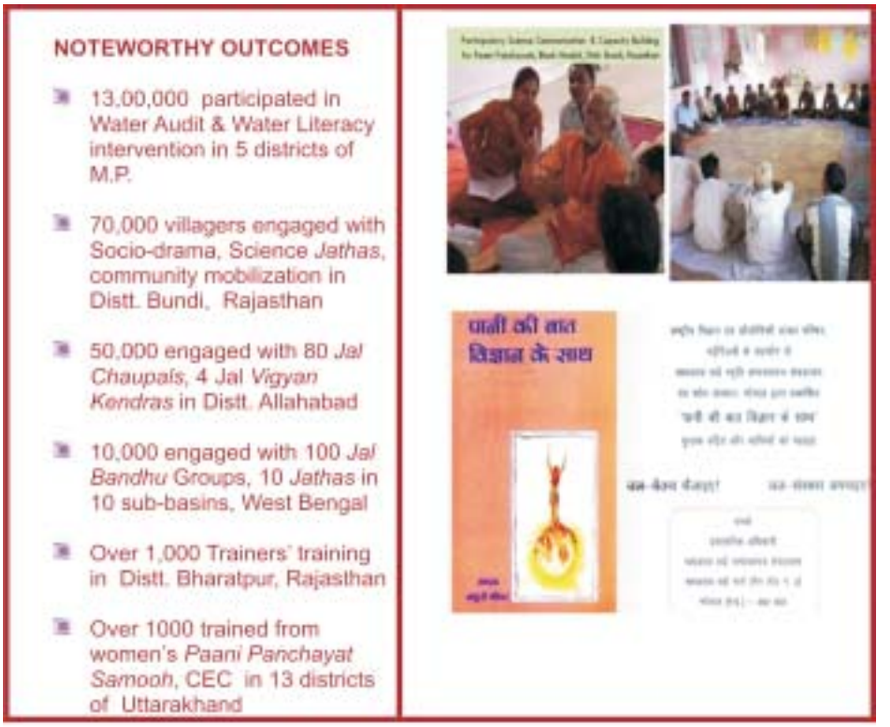


Fig. 5.41

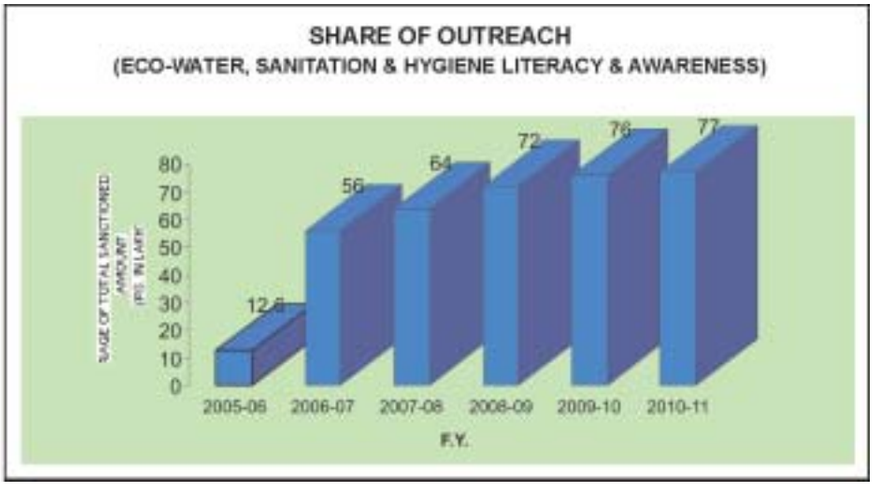


Fig. 5.42

Achievements expected during 12th Plan

'Eco-WaSH Awareness & literacy' programme would be scaled up with focus on the following:

i) Reaching out to inaccessible corners of the country, achieve wider spread and access

ii) Promoting research in designing location specific/regional messages

iii) Strengthening of human resources through S&T Communication Trainings for Water Journalists & Water Educators respectively, Water Quality Monitoring Communication Trainings & Trainings for prospective members of Paani *Panchayats* are being strengthened further. Role of State S&T Councils shall be enhanced in trainings of WaSH educators.

iv) Encouraging the participation by women and young girls for acting as science communicators within their communities

v) Integrating traditional forms of learning and knowledge into current practices.

National Children's Science Congress (NCSC)

The 19th edition of National Children's Science Congress was held at Jaipur National University, Jaipur, during 27-31 December 2011. About 700 projects were presented by child scientists from urban and rural areas both from different states, apart from the participation from ASEAN countries. Activity corner cum exhibition, daily workshops for guide teachers, face to face interaction with eminent scientists and cultural shows were the additional attractions of the event. The focal theme for 2010 & 2011 was *Land Resources: Use for Prosperity & Save for Posterity.*

National Teacher's Science Congress (NTSC)

NTSC is a forum for teaching community of the country to communicate their innovative concepts and share their creativity in methodologies of science education. The 6th NTSC was held at Banaras Hindu University (BHU), Varanasi, during 8-11 Nov. 2011. Apart from workshops on low cost teaching aids, there were five plenary sessions where experts talked about the challenges of science teaching in rural areas; current trends in teaching biology and research career options; different physical conditions prevailing in India and its correlation to crop production; National Curriculum Framework-2005 in light of teaching science; and the critical role of children in the teaching-learning process. More than 200 papers were presented on the focal theme: *Trends and Challenges in Science Education*.

Enrichment of Resource Material to Promote Popularization of S&T

This is an inter-institutional collaborative project. Besides DST, the Partner Institutions in the Project are United Nations Educational, Scientific and Cultural Organization, New Delhi; Central Institute of Education, University of Delhi; Society for Education and Social Development, Delhi. The project focused on the popularization of Science through enrichment of Science Kits as resource material for their pedagogical effectiveness and usage in school as well as community.

Empowering Next Generation of Innovators - IRIS

The 'Initiative for Research & Innovation in Science–IRIS' is a research based science fair initiative for students, with an objective to inspire budding scientists in India. IRIS is an example of a public–private partnership with DST, Confederation of Indian Industry (CII) and Intel as partners. This year the fair received innovative project entries from school students across the country. The students participated by sending synopsis across 10 categories: Behavioural Sciences, Bio-Chemistry, Botany, Chemistry, Computer Science, Engineering, Environmental Science, Mathematics, Physics, and Zoology. National fair was organized during 17-20 November, 2011 at PEC University of Technology, Chandigarh. Around 100 shortlisted participants showcased their projects. Eight Innovative projects were identified for participation in International Intel Science & Engineering Fair which will be held in USA during May 2012.

India Innovation Initiative – i3

This year, National finale of the India Innovation Initiative (i3), another programme under PPP mode, saw around 50 best-in-class innovation entries battling it out for top honours. i3 provides a unique platform to upcoming innovators above 18 years of age by giving them an opportunity to showcase their innovations and bringing them to life under the global expertise of Agilent Technologies in transforming innovations into products, the strong knowledge based networks of DST and the demand base for innovations from CII. The initiative is being supported by government and non-government incubator and investor associations for incubation, entrepreneurship and marketability. There were separate awards for young innovators, which was sponsored by Aries Ergo Limited on behalf of Yi (Young Indians).

Science Exhibitions & Fairs

In order to communicate S&T achievements among the public-urban and rural population, NCSTC conducted or participated in a series of science exhibitions & fairs in different parts of country. The Council also participated in the popular Perfect Health Mela during 19- 23 October, 2011 in New Delhi and put up its activity corners that attracted thousands of visitors.

Sri Srinivasa Ramanujan – Dr. S. Chandrasekar Legacy in Science

A two days' workshop cum exhibition was organized by the Tamil Nadu Science & Technology Centre, Chennai to celebrate the legacy of mathematics genius Sri Srinivasa Ramanujan, and Noble laureate Dr. S. Chandrasekar. The main objective of the workshop was to create awareness and inspire students. More than 250 students & teachers attended the programme.

Agrasar Lecture Demonstration Series

In Odisha and Tamil Nadu, 20 lectures cum demonstration programmes were organized on topics like Weather, Climate Change, Sustainable Development, Food Adulterants, Food Safety, Water, and so on.

Training Programme on Disaster Preparedness

Regional level training programme to develop resource persons on disaster preparedness was organized at Bhubneshwar. Besides NCC & NSS programme officers of Orissa, various officers from near by states like West Bengal, Sikkim, Bihar, etc. and students also participated.

Fig. 5.43: Workshop on Disaster Preparedness organized at Bhubneshwar

Grameen Jagriti

Two workshops for creating awareness about improved agricultural technologies, health hazards and their management, demystification of superstitions, etc. were organized in Allahabad during June and July 2011. About 150 progressive farmers, volunteers of grassroots organizations and extension functionaries from different districts of Uttar Pradesh were trained in each. These functionaries will further create awareness amongst farmers and help them in solving local problems. Topics like management of agricultural waste, usage of modern and improved machinery for tillage, sowing, etc., precautions during the usage of chaff cutters, threshers and reapers, etc. were discussed.

Motivational Programmes

To encourage talented students to select career in science, motivational camps are organized in universities, research laboratories and scientific institutions. Students of secondary & senior secondary school level come in direct contact with eminent scientists. They handle sophisticated instruments, visit research laboratories and get exposure to scientific careers. During the year, motivational programmes were organized in Bihar, Tamil Nadu Orissa, Uttrakhand, Assam and Manipur.

Promotion of Ayurveda Biology

Ayurvedic and *Vedic* systems of healthcare of India have been practiced effectively for thousands of years by millions of people. The empirical knowledge of *Ayurveda* is well established but the terms, concepts and its applications to describe types and functioning of the human body, to classify levels of health, and to describe the onset of disease have not yet been effectively related to modern scientific biology and medicine and needs intense research to establish and promote this area of utmost importance. Research in *Ayurveda* has placed much emphasis so far on herbal drugs and much more is needed for advancement of its science. Due to advances in modern methodology, science today offers an excellent opportunity to test many of the basic concepts, procedures and products in *Ayurveda*. With this background, DST has constituted a Task Force which is mandated to facilitate devising effective strategies and mechanisms.

Objectives

i) Development of basic understanding of concepts, procedures, and products of *Ayurveda* in terms of modern sciences such as Biology, Immunology and Chemistry. DST shall provide support for such interdisciplinary studies under this scheme to individual investigators and groups of investigators.

ii) To develop infrastructure facilities, Centers of Excellence, and major research facilities in this area.

iii) To promote human resource development in this area by offering fellowships, training opportunities, providing support to scientific meetings and workshops.

iv) To promote collaborative research with institutions abroad who are active in pursuing studies on traditional medicine and may have interest in Ayurvedic biology.

Achievements

Office of Principal Scientific Advisor to the Government of India has funded around half a dozen projects which have been completed. During the period two meetings of the Task Force were held in order to identify the priority areas of research and ways forward.

Achievements Anticipated during the 12th Plan

The programme of *Ayurvedic* Biology will be steered by the Task Force to promote high quality research which would lead to major contributions to scientific knowledge and that have implications for improving the standards of healthcare. The investigative work in this programme will involve full participation of scientists and *Ayurvedic* experts who would be part of established institutions of science, medicine, and *Ayurveda* in India. Individual or groups of scientists, physicians and *Ayurvedic* experts are encouraged to submit project proposals on any interesting aspect of *Ayurvedic* concepts, procedures, or products, which would lend themselves to investigation by modern scientific protocols.

National Awards for Science & Technology Communication

Each year, outstanding efforts in S&T communication are recognized with national awards. During 2011, National Award for Outstanding Efforts in Science & Technology Communication through Print Media including Books and Magazines) was given to Chitta Ranjan Mishra, Bhubaneswar and National Award for Outstanding Efforts in Science & Technology Popularization among Children was jointly given to Shri Jadhav Balasaheb Bharma, Mumbai and Dr. Promod Chandra Tamuly, Jorhat.

UNESCO Kalinga Prize for Popularization of Science

The department performed a major role in organizing 60th Anniversary of UNESCO Kalinga Prize for Popularization of Science which was celebrated in the form of an International Conference which was organized on 4th-5th January, 2012 in close co-operation with UNESCO, Department of Science & Technology, Ministry of Human Resource Development, Kalinga Foundation Trust and Govt. of Odisha co-jointly with 99th session of Indian Science Congress at Kalinga Institute of Industrial Technology, Bhubaneswar. The conference was inaugurated by Hon'ble Chief Minister of Odisha, Shri Naveen Pattnaik. There were 16 participants from various countries including previous UNESCO Kalinga Laureates and current jury members. A two-day conference was attended by 1500 delegates from India as well as abroad. Network of UNESCO Kalinga Laureates came out as an important recommendation of the conference, UNESCO, Paris officials supported the idea.

UNESCO Kalinga Prize for Popularisation of Science for the year 2011 has been awarded to Dr Réne Raúl Drucker Colin, Mexico. UNESCO Kalinga chair for the year 2009 to connect Indian efforts in the area with best Science popularization initiative in the world was awarded to Prof. Trinh X. Thuan, Vietnam. Prof. Thuan visited Jaipur, Bhubaneswar and Bangalore. He gave two lectures at each city.

The life and work of 66 UNESCO Kalinga Laureates has been compiled and brought in the form of a Book called **UNESCO Kalinga Laureates for Universal Peace**. The book was released by Hon'ble Chief Minister during the International Conference.

RAJAT Jayanti Vigyan Sancharak Fellowships

The Scheme Rajat Jayanti Vigyan Sancharak Fellowship continued during the current year. As a result of advertisement in the major national dailies in English, Hindi and local languages, 282 applications were received. The work relating to short listing and selecting the Rajat Jayanti Fellows is in pipe line. The work of Rajat Jayanti Fellows, who were awarded fellowship in the last financial year is being reviewed by eminent experts.

Model Rocketry Workshops

District level model rocketry training workshops were organized in 10 districts of Uttar Pradesh. Two training workshops on Model Rocketry were organized in Orissa

Mobile Planetarium

To popularize astronomy and its related activities in rural schools of Uttarakhand, Assam, Uttar Pradesh, Orissa, Maharashtra, Rajasthan, Jammu & Kashmir, Madhya Pradesh, mobile planetarium have been acquired from NCSM, Kolkata, for such demonstrations across the country.

Regional Innovation Science Hubs for Inventors

In order to promote creativity amongst young people, NCSTC is making concerted efforts to set up Regional Incubation Science Hubs for Inventors (RISHI) through the country for the purpose of fostering children's dreams and passions for S&T. Department has supported Pushpa Gujral Science City Kapurthala, Punjab to establish one RISHI at Kapurthala.

Academic Courses in S&T Communication

A variety of programmes, activities and courses were organized/ conducted to develop trained manpower in the area of science communication and science journalism. Different mass media were used for organizing some 30 training programmes at grassroots level in different parts of the country including remote, troubled and difficult areas. The students were also able to participate in various science communication activities.

S&T Communication in Indian Languages

The programme has helped develop content for science communication students and researchers. It will also help develop future plans and studies for effective S&T communication in the country.

Lights and Shades of Science Exhibition and Awards

Exhibitions of spectacular, riverting and intriguing images from the national science photography show 'Lights & Shades of Science' was organized at AIFACS, Rafi Marg, New Delhi during 10-17 April, 2011

and at Ravishankar Raval Kala Bhavan State Art Gallery, Ahmedabad during 6-10 September, 2011. The dramatic collection of photographs had been put together from the award winning and commended photographs of the unique National Science Photography Contest, conducted by Sri RRMehta Educational Trust, New Delhi. the contest was conceived and designed with a purpose to create a synergy between science and photography. To capture various facets of science, the contest was divided into five categories namely, Science in Action, Science as Art, Science Close-Up, Science as Concepts and Science and Society, and there were 13 awards for each category.

Fig. 5.44: Prof Kasturirangan inaugurating the exhibition

Fig. 5.45: People appreciating photographs

The evaluation was done by a jury comprising eminent personalities from the field of science as well as photography. The exhibition evoked a huge response and people from all walks of life came to the exhibition in large numbers. Many schools sent their students to partake of this novel experience of enjoying science through breath taking images. Every day on the spot awards were given to the students. The event was covered widely by the media, both national and vernacular.

Study on Scientific Understanding among Tribal Women

A study on scientific understanding among tribal women in Bihar is being conducted covering Oran, Karwar, Santhal, Tharu, Birhor, Gond, Paharia, Chero, Kol, Agaria and others tribal groups from from15 districts of the state by Vidyasagar Samajik Suraksha Seva Evam Shodh Sansthan, Patna, Bihar. The objective of the study is to make aware the tribal women on importance of scientific understanding for daily living, to study the level of superstition and ignorance present among them, and to sensitize them on issues related to science and technology.

Baseline Study and Capacity Building

To assess the needs study to profile the community, capture its current practices and knowledge base vis-à-vis a range of issues/subjects that will be addressed through the programmes, baseline studies and capacity building workshops for the production teams in terms of ensuring community participation in the respective community radios were organized in Chanderi ki Awaz, Bunkar Vikas Sanstha, Chanderi, Madhya Pradesh; PARD, Vaanoli Thirunmangalam, Madurai, Tamil Nadu; Radio Manav Rachna, Manav Rachna Institutions, Faridabad, Haryana; JUCR, Jadavpur University, Kolkata, West Bengal; Radio Hamara, M.S Panwar Institute, Solan, Himachal Pradesh; Radio Mattoli, Wynad, Kerala; Rudi no Radio, SEWA, Ahmedabad, Gujarat; Radio Namaskar, Young India, Konark, Odisha and Sarang CR, Mangalore, Karnataka.

Fig. 5.46: Baseline Survey for Community Radio.

Each station would now be producing programmes based on the recommendations of the study. The beneficiaries would include captive audience spread around 15 km radius of each of the radio stations covering two lakh listeners in a coordinated manner for one full year.

Science Communication through Community Radio

NCSTC is catalyzing and supporting awareness programmes related to Women & Child- Health & Nutrition and on Planet Earth by tapping the neo-literate groups. The radio magazine programs including phone-ins and community skits are being aired on diverse themes like health, nutrition, home appliances, science behind effective fuel utilization, environment, disaster management, food processing, demystifying myths and superstitions through science, etc.

Fig. 5.47: Nutrition camp for listeners

Fig. 5.48: Enjoying in production

University of Agricultural Sciences, Dharwad, Vidya Pratishthan Institute of Information Technology, Baramati, Aditanar College of Engineering, Tiruchendur, MOP Vaishnav College for Women Chennai, PSG College of Technology, Coimbatore, Sri Manakula V. Engineering College, Puducherry, BG B Pant University for Agriculture & Technology, Pantnagar and Sri Vishnu Engineering College for Women, Bhimavaram were engaged in producing and broadcasting the same. According to feedback reports, people admitted that they have undergone behavioural changes after listening to the programmes.

Occupational Health Hazards of Women Workers

Efforts have been made to connect art with science and eminent scientists, students & the target group. Video films have been prepared by the students of Art College, Maharashtra who were given fellowships to connect the textual material into visual narratives for women workers. The various professions taken up are: rag pickers, police personnel, painters, agriculture workers, women domestic workers. The impact of various postures taken by the female workers, chemical hazards posed by paints and dustbins etc. and what measures need to be taken to remove such hazards has been depicted.

Tamil Nadu Agriculture University has developed a workstation for women working in the call centres in collaboration with eminent scientists in the area. They have also conducted training programmes for the women working the call centres regarding postures they should take during their working hours.

A comprehensive health & science awareness with inter balancing of traditional knowledge, good practices of their indigenous ways for value addition to try to gain scientific rational to break social evil practices myth & superstition has been sanctioned for adolescent girls living in mountainous rural tribal area of Jaunsar Kalsi block of Dehradun district of Uttarakhand state.

A new project with emphasis on the eye disorders and ergonomic problems of Saltpan workers has been sanctioned to AV CODE, an NGO started by senior officers of Space department. It has been proposed to train women working in the area to avoid such health hazards in them and increase their work efficiency.

An innovative project from an eminent scientist to assess the problem and train people living in remote areas of Leh and Ladhakh in the area of epilepsy and stroke was supported.

Publications

The following publications were brought out over the period on various aspects of science communication:

- Science Meets Communication
- Science Communication Without Frontiers
- *Padarpan*
- Sharing Science
- Popular Science Magazines in Regional Languages
- Indian Journal of Science Communication

Capacity Building

The programmes on science through folk media and digital media were continued and offered advancement in the field of capacity building amongst masses towards enhancing science literacy and inculcating scientific temper. About 10 such programmes were organized in different parts of the country. Besides, a manual on Communicating Scientific Principles of Ecology through Waste Management has been developed by an eminent scientist for training villagers for purification of waste water using species of plants.

NATURAL RESOURCES DATA MANAGEMENT SYSTEM (NRDMS) AND NATIONAL SPATIAL DATA INFRASTRUCTURE (NSDI)

NRDMS Programme aims at promoting R&D in emerging areas of Geo Information Science and Technology. Studies supported under the Programme contribute to development of methods and techniques for operationalising the concept of local level planning. Building the required human resource base is an important priority of the Programme. Outputs of the studies are useful in drawing up local level planning strategies in support of the 73rd and 74th Constitutional Amendment Acts relating to the Panchayati Raj Institutions (PRIs) and Urban Local Bodies (ULBs). Sharing of spatial data by data providing agencies in the framework of Spatial Data Infrastructure (SDI) is an essential prerequisite. The National Spatial Data Infrastructure (NSDI) has thus been a major initiative.

Several activities have been completed towards the above goal during the year 2011-12. Based on a set of broad framework approved earlier by the Union Cabinet, a draft National Policy on Data Sharing and Accessibility has been drawn up for the consideration of the Cabinet. It has been decided to implement State Spatial Data Infrastructures (SSDI) countrywide using the experiences gained in the establishment of State Geo Portal prototypes. Studies have been completed in areas like Cartographic Generalisation, Disaster Management (floods and landslides). Fresh studies have been initiated in areas like Spatio-temporal Data Analysis, Sensor Web Enablement, Marine GIS, Digital Heritage, and Hyper Spectral Remote Sensing. Technical capacity has been built through a series of training and user awareness workshops amongst the scientific and the end user communities.

1. National Policy on Data Sharing and Accessibility

As per the Cabinet decision, the National Policy on Data Sharing and Accessibility (NDSAP) was assigned to Department of Science and Technology, during 2010. Over the last one year through intensive public consultations and several Inter-Ministerial meetings, the draft policy document and implementation guidelines have been evolved. Proactive mandatory sharing of data acquired through public funds has been a major approach in the Policy. Four types of accesses to data – open access, automatic registered access, authorized registered access, and restricted access – have been defined for providing access to government-owned data sets. The policy document has been submitted for Union Cabinet for approval.

2. Provision of Interoperable Web Map Service (WMS) for Open Series Maps (OSM) of Survey of India

In order to facilitate access to Open Series Topographic Maps of Survey of India, a method has been devised. Using the method, interoperable Web Map Service (WMS) for the OSM data has been operationalised. The WMS is OGC-compliant and is accessible from the India Geo Portal. Operational scale WMS (Figure 5.49) for the State of Andhra Pradesh in its entirety and for a part of Maharashtra has been released by the Hon'ble Minister of Science & Technology and Earth Sciences in the Third meeting of the National Spatial Data Committee (NSDC) held in New Delhi on 20 October 2011. Two training Workshops have been organised for the senior officials of Survey of India at Hyderabad on 21-22 November 2011 and at New Delhi on 7-8 December 2011 for preparing OSM data for provision of WMS on a routine basis.

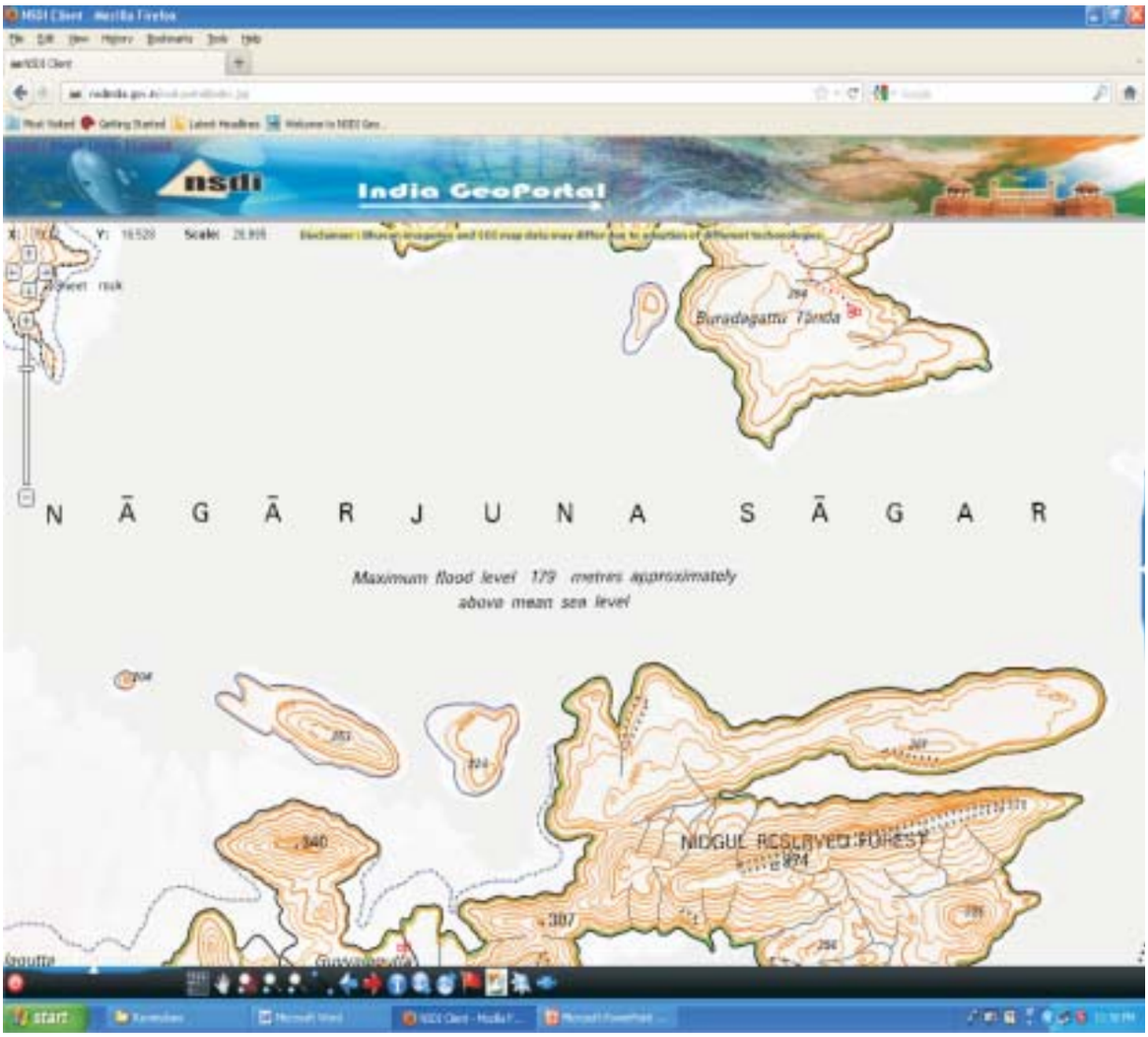


Fig. 5.49: Interoperable Web Map Service for a part of Andhra Pradesh showing various topographic features accessed through India Geo Portal

Re-engineering of OSM data for setting up an interoperable data node in SOI to store the topographic OSM data for provision of Web Feature Service (WFS) and Web Feature Service – Transaction (WFS-T) is being investigated currently. WFS-T will be useful in faster updation of topographic data and sharing.

3. Concurrent visualisation of Web Map Services of SOI and NRSC on India Geo Portal

As a single window access mechanism to access geo-spatial data from multiple sources, the India Geo Portal has been upgraded to access the WMS of SOI OSM data and that of NRSC concurrently (Figure 5.50). The mechanism provides for concurrent viewing of geo spatial data sets from both the sources over the web to update old data sets, detect changes, and facilitate quick referencing. Similar services from other data providing agencies are expected to help visualize data sets to support decision-making.

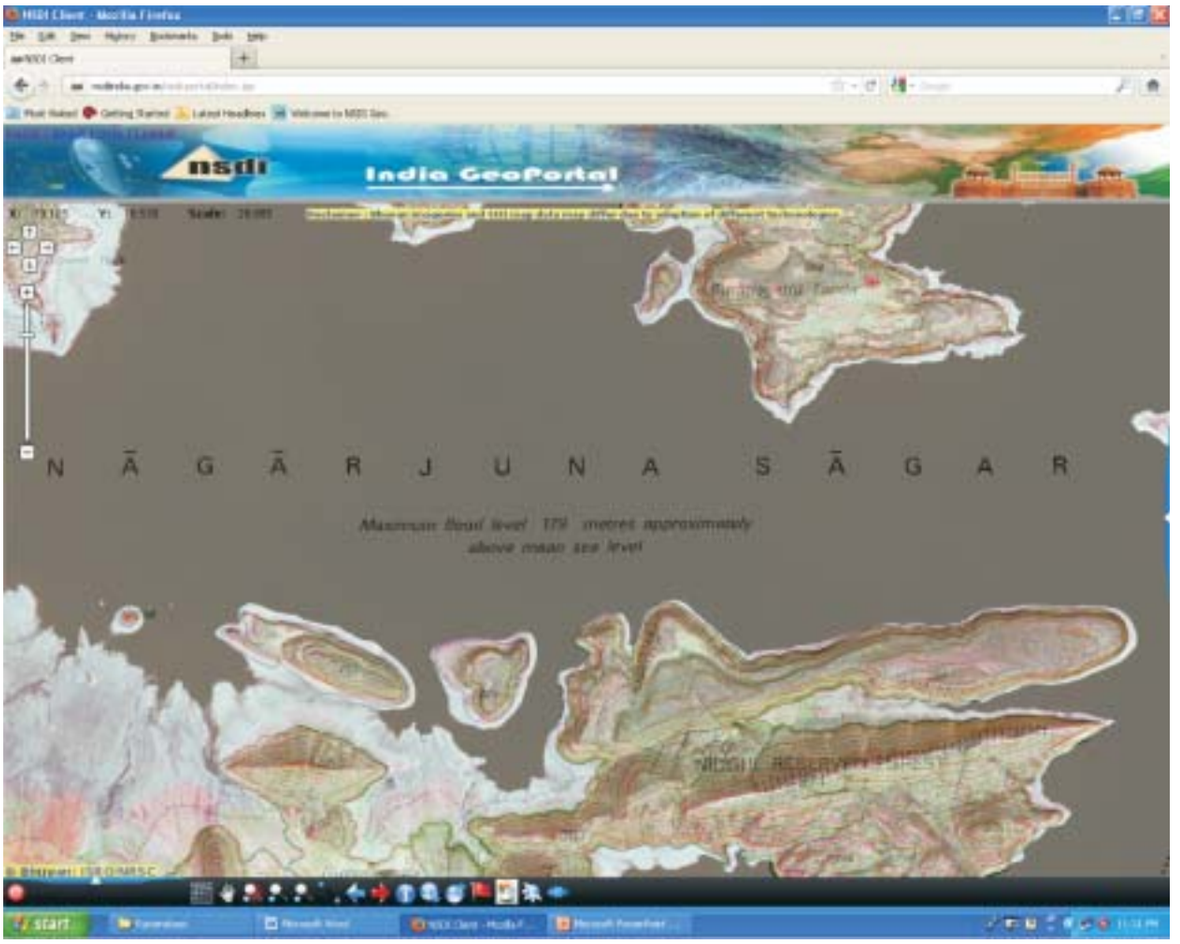


Fig. 5.50: Concurrent visualization of topographic data from SOI and IRS multi spectral imagery from NRSC on India Geo Portal

4. National Mirror Committee for TC 211 of ISO

NSDI has facilitated setting up of the National Mirror Committee coordinated by Bureau of Indian Standards (BIS) for the Technical Committee 211 (TC 211) of the International Standardisation Organisation (ISO). The Mirror Committee will help evolve and adopt national geo-spatial data/ process standards in harmony with the international standards from ISO's TC 211. The existing mechanism of standards development of NSDI is proposed to be involved in the activities of the BIS's National Mirror Committee.

5. Landslide Hazard Mitigation Programme

Under Landslide Hazard Mitigation Programme, site specific studies have been undertaken in three areas i.e. Naptha – Jhakri in H.P. Ooty in Tamilnadu and Munnar in Kerala. All these three sites have been instrumented to collect real time data on various parameters including surface and sub-surface to understand the underlying causal effect of landslides and develop an early warning system based on the monitoring of the active slopes. The exercises will help in developing the thresholds of parameters responsible for triggering landslides. Based on the studies, it would be easier to design suitable preventive measures for controlling landslides.

6. Urban Flood Risk Mapping of Chennai City

Urban Flooding is of great concern to the Planners in India with cities like Mumbai, Chennai facing havoc during monsoon season. In order to provide S&T solutions for urban flood mitigation and management in Chennai City, a joint project with the State Govt. has been initiated. Efforts have been made to develop a detailed spatial database of city, analyse models and suggest mitigation measures.

Airborne Laser Terrain Mapping (ALTM) has been used to collect data on high resolution topographic information to develop Digital Elevation Model (DEM) with an accuracy of about 15cm in altimetry. The process involves use of laser pulses emitted from the instrument fitted on Aerial Platforms like Air Plane, Helicopter to measure the variation of the ground thus help in generating much needed elevation data of the terrain. Photogrammetric process has been used in mapping physical features like buildings, trees, roads, culverts, bridges, drainage network with high positional accuracies. These features invariably influence the flooding process that occurs due to high imperviousness and encroachment of natural drainage. Other attributes like rainfall, observed runoff in rivers, socioeconomic condition of people, shelters, medical facilities have been collected through ground survey and integrated with spatial information in Geographical Information System. The integrated database acts as decision support for planners and administrators by provision of physical, socio-economic and environmental information required for mitigation and management planning.

Flood Simulation Modeling using tools like MIKE 21 and SWMM with input of topography and other spatial, non-spatial parameters has been attempted for predicting scenarios for different quantum of rainfall. Resulting output of flood risk maps thus would help in identification and quantification of areas and facilities that may be inundated for a given rainfall i.e 10cm or 20cm. The information derived from the simulation will quantify stress on typical urban infrastructure like roads, electricity, communications for quick response from the authorities to avoid loss of human life and damage to property. Some of the outputs for tank encroachment (Figure 5.51) and river flood modeling (Figure 5.52) are given below:

Fig. 5.51: Velachery tank encroachment in Chennai

Fig. 5.52: Flood inundation in Adyar (Chennai), 2005

7. Tsunami Wave Propagation Modeling of Nellore Coast

Tsunami, a gigantic wave with longer wavelength and large energy travels with a speed of 300 km/h and above in open seas. The waves have a very low profile in open seas with wave heights less than 0.5m.

As they reach the coast, with shallow bathymetry raises to devastating heights of even 15-20 m with large masses of water columns entering land and sweeping off the coastal features like buildings, bridges, and other natural and man-made features. Activities have been launched to understand propagation of Tsunami after it is generated due to uplift of ocean floor caused by massive earthquake of magnitude above 8.0. The MIKE21, a powerful modeling tool has been used to simulate tsunami wave propagation. A model has been developed with source parameters that caused 2004 tsunami (Figure 5.53) and validated with observations from coastal tidal observations and similar model outputs of NGI, Norway. Validated model has been further used to predict possible scenarios in assessing tsunami arrival time and wave height at the shore.

Run-up Simulation for M9.3 Source

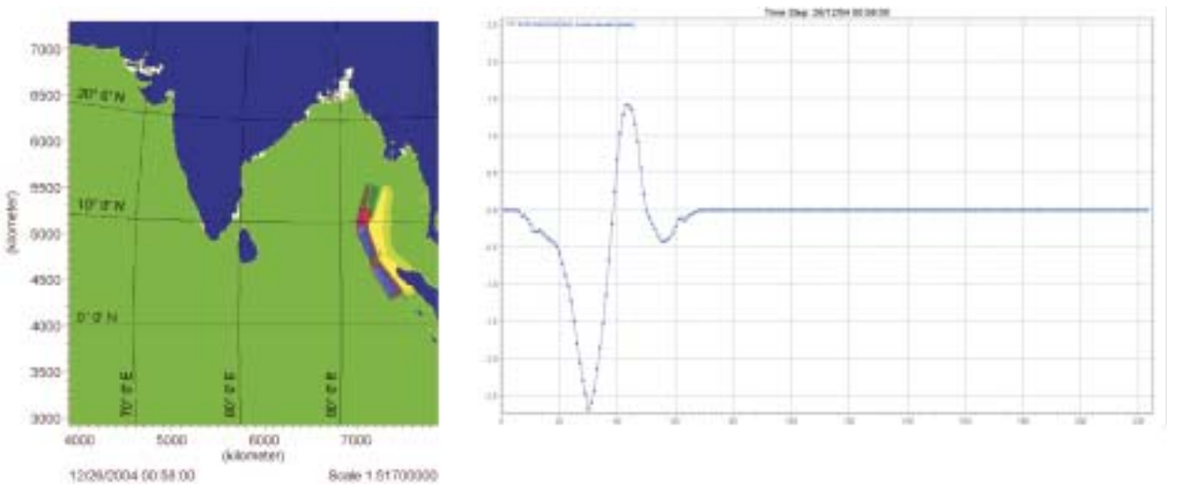


Fig. 5.53: Output of Tsunami Wave Propagation Model with source parameters that caused 2004 Tsunami

8. National Geotechnical Facility (NGF)

In order to develop the capacity for geotechnical engineering particularly for rock and soil testing, an advanced laboratory – the National Geotechnical Facility (NGF) - has been set up in Survey of India, Dehradun. NGF has been equipped with state of the art equipment that can handle edge cutting research in the area of Geotechnical Engineering. At present, the country is focusing on developing infrastructure facilities like dams, metros, highways, bridges, underground construction and micro-hydel projects. All these require high standard soil and rock testing facilities to develop the foundation design and maintain the performance of the facilities at optimal level. NGF is expected to support implementation of such major infrastructure projects. Recently a Step Frequency Ground Penetrating Radar has been acquired from the Norwegian Research Council that is technically collaborating with NRDMS to set up the NGF.

9. Sensor Networks & Web Enablement (SWE) Initiative

The goal of the SWE Initiative has been to enable all types of Web and/or Internet-accessible sensors, instruments, and imaging devices to be accessible and where applicable, controllable via the Web. The vision has been to define and approve the standards foundation for "plug-and-play" Web-based sensor networks. Sensor location has been usually a critical parameter for sensors on the Web and the Open Geospatial Consortium (OGC) - world's leading geospatial industry standards organization- has been

developing standards for the Sensor Web. Under the interdisciplinary SWE Initiative, researchers from a wide variety of fields like Telecommunication, Web Technologies, Geo-spatial Technologies, Domain Modelling, and Regional Planning etc. have been brought together to a common platform. Leading R & D Institutions like IISc, Bangalore; ISI, Kolkata; IIT, Madras; NPL, New Delhi; ISRO, Bangalore; JNU, New Delhi are participating in the initiative. As a part of this on-going activity, a Rural Automatic Weather Station (RWAS) has been developed and its communication aspects have been re-configured based on SWE Standards & Protocols. Data from a set of 100 AWS have been acquired and logged on to centralized data logger located at IIT Madras for common access and use. One season weather data has been provided to IITM, Pune; IMD, New Delhi; and NCMRWF, New Delhi and other weather modeling communities for analysis and validation. Availability of GPS sensor on AWS provides information on exact location of the unit and facilitates its integration with other collateral information in a GIS framework.

10. The India Digital Heritage (IDH)

The goal of the Indian Digital Heritage (IDH) project has been to develop Geo-Information & Communication Technologies (geo-ICT) and demonstrate their utility in preserving, using, and experiencing India's vast heritage in digital form. A multi-disciplinary team of professionals from the fields of Technology, Archaeology, Anthropology, Architecture, Social Sciences and Culture have been contributing to this unique initiative. A host of data and technologies like 1:500 scale two-dimensional spatial data, Terrestrial Laser Scanning of monuments for 3D data, Ground Penetrating Radar Systems (GPRS)-(Step Frequency) for buried monuments/ scripts/ coins, Computer Vision techniques for visualization, immersive technologies for touch and feel are being used in the creation of the Indian Digital Heritage. A group of leading institutions like National Institute of Advanced Studies, IISc, Bangalore; IIT Bombay; and Archaeological Survey of India is involved in the activities. Preliminary results for Hampi – a heritage site in Karnataka – are available.

11. Application of Geo-spatial technologies in Ecosystem Restoration & Management – A case study of Kolleru Lake

Kolleru - a shallow fresh water lake in Andhra Pradesh – has degraded over the years to marshy wet lands due to various anthropogenic activities like aqua culture, fish cultivation etc. Recognising the need for restoring the ecology of this Ramsar site to its original form, an R & D initiative to develop and demonstrate appropriate Geo-spatial Technologies has been launched with the involvement of academic institutions like Andhra University, Visakhapatnam; Acharya N.G. Ranga Agricultural University, Hyderabad; Jawaharlal Nehru Technological University, Hyderabad; SRKR Engineering College, Bhimavaram; EPTRI, Hyderabad; APSRAC, Hyderabad; NRSC, Hyderabad; and Govt. of Andhra Pradesh. The scientific framework for this initiative includes ALTM survey, generation of 10K maps, pollution studies, hydrology and water discharge studies, ecology and environmental studies, defining the Lake Geometry, bathemetry, contours, DEM and creation of an International standards based Kolleru Geospatial Information System (KGIS). The KGIS will facilitate spatial data sharing on the Lake with the stakeholder community.

12. Programme on Hyper spectral Remote Sensing (HSRS)

A space borne hyper spectral sensor is capable of monitoring both static and dynamic targets at higher spectral and spatial resolution with greater accuracy. Analysis of a hyper spectral scene involves decomposition of each pixel in an image into its constituents, where these are represented by spectra of relatively pure material, that are themselves extracted from the scene. Identity of these constituents is

determined by comparison with 'library' spectra of known materials measured in the field or in the laboratory. A hyper spectral sensor, using reflected solar radiation (0.4 micrometers - 2.5 micrometers wavelength range), captures the unique spectra, or 'spectral signature', of an object, which can then be used to identify and quantify the material(s) of which it is composed. A network of research institutions/ universities like IIT Bombay, IARI New Delhi; Annamalai University, Chennai; JNTU Hyderabad; University of Madras; IIRS Dehradun; Institute of Remote Sensing, Anna University, Chennai etc. have been supporting the implementation of this initiative. Equipment like Spectral radio meter, Gonio meter, and ENVI software have been provided as a central facility. While creation of spectral library for man made and natural features has been a major focus of the Initiative, standards based preliminary spectral library has been created and tested for around 50 features over the past years. Human resource development and creation of expertise in various institutions/ universities have been the other objectives.

13. International Collaboration/ Participation

A Memorandum of Understanding (MoU) has been signed with the Natural Resources Canada (NRCan) for launching a collaborative project on development of SDIs in India in November 2009. As a follow up of the MoU, a work plan has been drawn up between NSDI/ DST and NRCan for pursuing collaborative activities during the visit of the DST delegation to Canada in June 2011. 'Spatial Data Infrastructure (SDI)' and 'Natural Disaster Management (Landslides)' are the two key areas for collaboration between NRCAN and DST. Some of the specific sub-areas that may immediately engage attention include 'Geo-spatial Policy', 'Geo Portal Development (landslides)', 'GI management', 'Knowledge Exchange', and 'Academic Exchange Visits'.

GENDER INITIATIVES

DST had over the years introduced a number of gender sensitive initiatives with the objective of gaining gender parity in science sector. These initiatives include scheme for empowerment of rural women as mentioned earlier by enhancing livelihood through S & T interventions and also schemes for providing opportunities to women scientists to return to careers in science after a break. All these initiatives are planned keeping in view a gender perspective and providing a variety of options to suit individual aptitude and capabilities. The gender initiatives are supported within the budget head of the women component plan. Specific outcome in repect of scholarship scheme for women scientists (WOS) are as under:

WOMEN SCIENTIST SCHEME – A (WOS-A)

'Women Scientist Scheme- A (WOS-A)' is one of the pioneering schemes under the umbrella of Department of Science & Technology, which encourage and empower women. The scheme provides opportunities to women scientists and technologists who had break in their careers for pursuing research in frontier areas of Science and Engineering.

Since its inception, the Department has received 5969 proposals against which 1297 projects have been supported in different disciplines - Life Sciences: 694, Chemical Sciences: 193, Physical and Mathematical Sciences: 184, Engineering Sciences: 145, Earth and Atmospheric Sciences: 81. The age-wise distribution of women scientists supported under the Scheme shows that maximum number (approx. 70%) of selected candidates are in the age-group of 35-50 years, which seems to justify the aim of the scheme.

WOS-A DURING XI PLAN

During 11th Plan, Department received 2846 proposals under WOS-A scheme and sanctioned 906 projects which showed approx. 32% of success rate. The Department has received approx. double proposals in 2011-12 from 2010-11. Last year, the Department has revised the budget limit for a WOS-A project from Rs. 17 lakh to Rs. 23 lakh, while the fellowship amount has been increased from Rs. 20,000/- pm to Rs. 35,000/-pm. This shows the impact and goodwill of the scheme among women researchers. Approximately 30% of the awardees have got employment in universities and national labs – a significant addition to the scientific workforce of the country.

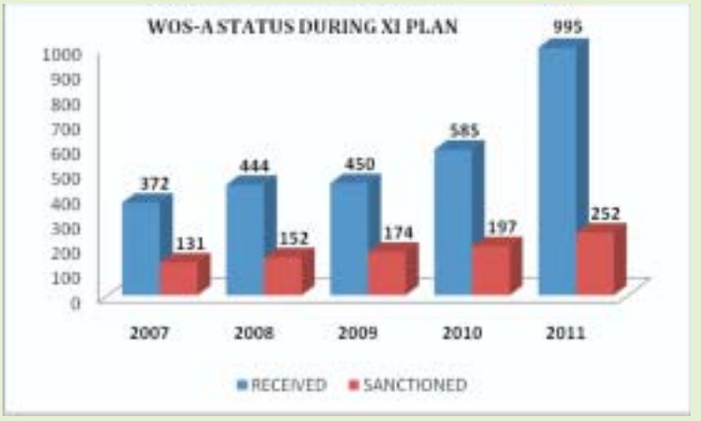
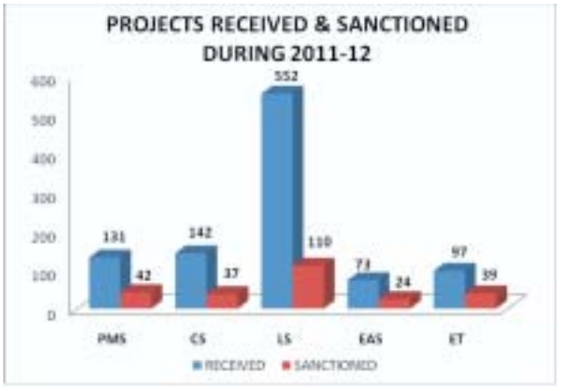


Fig. 5.54

This year the Department received a total of 995 new proposals (Life Sciences – 552, Chemical Sciences – 142, Physical and Mathematical Sciences – 131, Earth and Atmospheric Sciences – 73, and Engineering Sciences – 97) against which a total of 252 projects have been sanctioned this year. The subject-wise distribution of sanctioned projects was: Life Sciences – 110; Chemical Sciences – 37, Physical and Mathematical Sciences – 42; Earth and Atmospheric Sciences – 24; and Engineering Sciences – 39. It indicates approx. 25% approval rate.



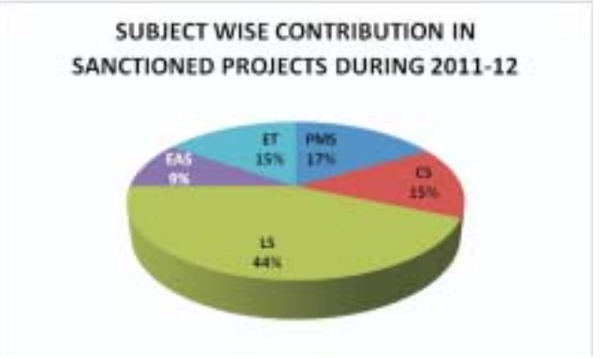


Fig. 5.55

During the year, the Department has also monitored 248 ongoing projects funded under this Scheme. Out of these, 15 were graded very good, 61 – good and 91 were graded as satisfactory.

Special efforts were made to identify and encourage women scientists in small cities and remote areas through Sensitization Workshops which became very fruitful practice in WOS-A scheme to mentor the women with break in career for pursuing research. This has proved to be a very effective tool in generating research proposals from such women scientists. This year Department has organized Sensitization Workshops at various places viz.- (i) University of Madras, Chennai (Jan 2011), (ii) BRA Bihar University, Muzaffarpur (Apr., 2011) (iii) Jawaharlal Nehru Technological University, Kakinada (Aug., 2011) and (iv) BMD College, Vaishali (Dec., 2011).

Strengthening Basic Research & Expanding R&D Base – Institutional Capacity:

During 11th Plan, Department has initiated a special programme "CURIE" (Consolidation of University Research for Innovation and Excellence in Women Universities) in 2009 to enhance R&D infrastructure in women universities. Since 2009, 6 Women Universities namely, i) Avinashilingam Women University, Coimbatore, ii) Banasthali University, Banasthali, iii) SNDT Women University, Mumbai, iv) Sri Padmavati Mahila Visvavidyalayam, Tirupati, v) Karnataka State Women's University, Bijapur , and vi) Mother Teresa Women's University, Kodaikanal have been supported for 3 years under CURIE programme. This new initiative is expected to make an impact on the quality of research output from these universities.

WOMEN SCIENTIST SCHEME – B (WOS-B)

This scholarship is specially intended to motivate women scientists to contribute to the development of the country through (i) research, development and adaptation of technology for improving the quality of life and provide additional opportunities for income generation in urban slums or rural areas. (ii) Adaptation and transfer of an innovative technology form laboratory to field in rural areas. Under the scheme, projects will be considered from the scientist in areas of science, engineering or medicine.

Fellowship under WOS-B scheme has been increased with respect of their qualification, experience and publications in index journals. Cut off age for the candidate and time duration for the project has also been increased 55 years and 5 years simultaneously.

A total of 4 Selection Committee meetings-cum-Group Monitoring Workshops for selection of new projects for implementation and reviewing the progress of on-going projects were also held simultaneously at New Delhi, Pune, Kolkta and Bangalore. Under this scheme, 31 projects have been supported in this year. Recommended projects are from different fields like food & nutrition, health, agriculture, engineering, technology development, value addition etc.

Department has also planned to organize workshop-cum-training seminars for selected candidates to train in research methodology, planning and implementation of their projects in coming days.

Brief progress report on some projects

1. **Revival and sustenance of traditional construction technology and ornamentation techniques of Shekhawati, Rajasthan:**

   The project is aimed at research, adaptation of traditional building technology of Shekhawati to facilitate scientific and authentic conservation of heritage buildings, development of a mechanism for its sustenance and providing opportunities to traditional artisans for income generation as part of a larger vision of saving the rich built heritage of the Shekhawati region.

As part of the research, study of havelis in Shekhawati specifically in Nawalgarh was undertaken for documenting processes and building materials involved in the construction, finishing and ornamentation of various building components. A Historic Building Information Database has been compiled. Field study has revealed that surface ornamentation in the form of ornamental wall plasters is a unique feature of havelis in Shekhawati. Technique of wall plastering practiced all over Shekhawati had slight variations in terms of the nature and characteristics of materials used, proportions, methods of preparation, lengths of processes and application technique largely depending on the quality of the locally available building materials. Broadly three types of wall plastering was common namely lipai, loi and panna. Slaked lime or lime putty was mixed with water and aggregates to make the mortar for plastering. Field testing of samples collected from select havelis has also indicated that the use of a calcitic lime based mortar, crushed khor/brick as a primary aggregate with occasional occurrence of calcareous stone pieces and vegetative fibres, pieces of wood and small and large bits of coal. Lime slaked for several months and sometimes even years under excess water was used in the final layers of plastering. For ornamental panna plaster well matured or aged lime was mixed with various grades of marble powder and applied in several layers and the surface was thoroughly burnished to achieve smoothness. Aging of lime putty had been recognized for centuries as a means to improve the quality of hydrated lime. This has now been validated by various scientific studies that have proved that slaking ensures complete conversion of calcium oxide into sub micrometer, nanometre-scale plate like crystals of calcium hydroxide thereby improving the characteristics of lime. A protocol for different types of wall plastering techniques is being formulated.

A field office has been set up in the study area Nawalgarh for undertaking activities of the research project like field survey operations, building material sample collection and storage and preparation and storage of building materials for demonstration and training works. Traditional tools used in lime plastering have also been collected. Quick Lime has been slaked at the field office in Nawalgarh for use in the demonstration works to be taken up at a later stage of the project. Field study has revealed that craftsmen with specific skills performed the different tasks in the construction of a haveli. A list of various categories of craftsmen involved in the construction of havelis and the specific skills required for the execution of various tasks has been prepared to constitute a Traditional Craftsmen Guild. The Traditional Technology Transfer Program and Repair and Maintenance Toolkit are also in the process of being formulated.

2. Standardization of protocol for development of mulberry wine

Mulberry is a very hardy plant belonging to the genus *Morus spp.*, under the family Maraceae. India has nearly 280,000 ha area under mulberry cultivation. It is grown mostly for the production of the silkworm that feeds exclusively on its leaves and not for the fruits. However, since its fruit is rich in sugars and other nutrients and has enormous medicinal properties, an attractive colour with high medicinal value.

Its use for wine and ready to serve beverage will open new vistas in beverage industry where red grape wine and other fruit juices are dominating. Mulberry varieties, MI-118, MI-497 and MI-362 were screened for preparation of wine. The mulberry juice was ameliorated with sugar and citric acid to maintain a TSS of 20^0 Brix and acidity 0.5 per cent before inoculation with *Saccharomyces cerevisiae*. After completion of fermentation (two weeks) at 16^0 C, the wine was siphoned and kept for aging. The final evaluation showed that mulberry variety MI-497 was better. The analysis showed that MI-497 had 7.6^0B TSS; 0.34 per cent acidity; 0.16 per cent tannins; 0.23 per cent reducing

sugar; 0.41 per cent total sugar; 2.89 µm antioxidants; 10.17 mg per cent anthocyanin and 13 per cent alcohol. The wine has attractive deep red colour, high medicinal value and significant domestic and export potential. This study will be helpful in exploring better post harvest use of mulberry fruit.

An attempt was made to enrich mulberry juice based RTS beverage with vitamin-C by blending it with Indian Gooseberry. The mulberry fruit juice was blended in different ratios with aonla juice to improve the taste and astringency. The beverages were prepared from 10 % blended juice having, 14^0B TSS; 0.24 % titratable acidity; filled in pre-sterilized glass bottles, pasteurized by putting the bottles in boiling water for 5 to 10 minutes and stored up to six months under 20 ± 5^0C temperature. Microbiological, biochemical analysis and sensory evaluation of RTS beverage were carried out at zero, three and six months of storage. No microbial growth was detected in any of the samples during the storage. After six months of storage the RTS beverage had, viz. 14.2 ^{0}B TSS; 0.32 % titratable acidity; 2.01 mg/100ml ascorbic acid; 5.39 g % reducing sugar; 12.5 g % total sugar; 1.38 mM/ml antioxidants and 1.99 mg /100ml anthocyanin and 88 mg/100 ml protein content observed during storage. Phenolics viz. gallic acid, catechin, epi-catechin, p- coumaric acid and kaempferol were detected by High Pressure Liquid Chromatography. RTS made from mulberry-aonla juice blend has better acceptability.

Functional foods from mulberry have developed an integrated technology for extraction of fibre, pectin and pigment from mulberry pomace and oil from seeds of mulberry fruits, using a combination of organic and inorganic solvents. A yield of 5.3 per cent fibre, 1.58 per cent pectin, 2.0 per cent pigment from pomace and 28-30 per cent of oil from seeds was obtained. The technology needs validation on larger scale before transfer to industry.

There are many health benefits of Mulberry fruits. Mulberry has health benefits that have been proven in scientific research as well as health benefits that have survived the test of time in traditional Chinese medicine. But no matter to which medical belief you subscribe, what you can't deny is that the popularity and potential health benefits of berries are on the rise more than ever. So why not take a chance on this new wonder fruit and see if its benefits work for society.

3. Pharmacogenomic Study in Breast Cancer Therapy

Breast cancer is one of the most common cancers among women worldwide. Despite enormous efforts spent in the development of cancer chemotherapies, there is a large inter-individual variation in response and toxicity to anticancer therapy. Often these therapies are effective only in a relatively small proportion of cancer patients. It is now well recognized that inter-individual variation of drug treatment outcomes is contributed by commonly occurring genetic polymorphisms of drug-metabolizing enzymes and transporters. In this study it was aimed to analyze the role of genetic variants in ABCB1, GST and *CYP* genes in anticancer therapy and to identify the host genetic variations that can contribute to drug efficacy and/or the risk of toxicity. The results obtained from the study will be shared with other investigators and clinicians. Later a multi-centric trial will be required for validating the association. The results obtained from the proposed study will be helpful in clinical management of breast cancer patients as well as individualization of chemotherapy. The pharmacogenomic knowledge will help our pharmaceutical industry to develop drugs, which are more suited to the people of the country. The clinical trial data for newer anti-cancer drugs will be more relevant if data on the genomic profile of our population is available.

WOMEN SCIENTIST SCHEME (WOS-C)

Under this scheme, a workshop on Trademarks, Copyright, and Designs was held in April, 2011 at New Delhi for the women scientists candidates of Delhi and Kharagpur centre of women scientists. The sixth batch of the 73 women scientists completed their one year training in IPR in May 2011. They were given a certificate at the end of the training. Out of these, 13 women successfully cleared the Patent Agent Examination conducted by the Indian Patent Office. These women prepared 9 technology scan reports based on patent analysis. The titles of the project reports prepared are enlisted as below:

S. No.	Project	Prepared by
1	Landscaping of antimalarial drugs and compounds	Ms. Rounak Dubey
2	International Depositary Authorities and the deposit of microorganisms for the purposes of patent procedure	Ms. Deepika Singh
3	Molecular medicine and treatment of infertility–a patent analysis	Ms. Neeti Sahu
4	DNA sequencing technologies – a patent analysis	Ms. Divya Pandey
5	Culture media for microbes : bacteria, fungi & algae - a patent analysis	Dr. Rollie Verma
6	A patent landscaping of management of radioactive waste from nuclear power plants	Dr Anshul Fuloria
7	Patent analysis of eco-friendly technologies for waste management and patented technologies donated to "eco-patent commons"	Ms. Anu Bala
8	Biosensors	Ms. Navneet Kaur
9	Patent analysis of herbal compositions used for the treatment of cancer, diabetes and asthma	Ms. Deepika Chabba

To strengthen gender initiatives, during 12th Plan period DST will be introducing DISHA - Women Mobility Scheme for Employed Scientist which aims at enhancing the role of women in science. This would strengthen the ongoing schemes of the women component programme and add a new component for employed R&D women professionals by introducing a scheme for seamless mobility.

CHAPTER 6

SCIENTIFIC SERVICES

The Department of Science and Technology is serving and servicing social contract of Science and Technology. It provides diversity of scientific services through its arms viz. Survey of India (SOI), National Atlas and Thematic Mapping Organization (NATMO), Technology Information, Forecasting and Assessment Council (TIFAC), Vigyan Prasar (VP), National Science and Technology Management Information System (NSTMIS), National Accreditation Board for Laboratories (NABL) and National Good Laboratory practices Compliance Monitoring Authority (NGCMA).

The **Survey of India (SOI)** is the National Mapping Organization with the responsibilities to create, maintain & disseminate the Topographical Data for entire country for various applications. **NATMO** is another knowledge based service organization of DST in the field of preparation of thematic maps, educating people about the changing scenario of the political, social, economical & cultural set up of the country and helping the planners to use the maps as development tools for resource mobilization at grass root level. Training in GPS and remote sensing applications has been taken up by NATMO in different parts of the country as capacity building exercise at the colleges and Universities level.

TIFAC, an autonomous institution of DST supports innovative programmes such as R&D support to Micro Small and Medium Enterprises (MSME), Technology Refinement & Marketing Programme (TREMAP), Collaborative Automotive R & D and National missions (eg. Geospatial Applications, & Bamboo Applications) and also supports a Patent Facilitating Centre, thus creating awareness about intellectual property rights (IPR), assisting scientists and technologists in protecting their inventive work and spreading the IPR culture in the country. **Vigyan Prasar (VP)** continues to play a major role in science and technology communication throughout the country and produced science communication materials and disseminated through print and digital media including monthly science magazines namely *Dream 2047* and VIPNET News. While, NSTMIS continued its efforts of generating and making available information on resources both manpower as well as financial devoted to scientific and technological (S&T) activi-ties in the country.

NABL and **NGCMA** are linkages of laboratories and test facilities in the country with regulatory authorities. On one hand, NABL implement and maintain an accreditation system for laboratories in accordance with the relevant national and international standards, while the NGCMA is responsible for compliance monitoring of GLP certified test facilities in the country in accordance with the OECD Principles and Guidelines to ensure that safety data (on chemicals) produced by test facilities are internationally accepted. During the year, it has been possible to gain full membership for the country and sign mutual recognition treaty for GLP in March 2011.

Thus, SOI as well as NATMO have offered valuable Geo-spatial technology services and support system. "Generation of National Digital Topographical Database on 1:10,000 Scale" during 12th Five year Plan will be new initiative which will facilitate the user agencies/ village/Panchayat level planners for the micro-level planning like watershed development, irrigation etc. During 12th Plan period, NABL will continue its service potentials for NABL Accreditation of laboratories and through awareness programs, while, India's entry into Good Laboratory Practice (GLP) certification will have importance to many sectors of the economy as India has now been conferred OECD full adherent status which has removed a huge non tariff trade barrier in export of chemicals.

SURVEY OF INDIA

Survey of India, under the Department of Science & Technology is the repository of National Frame work data, Geodetic Control (Horizontal and Vertical) & Geodetic surveys, Topographical Control, Surveys and Mapping, within India and neighbouring country, International Boundary matters, Surveys for Developmental Projects, Cantonments, Large Scale City Surveys, Guide Maps etc, Mapping and Production of Geographical Maps, Aeronautical Charts, Survey and Mapping of special maps and Toponomy.

With the advent of technology, especially in the field of Information Technology, there is a horizontal growth in user base and vertical growth in demands of updated geospatial data. The user's demands of data are in respect of both resolution and currency for various applications. This poses a challenge as well as provides an opportunity to Survey of India (SOI), the National Mapping Orgnisation with the responsibilities to create, maintain & disseminate the Topographical Data for entire country.

SCIENTIFIC RESEARCH

1. Antarctica Expedition

Initiative:

Large scale maps and a network of well distributed precise control points is essential for carrying out location based research activities, Survey of India started participation in Indian Antarctica Research Programme from **10th Expedition, 1990-91 and** start providing a network of Ground Control Points and mapping for scientific studies in Antarctica.

Achievement:

Survey of India has already prepared a large scale base map of Indian permanent station, Maitri and its surroundings and mapping of new site "Larsemann" on scale 1:2,500 has also been completed. This will facilitate India's claim for establishment of permanent station at this site. Survey of India also carries out continuous GPS observation which will contribute for analysis of continental drift.

During 30th Antarctica Expedition survey team carried out 07 days GPS observation was at the main GPS reference station at Bharati Island (Larsemann hills) and Detail survey on 1:5,000 scale with 5 metre contour interval was carried out for an area of 1.493 sq. k.m in the Fisher Island area. This field data collection work was carried out for the preparation of large scale topographical map of the Fisher Island area.

Fig. 6.1: Plane Tabling Survey in Larsemann Hills

2. HUMAN RESOURCES FOR INDIAN S&T ADVANCEMENT

Indian Institute of Surveying & Mapping (IISM), the capacity building arm of Survey of India is now recognised as the prestigious training establishment in the field of Surveying and Cartography to impart training to the Officers and Staff of Survey of India and Government Organisation, Private Individuals and Scholars from other Afro-Asian counties.

The Institute also conduct M.Tech (Geomatics) and M.Sc. (Geospatial Science) Academic two years Post Graduate Programme in collaboration with Jawaharlal Nehru Technological University, Hyderabad.

IIS&M courses are held in high esteem by Scientific Department and organizations. Total 515 persons including 11 foreign trainees were trained during 2011-12.

3. TECHNOLOGY DEVELOPMENT PROGRAMMES

i) Open Series Map (OSM) on Scale 1:50,000:

Initiative

Survey of India has been preparing maps on Everest Datum and Polyconic Projection since its inception, but after the New National Map Policy, 2005 there was a major change in the policy of map making wherein Survey of India has been mandated to prepare map on WGS-84 Datum and

UTM Projection for public use without restriction. Also due to major activities in the Industry for GIS preparation, data is mostly required in Geo-data base form.

Survey of India has generated two series of maps – Defence Series Maps (DSMs) and the Open Series Maps (OSMs) on WGS-84 Datum and UTM Projection.

Achievements:

Survey of India has completed 4400 Open Series Maps (OSMs) on WGS-84 Datum and UTM Projection. To prepare a paper map, the major effort required was patterning (conversion of vectorised data into symbolized form) of digital data and another activity for printing a paper map was transformation of patterned data into CYMK (which requires generation of colour separates on either film or directly on to plate for printing machine).

To complete patterning and CYMK generation in time Survey of India prepare a Plan Scheme "**Patterning and Conversion of Digital data into Geo-database"** for 11th Five Year Plan. Year wise achievements during 11th Five year Plan are shown as below:

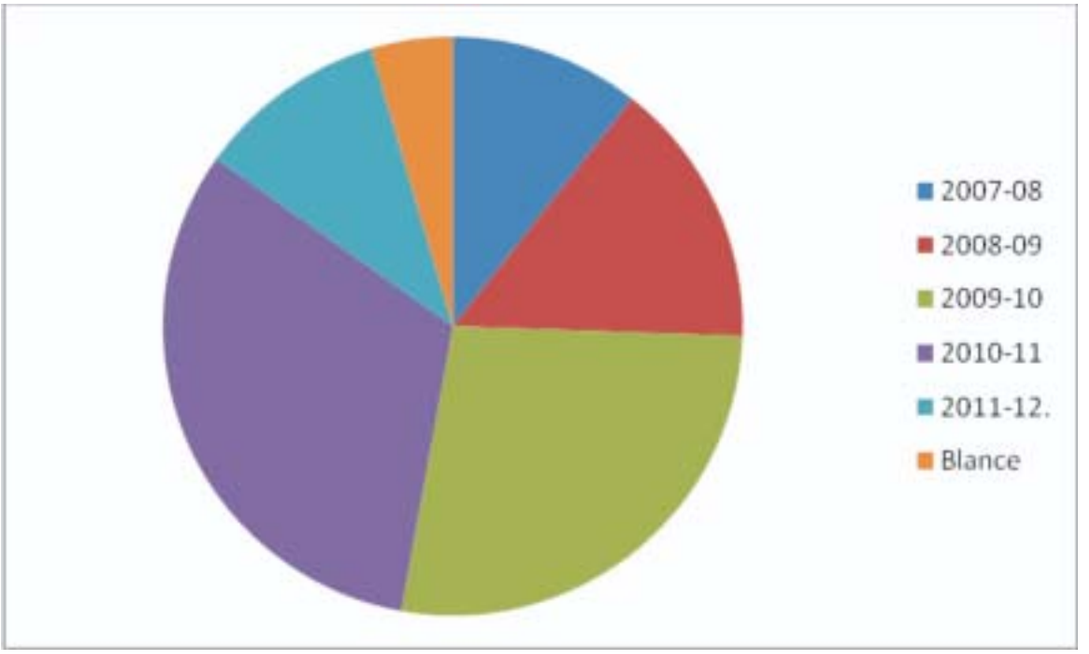


Fig. 6.2

ii) Digital Topographical Base on 1:25,000 Scale:

Initiative:

The main purpose of the National Map policy (NMP) is to promote a flourishing geo- spatial industry with participation from academia, NGOs, Private sector etc. Therefore the NMP encourages the user not only to access the map freely but also add value to them.

To fulfill the above purpose Survey of India generate Digital National Topographical Data Base (DTDB) of existing maps available in the Hard copy form as Printed maps, PT section, Air survey section, Scribing section etc. on deferent Scale.

Achievements:

Survey of India has completed Digital Topographical Data Base of 394 Sheets of 1:250K, 5060 Sheets of 1:50K and 7,500 Sheets of 1:25K . For Generation of Digital Topographical Database on scale 1:25 K Survey of India prepare a Plan Scheme "**Implementation of New National Map Policy**" during 12th Five Year Plan (2007-2012) and Yea wise achievements are shown as below:

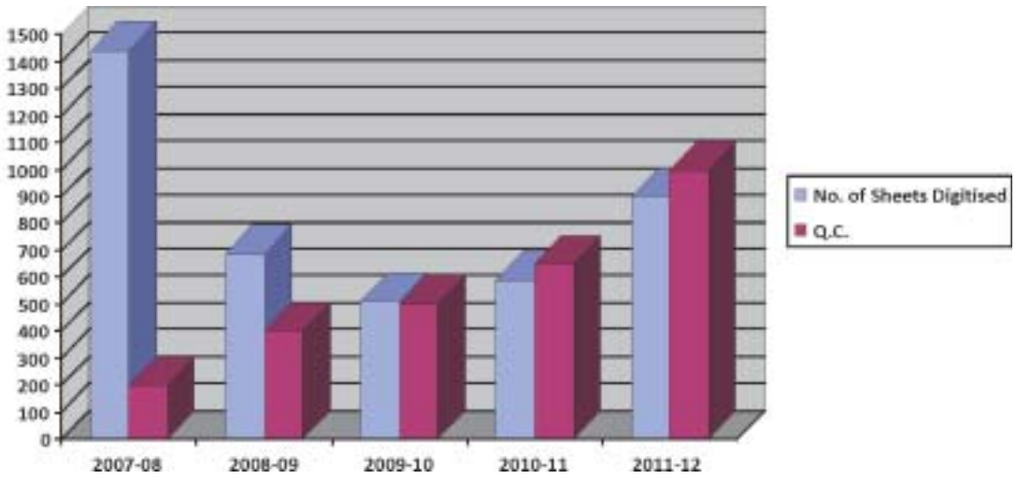


Fig. 6.3

(iii) Tidal Data.

Initiative:

Tidal data will provide a basic tool for various scientific studies related to sea level variations and crustal movements and Survey of India provides accurate tidal predictions for safe commercial navigation, sea level development work and for strategic planning with our traditional Indian tidal network. Survey of India takes the initiative to modernize the Tide gauge stations during 10th and 11th Plan and Prepare a plan Scheme "**Modernization and expansion of Indian Tide Gauge network with special reference to storm Surge Modeling and Tsunami Warning System".**

Achievements:

Survey of India has equipped the 18 nos. out of 36 Tide gauge stations with digital tide gauges co-located with GPS receiver to monitor sea level variation and crustal movement. Real time data communication facilities have been established at National Tidal Data Centre, Dehradun as well as at several remote locations along Indian coastline and Islands.

Tidal data received from the remote locations is being analyzed in real time at National Tidal Data Centre, Dehradun. This data is also being mirrored to National Tsunami Warning Center, INCOIS, Hyderabad on real time for further analysis and issuance of alert/ warning in case of extreme events

like tsunami and storm surges taking place in the region. This will facilitate timely evacuation of public from tsunami and storm surge hit areas.

Fig. 6.4

(iv) National Standardised Control Framework

Initiative

Survey of India is the only government agency, which provides Geodetic Control throughout the country and also provides data to the various governments and other national orgnisations including defence forces, according to their requirements. With the introduction of GPS technology, Survey of India also develops a GPS Control network throughout the country. Standard Ground Control Points (GCPs) enable state cadastral department besides other agencies engaged in generating geo-spatial information to carry out their job in a national geodetic reference system.

Survey of India Prepared a Plan Scheme "Creation of National Ground Control Points (GCP) Library for India" during 10th and 11th five year plan to carry out in three phases. The first phase envisages the establishment of 300 well spread high precision Ground Control Points (GCPs) at a spacing of 250-300 km apart. In the second phase, the responsibility will be to densify it with 2200 precision Ground Control Points at a spacing of 30 to 40 km apart and in the third phase, it will be further densified to 65,000 GCPs connecting all the tri-junction village boundary pillars available on the ground.

Achievement

Survey of India has completed the observation at 300 Ground Control Points (GCPs) covering the entire country in 1st phase. Densification of first order network at a spacing of 30 to 40 km. apart is likely to complete.

Reece/ Site selection of 2262 points, construction of 2247 pillars and GPS observation at 1550 stations have been completed so far. State wise processing & adjustment of GPS data for GCP Library Phase-II is under progress.

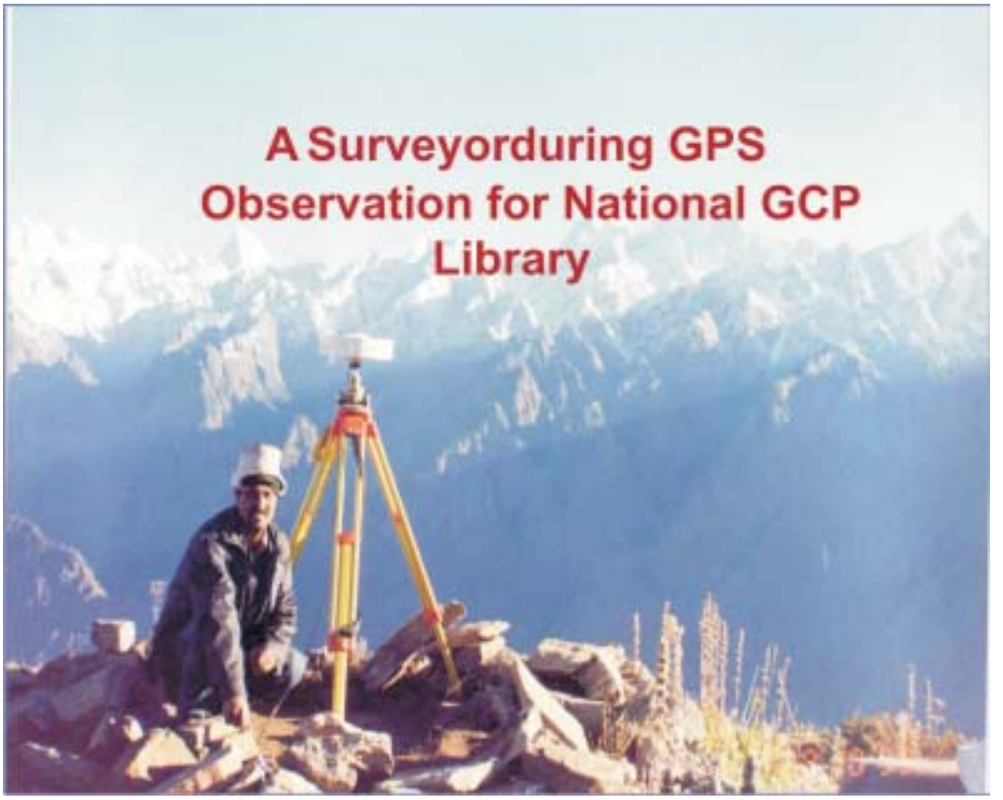


Fig. 6.5

(v) Mapping on 1:10,000 scale for micro-level planning

Initiative:

Providing reliable and accurate information with necessary details on time is extremely important for geospatial solutions in the areas of rural and social development, infrastructure and natural resources management programmes. Presently Survey of India has topographic maps on 1:250,000, 1: 50,000 and 1: 25,000 scale, covering entire country Keeping this constraint in mind, it is a necessary prerequisite to generate large scale base maps for use in decision making and developmental programmes.

In view of the users' demand for high resolution map data, Survey of India had taken initiative for generation of maps on 1:10,000 scale for the entire country. To complete the above task survey of India prepares a Plan Scheme "**Generation of National Digital Topographical Database on 1:10,000 Scale"** during 12th Five year Plan. This will facilitate the micro-level planning like watershed development, irrigation etc. and will be made available for village/Panchayat level planners.

Achievement:

Survey of India has completed a pilot Project of 1:10k mapping and launched on the website for the use of public. The map content, data model, alternate source material and their availability and technical

methodology to be adopted have been finalized, based on that Standard Operating Process (SOP) has been prepared. Data Model & Symbology Library for 1:10,000 Scale mapping has been prepared.

4. INTERNATIONAL SCIENCE AND TECHNOLOGY COOPERATION

The rapid advance in geospatial information and technologies, and their easy accessibility, has made such information an invaluable tool in research, business and policy planning and implementation. The effective use of geospatial information helps many of the current humanitarian, environmental, and developmental challenges facing by the world, such as climate change, natural disasters, population displacement, peace and security, food and economic crises which are a cross-border nature requiring both global and national policy. Survey of India represents at various International conferences/Seminars to promote the growth of geospatial data/information and introduce the latest technology of surveying for optimum results.

Surveyor General of India participated in the "First Level Forum on United Nations Global Geospatial information Management" held on 24th to 26th October, 2011 in Seoul, Republic of Korea. The objective of the Forum is to provide an opportunity for in-depth discussion and consultation among Governments, non-governmental organisations and the private sector.

Survey teams from Geodetic & Research Branch of Survey of India are sent to Bhutan for Check Survey of various Hydel projects under construction, with reference to the control points already established by Survey of India and fixing some additional control points due to change of power house site for Punatsangchu Hydro Electric Project for stage –II in Bhutan.

5. NATIONAL SCIENCE AND TECHNOLOGY MANAGEMENT INFORMATION SYSTEMS (NSTMIS)

i) Mapping and Delineation of Hazard Line:

Initiative

To ensure effective protection of shore lines, coastal infrastructure, livelihoods and lives through improved coastal management a Coastal Management Program undertaken by Ministry of Environment & Forest (MoEF) and entrusting the work of supplying a requisite coastal data and vulnerability mapping,(involving hazard line demarcation of coastal areas) to Survey of India through its Integrated Coastal Zone Management (ICZM) Project.

The objective of the project is to delineate, map and benchmark the coastal hazard line all along the mainland coast of India under World Bank Assisted "Integrated Coastal Zone Management" (ICZM) project, where SOI has to generate a 0.5 meter elevation contour map on 1:10,000 scale as base map to delineate the Hazard Line for the entire mainland coast of India upto the maximum width of 7 km from shore line on the landward side.

Achievement

1. Tidal data pertaining to 40 years (as available with G&RB) for extraction of maximum annual elevation and extra-pullation for 100 years pertaining to 20 ports (converted to MSL heights as compiled by G&RB) has been submitted to MoEF.

2. Primary GPS Control has been completed.

3. DT/ST leveling is under progress.

4. Shape file generation for flight planning in respect of K&L GDC, M&G GDC, KGDC, TNP&ANI GDC and WB&SGDC Completed.

5. Collection of co-ordinate by hand held GPS on existing GTS BM & GCPs is under progress.

Fig. 6.6

ii) Coal Mine Project

Initiative

Survey of India is going to generate up-to-date digital topographical maps of Major Indian Coal fields covering an area of 26,400 sq.km. in five years time for Central Mine Planning & Design Institute, a subsidiary of Cold India Limited using aerial photographs and adequate ground checks.

To generate the Topographical maps of the major coalfields on 1:5000 scale with 2 meter contour interval in Plains (in case of hilly terrain contour interval may be 3-5 meter as practical) in GIS digital format based on Digital Photogrammetric Techniques using high resolution aerial photographs and adequate ground verification.

Survey of India also impart on-job training on data processing and interpretation to 4 scientists of Central Mine Planning & Design Institute for three months at the initial stage on preparation of Topographical maps based on aerial photographs using digital photogrammetric technique.

Achievement

Construction of 82 Primary BM/ GPS Pillars and 12 hrs. GPS observation on75 control points for 17 Coal Fields are completed. 2500 linear Km. DT leveling line has been carried out for providing height contol. Aerial Photography in respect of 10 Coal Fields (Priority – 1 area) (Bisrampur, Lakhanpur, Korba,Chirimiri, Sonhat, Sohagpur, Talcher, Hasda, Arand,,I.B. Valley & Mand–Raigarh) has been received and feature extraction is to be initiated.

iii) Urban Mapping for NUIS

Initiative

The Ministry of Urban Development (MOUD), hosts the National Natural Resources Management System (NNRMS) Standing Committee on Urban Management (SC-U) and the proposal to develop holistic National Urban Information System (NUIS) Scheme was mooted by the SC-U to be taken up in a National Mission Mode. The objective of the project is to develop attribute as well as spatial data base for various levels of urban planning and decision support to meet requirements of urban planning and management. Survey of India has taken up the work to generate and supply the geo-spatial data required for the project.

Databases to be developed at two levels on 1:10,000 scale GIS database for Development/Master Plan for 152 selected towns using remote sensing satellite imagery and on 1:2,000 scale GIS database for detailed town planning schemes using high resolution remotely sensed data sources (Aerial Photographs) for the same 152 selected towns. On 1:1,000 scale Utility Maps derived from the 1:2,000 base maps, for 22 towns to be undertaken using Ground Profiling/Penetrating Radar (GPR) technology.

Achievement

- **Databases on 1:10,000 scale** –Thematic mapping and thematic mapping of 125 towns have been completed and final product of 116 towns has been sent to state nodal agencies.

- **Databases on 1:2,000 scale** - Aerial photography of 133 towns have been completed. Control points of 119 towns have been completed. 2D Feature extraction of 94 towns and ground Survey of 4 towns, using Total Station has been completed. Final data of 86 towns has been sent to State Nodal Agencies.

iv) Delhi State Spatial Data Infrastructure (DSSDI) Project

Initiative

Survey of India has to create Land Information System and central data base for all Govt. Department of Govt. of National Capital Territory of Delhi (GNCTD) and 3D GIS solution including generation of large scale base map.

Achievement

- Extensions of framework control, Aerial Triangulation, DEM generation and preparation of Ortho-photo have been completed.

- Installation, Testing, Integration and operationalisation of 2 main control centres and equipment & commissioned for 8 monitoring centres are completed. Delhi Geo Portal for DSSDI project completed.

- 3D Feature extraction, Ground validation over ground utility survey & creation of topographical database have been completed. Property survey for property GIS, linking of property data with the buildings and Utility Mapping (Underground) are under progress completed. 3D Topology generation completed.

v) GIS BASED MAPPING OF CITIES/TOWNS

Initiative

Survey of India has taken up a job for Registrar General of India to supply the digitized ward Maps with attached attributes. Ward map will be prepared on large scale (1:2000) and will be verified on the ground to collect the house number along with the other information in tabular form. When the maps are digitized (with attribute house number map), the digital ward is joined with the tabular information to give the digital data of ward with complete information.

Achievement

Survey of India has completed Ward wise Mapping and GIS creation of 28 cities, Project completed.

6. SCIENCE AND TECHNOLOGY PROGRAMMES FOR SOCIO – ECONOMIC DEVELOPMENT

(i) Topographical activities:

(a) Control Work:

- Traverse ... 372 linear km
- Levelling ... 6882 linear km

(b) Surveys:

- Boundary demarcation(Indo-Pak) … 113 linear km
- Boundary demarcation(Indo-Bangladesh) .... 345 linear km
- Joint demarcation /relocation of missing / ..... 20 pillars
- Joint demarcation, relaying & construction of Boundary pillars (India – Bhutan) ..... BP 2-BP9, BP66/1-68/9, BP15/8-24, BP68/10-75
- Verification surveys for IAF .... 15 Aerodromes

(c) Printing:

- Printing of various types of maps ... 1000 Maps

(ii) Digitisation and creation of Digital Cartographic databases

- Departmental maps on various scales ... 601 Maps on 1:25,000 scale
- Extra Departmental maps on various scales ... 100 Project maps

(iii) Geodetic and Geophysical surveys:

a) Geodetic surveys for monitoring of progress of various developmental projects are in progress.

b) During the year, Survey of India is committed to carry out the following tasks as departmental commitment:

- GPS observations - 594 stations
- Precision Levelling - 1396 linear km
- EDM Traverse - 82 linear km
- Gravity observations - 1057stations
- Installation of Tide Gauges - 13 Stations

7. DST SCIENTIFIC INSTITUTIONS & PROFESSIONAL ACADEMIES - Not Applicable

8. SCIENCE AND TECHNOLOGY BASED SERVICES

The following projects based on latest available technologies have been taken up by Survey of India.

a) Hydro- Electric Projects

Large scale survey with provision of precise height and planimetric controls for planning of various Hydro-Electric Projects at different places have been taken up.

(i) Kauli Hydro Electric Power Project (Himachal Pradesh):- Providing plan & Height control points & Mapping on 1:200 scale..

(ii) Thana – Plaun & Beri – Nichli H.E.P. Project **(**Himachal Pradesh**):-** Providing control work by GPS and leveling (Provision of Control & levelling for 27 points.)

(iii) Kadwan Project (Uttar Pradesh**):-** Supply of Control data (Co- ordinates, BMs &Hts,) & Field verification. Work is under progress.

b) Relaying of Bhakhra Grid junction point in seven village of Haryana: Grid junction points of 7 villages completed .

c) NRSC Project:- Survey of India Converted Digital Topographical Data base of 2890 maps on 1:50,000 scale from DGN to Arc Geo data base and supply to National Remote Sensing Centre.

d) Special Survey for IAF /Air Ports :- Survey of India carry out special survey for India Air Force and Prepares IAF(OGM), IAF (PGM) & Land Approach Chart (LAC) etc.

NATIONAL ATLAS & THEMATIC MAPPING ORGANISATION

National Atlas and Thematic Mapping organization is a subordinate office under the administrative control of the union Ministry of Science & Technology (Department of Science & Technology) Government of India. The organization is headed by a Director and assisted by two Joint Directors, seven Dy. Directors, Twenty seven Group 'A' officers, thirty seven Group 'B' officers of Gazetted category, one hundred seventeen Group "B" non-Gazetted officers, one hundred forty nine Group 'C' officers. The organization has a total strength of 400 till date which includes a large number of qualified professional geographers and Cartographers, perhaps the largest number under one roof anywhere in the world. It is a permanent government organization and premier organization in the field of preparation of thematic maps.

The main objective of organization is to educate people of India about the changing scenario of the political, social, economical & cultural set up of the country. To help the planners to use the maps as development tools for resource mobilization at grass root level. State atlases help in a big way for better planning when resource data base is available in atlas form. Historical & cultural heritage atlases are the comprehensive cartographic record of historical and cultural heritage of India. To cope up with the demand from the users, atlases for visually impaired are being prepared to help blind persons to have a clear idea about India's physical, cultural and socio economic aspects. Electronic Atlas of India will facilitate its users in different aspects of India as depicted in National Atlas in digital format. Golden Map Service covering whole of India is being prepared to provide village level information for any sorts of planning and developmental works.

Functions:

a) Compilation of the National Atlas of India in English and Hindi

b) Preparation of National Atlas Maps in regional languages

c) Preparation of thematic maps based on research studies on environmental and associated aspects and their impact on social and economic development.

d) Any other work entrusted by the Central Government to NATMO

e) Automated Mapping & Geographical Information System for increasing efficiency in mapping technology.

f) Geographical/Cartographical research & training.

g) Golden Map Service covering whole India.

h) Development of Digital Cartographic Database for large-scale Thematic Mapping.

i) Web-based National Atlas of India.

j) Maps for Low Vision Persons.

k) Maps for Visually Impaired.

TARGET AND ACHIEVEMENT FOR THE YEAR 2011 -12

	PROGRAMME	*Target 2011-12 By no. of maps*	*Achievements 2011-12 By no. of maps*
a.	DPMS (Revision)	4 maps	4maps
b.	DPMS (New)	1 map	1 map
c.	State Atlas of Jharkhand	5 maps	5 maps
d.	State Atlas of M.P.	10 maps	10 maps
e.	Special map	4 maps	3 maps
f.	School Atlas for visually impaired (English) to be continued as per TIFAC (DST) Programmed on regular basis.	5 maps	5 maps
g.	School Atlas for visually impaired in Assamese (to be continued on regular basis)	4 maps	4 maps
h.	Electronic Atlas of India	5 maps	5 maps
i.	Golden map Service	10 Scenes	9 scenes
j.	Atlas of Freedom Movement	20 maps	20 maps
k.	Re-printing of National Atlas Maps	6 maps	5 maps
l.	Revision of NATMO maps	4 maps	3 maps
m.	Primary School Atlas in Hindi	6 maps	5 maps

Key Achievements for 2011-2012

1. Final Detail Project Report of NDMA for 1:10,000 & 1:2,000 scale mapping has been submitted.

Research, Development and Training:

Regular activities on research and development is a continuing job and done its share for the period successfully. Training in GPS, remote sensing, and GIS has been imparted to 50 extra persons belonging to different colleges and Universities of different parts of country. The in-house training in thematic cartography, photogramatry, GPS, remote sensing, and GIS has been imparted to departmental candidates as well.

Other activities done during the period:

i) Several NATMO officials actively participated in many national and international conferences and seminars.

ii) NATMO Participated in regional, national and international exhibitions, book fairs to popularize the utility of the maps, atlases and data base of NATMO.

iii) Database creation through GIS is in progress as an ongoing job.

iv) NATMO maps in electronic media are an ongoing project and are also done during this period.

v) Scanning, plotting as a part of extra departmental activity is also done for generating revenues.

vi) As envisaged in the TIFAC (DST) activity maps and atlases for visually Impaired in regional languages was also feeling necessary in addition to regular job in English, Hindi and regional languages. As such the same has been initiated during this period and completed in Assamese.

Revenue Generated during 2009-2010

a) During the period from April 2011 to December 2012, the Organization has generated revenue of Rs-11, 82,349.50 through selling of various maps, atlases, monographs and other sources.etc.

TECHNOLOGY INFORMATION, FORECASTING AND ASSESSMENT COUNCIL (TIFAC), NEW DELHI

A. Organization Particulars

1.	**Name of the Institute**	**:** Technology Information, Forecasting and Assessment Council (TIFAC) 'A' Wing, Vishwakarma Bhavan, Shaheed Jeet Singh Marg, New Delhi 110016
2.	**Established in the year**	**:** 1988
3.	**Number of scientists / faculty**	**:** 33
4.	**Total number of Employees**	**:** 81

B. Report on Activities during 2011-12

a.	Areas of Focus	: Technology Foresight, Special Reports, Technology Support Programmes
b.	Major Accomplishments	: –

c. Important Highlights of 5 Major Programmes:

1. Foresight and Assessment Activities/Studies

1.1 Technology Vision 2035

As a sequel to the Technology Vision 2020 commended by it to the country in 1996, TIFAC has geared itself towards scripting the Technology Vision 2035, a document that would comprehensively assess the technologies besides identification of the priorities, demand drivers, constraints & opportunities. An Inclusive and consultative approach is being followed for the exercise.

1.2 Manpower needs Assessment for Science & Technology in India

A team of TIFAC scientists and Project Associates have completed a study on the S & T manpower needs for Science & Technology (S&T) in India. The report covers the following:

- Stock of S&T manpower (Natural Sciences, Engineering, Medicine, Agriculture & Veterinary) has been estimated degree wise (PhD, Post Graduate, Graduate etc.) and projected in the future

- Current Status and Demand of S&T manpower in academia, industry and health and the government sector have been projected for 2012, 2017 and 2022.

- Different scenarios have been drawn in the projection of manpower in R&D in next 10 years

2. Innovation Support Programmes

2.1 Technology Refinement & Marketing Programme (TREMAP)

Technology Refinement and Marketing Programme (TREMAP), with the objective of pushing innovative products / prototypes, up the commercialization cycle, towards market through a network of Technology Commercialization Facilitator (TCF) agencies, facilitated transfer of five technologies of individual innovators to industry.

Fig. 6.7

Fig. 6.8

2.2 Patent Facilitating Centre (PFC)

During this period PFC has conducted nine (9) Patent/IPR awareness workshops in various states, sensitizing about 1500 scientists and technologists. Under the National Programme for Training of Scientists and Technologists, entrusted by DST, PFC has conducted one training programme on "IPR and WTO issues" for the scientists from August 22-26, 2011 which was attended by 31 scientists from various scientific organizations. The second programme would be organized in the month of January, 2012 at Mumbai. PFC has technically examined more than 73 requests and out of that 34 cases from various institutes were recommended for patent filing which includes 6 PCT applications. The sixth batch of the 73 women scientists completed their one year training in IPR in May 2011. Nine (9) technology scan reports based on patent analysis were prepared.

Fig. 6.9

3. Technology Innovation/ Demonstration Programmes

3.1 TIFAC-SIDBI Revolving Fund for Technology Innovation Programme (SRIJAN)

The programme was launched jointly with SIDBI with the objective of facilitating Indian industries to scale up technology innovations which are not yet proven at scale-up or commercial level in the country in 2010. The programme synergizes strengths & capabilities of TIFAC and SIDBI for carrying out technical and financial appraisals of project proposals respectively. During the year, around eighteen new project proposals were technically appraised by TIFAC out of which four project proposals were technically recommended to SIDBI for financial appraisal. Two projects were supported and technically monitored and reviewed. Several others are in pipeline.

3.2 Umbrella Scheme On Technology Vision 2020 Projects in Mission Mode (TV 2020)

3.2.1 Agriculture

Two projects, one at Varanasi district of U.P on 'Quality Mode Production in Rice-Wheat Cropping System through Farmers Interest Groups' and the other at Kota and Jaipur districts of Rajasthan on 'On Farm Demonstration and Commercial Cultivation of *Trichoderma* as Bio-Pesticide & Growth Promoter' are being implemented. Under the project at Varanasi, U.P. the net income of farmers has been significantly increased to the tune of 20-25% with adoption of quality mode production methods. In the project at Kota and Jaipur districts, the incidence of diseases, especially root rot in Groundnut, was significantly reduced through IPM practices. Similar results were achieved in wheat, soybean, barely, vegetables, etc.

3.2.2 Collaborative Automotive R & D (CAR)

Collaborative Automotive Research (CAR) is an inter-ministerial program led by Office of Principle Scientific Adviser to the Government of India, implemented through TIFAC and the sectoral ministries of Heavy Industries, Electronics and Road Transportation are supporting the program. The mandate of CAR program is to develop a process by which automotive related R&D can be conducted cooperatively between government, industry, academia and national labs. The following four key

areas were chosen for conducting pre-competitive R&D: (a) Automotive Electronics & Control Systems (b) Advanced Materials & Manufacturing (c) IC Engine & Power-train (d) Electric & Hybrid Electric Vehicles. Five projects are ongoing.

3.2.3 Targeted Programmes in Other Important Areas

3.2.3.1 Bioprocess & Bioproducts Programme

Two projects were completed. In the first one entitled 'Development of prostaglandins & advanced intermediates' in partnership with Hygeia Laboratories, a pilot-plant commissioned with its equipment, utility systems, pipelines etc. for the manufacture of prostaglandins. In the second project entitled 'Development and optimization of enzymatic process for producing Stevioside from Stevia leaves', in partnership with M/s. Stanpack Pharma Pvt. Ltd. at Baddi, Himachal Pradesh, the process for producing stevioside from stevia leaves was successfully optimized in the project, by way of setting up a production unit.

Four other projects, including 'Centre for Biofuels' at the National Institute for Interdisciplinary Science & Technology (NIIST), Thiruvananthapuram, for undertaking cutting edge research activities in bio-refinery related technologies, 'Process development for production of L-arginine by fermentation' in collaboration with Jawaharlal Nehru Technological University (JNTU) & M/s Celestial Labs Ltd., 'Efficient utilization of jatropha seed cake by detoxification' in collaboration with Osmania University (OU) & M/s. Naturol Bioenergy Ltd., Hyderabad, 'Development of biotransformation process for synthesis of chirally pure compounds' in association with IIT- Bombay and M/s Sci Molecules India Pvt. Ltd., Pune are pursued towards achieving the objectives.

3.2.3.2 Technology Up gradation of select MSME clusters

TIFAC has an ongoing program focused towards providing R&D support to Micro Small and Medium Enterprises (MSME), on a sustainable basis and plan technological interventions in select MSME cluster. The Progress during the period is as below:

Technology Gap Studies for Sanganer Handmade Paper Industry cluster, and rubber manufacturing units implemented by NIT-Agartala were completed. **12** Technology Gap Analysis Studies have been commissioned in the year 2011 in **11 MSME clusters** in India with nearby and capable Knowledge Partners in areas such as readymade garments (Tirupur & Delhi/NCR), plastic cluster (Mumbai and Delhi/NCR), sewing machine (Ludhiana), bicycle parts cluster (Ludhiana), textile cluster (Panipat), etc.

Six draft reports on 'Technology Gap Analysis Studies' have been submitted respectively by the Knowledge Partners for the MSME clusters namely, for the 'Sewing Machine Cluster' (Ludhiana), 'Bicycle Parts Cluster'(Ludhiana), 'Plastic Cluster'(Delhi/NCR), 'Mini Gas Cylinder Cluster'(Meerut), 'Voltage Stabilizer Cluster'(Meerut), and 'Electronics Cluster'(Mohali). **Four Validation Workshops** have been conducted in the 'Mini Gas Cylinder Cluster' (Meerut), Voltage Stabilizer cluster, (Meerut), Mini gas cylinder cluster, (Meerut), 'Sewing Machine Cluster' (Ludhiana) and 'Electronics cluster' (Mohali) to validate the findings of the draft studies.

TIFAC has taken lead in getting the cupolas of the cluster to be redesigned to make them more energy efficient. Once the designing is done, the industry puts its own resources to carry out the modification as per the design under the supervision of the Centre. During the period, three cupolas were converted and more are in pipeline.

Fig. 6.10

Fig. 6.11

Pictorial view of the divided blast cupola after modification

4. Special Linkages

India International Institute for Applied System Analysis (IIASA) Programme: As a capacity building initiative under the IIASA Programme, two Indian researchers participated in the Young Scientist Summer Program (YSSP) at IIASA jointly funded by IIASA and TIFAC.

5. Major and Unique National Facilities created : NIL

6. Important collaborations (national and global) established:

Collaborative Automotive R & D (CAR)

CAR has been closely associated with Department of Heavy Industry (DHI) and National Manufacturing Competitiveness Council (NMCC) and developed a 'Technology Roadmap' as part of input for newly initiated program on 'National Mission on Electric Mobility (NMEM)'.

CAR-Fraunhofer Gesellschaft collaboration: This initiative aimed at bringing together Indian academia and industry with laboratories under the Fraunhofer, Germany for joint technology development efforts. After two consultation workshops jointly, four consortium projects were developed, for consideration of funding. One of them was taken up by TDB (MultiJoin – Techniques for joining Aluminum with other metals) and an agreement has been signed between Indian and German parties.

C. Important Output Indicators for 2011-12

S.No.	Parameters	Output
1.	Papers in refereed journals	**Collaborative Automotive R & D (CAR)** 1. 'The Quest for Electric Vehicle Batteries with High Specific energy', Auto Tech Review, September, 2011. 2. 'Permanent Magnets-based Electric-drive Vehicles - Resource Assessment in India', Auto Tech Review, November, 2011
2.	Books	**Umbrella Scheme On Technology Vision 2020 Projects in Mission Mode (TV 2020)Agriculture** A Training Manuals on "Biological Control - *Disease diagnosis, Evaluation and Management*" was published under the project "On Farm Demonstration and Commercial Cultivation of *Trichoderma* as Bio-Pesticide & Growth Promoter" being implemented at Kota and Jaipur districts in Rajasthan.
3.	Papers in Conferences	**Collaborative Automotive R & D (CAR)** 1. ''Plug-in Hybrid Electric Bus for Public Transport – Benefits and Impacts ' (SAE Paper No. 2011-28-0067), October, 2011- this paper was awarded **"Best Indian Paper on Safe and Smart Mobility"** 2. 'Lightweighting of Public Transport Buses in India : An Impact Analysis' (SAE paper no. 2011-28-0054), October, 2011
4.	Number of Technologies/Designs and other intellectual products commercialized	**Technology Refinement & Marketing Programme (TREMAP)** 1. Novel fluorescent reagent 2. Side view mirror adjustment and protection system 3. Low energy dental/medical aspirator 4. Nimble carpet shearing machine 5. Auto wash Gear Roller wall Mount Wet Grinder **Collaborative Automotive R & D (CAR)** The following two technologies: 1. Development of Engine Management Systems 2. Vehicle Tracking and Control Systems using GPS **Technology Up gradation of select MSME clusters** 1. Three cupolas redesigned in Howrah Foundry Cluster
5.	Number of Technology leads awaiting transfer	**Collaborative Automotive R & D (CAR)** Four following technologies: 1. Intelligent Acoustics Diagnostics for Quality Control of Automobile Engines 2. Tailor Welded Blanks and Hydro forming 3. Low cost Flexible Automation using robotic arms 4. Semisolid Forming and Squeeze Casting
6.	Other Products/ Indicators	
	Collaborative Automotive R & D (CAR) 1. A study on NOx Control in Internal Combustion Engines was completed. The report discusses trends in NOx control technologies and prepares a roadmap for development of NOx control technologies in India.	

	2. Under the CAR project "Use of straight vegetable oils (SVO) in IC engine", an exhaustive database has been generated with 17 physical, thermo-chemical, physio-chemical and chemical properties of 4 different types of straight vegetable oils, with samples sourced from various geographic locations for each of them. A unique experimental facility has been created and detailed studies on spray characteristics of Indian SVO's have been conducted at atmospheric and high pressures. A constant volume high pressure spray visualization chamber is designed to study SVO sprays at high gas pressure and temperature conditions. 3. TIFAC has prepared a draft Roadmap for National Mission on Hybrid and Electric Vehicles and handed over to Department of Heavy Industry and National Manufacturing Competitiveness Council.

PATENT FACILITATION PROGRMME

Department of Science & Technology has created Patent Facilitation Centre in 1995 with the "May I help you" mantra under its flagship programme of Patent Facilitation for creating awareness about intellectual property rights (IPR) in the country, assisting scientists and technologists in protecting their inventive work, spreading the IPR culture to the State level, evolving policies at the national level, providing technical input to the government on IPR related issues, interacting and supporting other government departments in protecting their innovations, keeping a watch on developments in the area of IPR and making important issues known to policy makers, scientists, industry, etc.

IP Facilitation

DST through PFC has a mechanism to extend full technical and financial support to R&D institutes, universities, educational institutions and schools in protecting their inventions in India and abroad.

A Committee on IP Facilitation (CIPF) scrutinized National and International IP filing requests received by PFC from various universities, educational institutions and government agencies. During the three meetings held this year in August, September and December, more than 73 requests were evaluated and out of that 34 cases were recommended for patent filing which includes 6 PCT applications. These 34 patents are being filed in the name of the following institutes:

Sl. No.	Institute	Subject Area
1.	M D University, Rohtak	Biochemistry
2.	University College, Trivandrum	Biochemistry
3.	Manipur University, Imphal	Biochemistry
4.	University of Lucknow, Kucknow	Biochemistry
5.	Panjab University, Chandigarh	Biochemistry (5 applications) and Chemistry (1)
6.	Pondicherry University, Pondicherry	Biology
7.	University of Allahabad, Allahabad	Biology
8.	University of Rajasthan, Jaipur	Chemistry
9.	Himachal Pradesh University, Shimla	Chemistry
10.	Banaras Hindu University, Varanasi	Chemistry
11.	TKM College of Engineering, Kollam	Electronics
12.	Govt. High School, Mehtan	Electronics
13.	Anna University of Technology, Chennai	Electronics

14.	NIT, Trichurapalli	Electronics (1) and Mechanical (1)
15.	IIT, Delhi	Electronics (2 applications)
16.	IIT, Guwahati	Mechanical
17.	Amal Jyoti College of Engineering, Kottayam	Mechanical
18.	DIPSAR, New Delhi	Pharma
19.	Cochin University of Science & Technology, Cochin	Physics
20.	IIT, Kharagpur	Physics/Electronics (7 applications) and Mechanical (1)

New Patent Information Centre (PIC's) Established:

Department of Science & Technology (DST) under its umbrella created the Patent Information Centres (PIC) at state level for spreading the awareness about patent , GI's , Trdemark , Copyright filing , registration among Scientists / technologists / Researchers / Engineers & Traditional Medical Practitioner. These PIC's to further expand network have established the Intellectual Property Cells (IPCU) at various universities in their states. During this year new Patent Information Centres have been established in the state of Nagaland, Orissa, Uttarakhand & Arunachal Pradesh.

Future Plan

The ongoing activities of the programme PFC would continue as such in 2012-13 as well, apart from the following activities envisaged:

1. Filing of 70 new patent/IPR applications for academic and R&D institutions.
2. Conducting 20 patent/IPR awareness workshops throughout the country.
3. Training 120 women in the area of IPR under the 7th Batch of Women Scientist Scheme (WOS-C).
4. Setting up of new centres for training of women scientists.
5. Organising 4 advanced training programmes at national and international level.
6. Conducting online courses for IPR training.
7. Reinvigorating IPR Bulletin
8. Further mechanisms to protect INSPIRE ideas/exhibits are being envisaged
9. Updation of PFC website
10. Development of efficient PFC information systems
11. Recommendations of Think-Tank Committee would be initiated as activities/programs.
12. Strengthening of Patent Information Centres for the playing leading role in identification of patent , GI's and opening of new Intellectual Property Cells unit (IPCU) in various universities of the country and subsequently arm them with sufficient resources so that they may also play advisory role at state level.
13. Initiation of student level training programme (Diploma engineers, Graduate Engineers and MSc students etc.)

VIGYAN PRASAR (VP), NOIDA

A. Organization Particulars

1.	Name of the Institute	: Vigyan Prasar, Noida
2.	Established in the year	: 1989
3.	Number of scientists/faculty	: 12
4.	Total number of regular employees	: 33

B. Report on Activities during 2011-12

C. Areas of Focus: Science and Technology Communication

D. Major Accomplishments: Vigyan Prasar conceptualized a number of programmes during the International Year of Chemistry-2011 and successfully completed a majority of those. VP continued to play a major role in disseminating science and technology throughout the country and produced science communication materials and disseminated through print and digital media. A total number of 42 books including reprints were published. Television programmes were produced and telecast through Doordarshan and Lok Sabha TV. Science radio programmes were broadcast through 117 AIR stations in 19 Indian languages. A number of workshops were conducted throughout the country for students, teachers and science communicators. VP brought out monthly science magazines namely *Dream 2047* and VIPNET News. A number of training workshops were conducted for science clubs.

E. Important Highlights of Major Programmes:

Programmes during International Year of Chemistry

- VP produced 26 episode radio Serial "Colours of Chemistry'. This was broadcast through 117 radio stations of All India Radio, in 19 Indian Languages.

- **Activity kit and interactive CD on Chemistry**

  Vigyan Prasar developed an activity kit (English and Hindi) on chemistry jointly with Gujarat Council of Science City, Ahmedabad. Forty-five activities related to Chemistry can be performed using the kit.

  An interactive CD on innovative experiments in Chemistry was developed by Vigyan Prasar.

- **Nationwide Sensitization Programme for Chemistry Teachers**

  Nationwide sensitization programmes for Chemistry teachers were organized at Allahabad (UP),Delhi, Palakkad(Kerala) Madurai (TN),Guwahati(Assam),Jammu(J&K), Vadodara (Guj), Goa ,Vijayawada (AP).Total 500 teachers were trained in through these programmes.

- **Demonstration Programmes**

  Demonstration programme of activities kits/experiments were organized at different places of the country. 700 students and 200 teachers participated.

- **Development of activities on Green Chemistry**

  VP is working towards the development of an awareness programme on Green Chemistry in collaboration with Green Chemistry Network Center, Department of Chemistry, University of Delhi.

- **Activity Book on Chemistry behind Miracle**

  Vigyan Prasar is in process to develop an activity book on "Chemistry behind Miracles" to explain the miracles shown by God men and others in scientific way and book on success stories on Indian Chemistry.

- **Chemistry Quiz Programme**

  Vigyan Prasar jointly with Chronicle Groups is organizing Chemistry Quiz on monthly basis. This is being published in Civil Services Chronicle Magazine every month both in Hindi and English and this programme will continue up to January – 2012.

Science programmes on Television

- **Telecast by Doordarshan**

  A 12-part video serial 'Our Celestial Neighbour- Far and Near', was telecast during 10th May, 2011 to 26 July, 2011 every Tuesday on DD National at 09:30 am -10:00 am.

  A 13-part video serial 'Nano Ki Duniya' telecast during 2nd August, 2011 to 25 October, 2011 every Tuesday on DD National at 09:30 at -10:00 AM. Nano Ki Duniya based on Nanotechnology.

  A 26-part Video serial Science Video Serial "Kuch Tukke - Kuch Teer: Prayog Jinhone Duniya Bdal di (Experiments That Shaped the World)" telecast from 1st November, 2011 in DD National at 08:30-09:00 am.

- **Lok Sabha TV**

  A 42-part video serial 'AISA HI HOTA HAI" telecast from 2nd January, 2011 every Sunday on Lok sabha TV at 9:30-10:00 AM.

  Weekly current affairs/ news based video programme "Vigyan Darpan" in Hindi and "Science this Week" in English is being telecast every Thursday and Friday at 09:30- 10:00 PM from Lok Sabha TV.

Radio Programmes

Science radio programmes produced by Vigyan Prasar were broadcast through 117 radio stations of All India Radio, in 19 Indian languages.

- Radio serial "Colours of Life" based on Bio- diversity(13 Episode)
- Radio Serial 'Swa-Shakti" based on Women Empowerment(13 Episode)
- Radio Serial "Baat Vigyan Ni" in Bhil language (13 episodes)

  This 13-episode radio serial was broadcasted from Akashvani Kendra Indore, (MP)

Networking through EduSAT interactive terminals

Intercative live programmes through EduSAT terminals on different aspects of science were organized. Presently there are 50 terminals.

Publication Programme

A total number of 42 books including reprints were published. Various publishers have brought out Vigyan Prasar's publication in different Indian languages.

VP brought out all 12 issues of bilingual science magazine 'Dream 2047' and activity based magazine 'VIPNET News' for science clubs. *Dream 2047* has 50000 subscribers and e-version has 4000 subscribers. VP is encouraging e-version of the magazine.

Readers' responses of Dream 2047 have been analyzed and actions initiated to implement the recommendations.

VIPNET Science clubs

VP has established a nation-wide network of science clubs called VIPNET Science clubs. Presently there are over 10000 science clubs located in 425 districts of the country. Training programmes on hands-on science activities for the members of the science clubs are being organized.

Vigyan Prasar Information System and Laboratories

VP website continues to be one of the most comprehensive website on S&T communication. Digital Library has become very popular. It has over three lakhs readers.

Rashtriya Vigyan Chalchitra Mela and Competition (RVCMC) -2012

To felicitate, recognize and encourage science film producers and production of S&T related films/ videos as well as to attract outstanding science and technology video films produced in the country to set new bench mark for excellence. Vigyan Prasar has initiated Rashtriya Vigyan Chalchitra Mela and Competition since year 2011. Award winning films were felicitated and shortlisted films were screened during 99th session of Indian Science Congress at KIIT University, Bhubneswar.

National Technology Day Celebration – 2011

Vigyan Prasar organized the first Round Table Discussion on "Chemistry and Clean Technologies" on the occasion of National Technology Day at Indian Institute of Public Administration (IIPA), New Delhi on May 12, 2011.

Brainstorming workshop on Technology Communication

Vigyan Prasar has taken up initiatives towards technology communication to the masses. A two day brainstorming workshop on "Technology Communication – the Way Ahead" was organized jointly with Centre for Rural Development & Technology and Hindi Cell of IIT Delhi during September 27-28, 2011.

Workshops on Science Broadcasting

Vigyan Prasar organised four regional workshops on Science Broadcasting in New Delhi, Lucknow, Kolkata and Pune. These workshops were organized in collaboration with Indian Institute of Mass Communication, New Delhi; Amity University Uttar Pradesh, Lucknow; University of Calcutta, Kolkata and Film & Television Institute of India (FTII), Pune respectively.

Exhibition and Dissemination

VP has been taking part in different exhibitions/book fairs throughout the country and disseminating science through posters, charts, multimedia CD-ROMs etc.

VP has been regularly participating DST-INSPIRE science camps. Lectures and demonstrations are being organized by VP for the participating students.

Astronomy Activities

VP has initiated national campaigns, workshops, training programmes and mass mobilization for popularization of astronomy. Vigyan Prasar has planned a nation-wide programme to be taken up on the occasion of Venus-Transit - 2012.

HAM radio

VP has conducted a number of demonstration-cum-training workshops in different parts of the country to popularize HAM radio.

F. Major and Unique National Facilities created : NIL

G. Important collaborations (national and global) established:

"Development of life skills integrated learning materials" for National Institute of Open Schooling (NIOS)

Vigyan Prasar in collaboration with NIOS and UNPFA (United Nations Population Fund) is developing material on "Development of life skills integrated learning materials" for secondary curriculum in science for National Institute of Open Schooling (NIOS). This project is being coordinated by UNFPA- MHRD, Govt. of India supported Adolescence Education Programme (AEP in Schools).

H. Important Output Indicators for 2011-12

S.No.	Parameters	Output
1.	Papers in refereed journals	2
2.	Books	2
3.	Chapters in Books	8
4.	Papers in Conferences	20
5.	Number of Ph.Ds. produced	-
6.	Foreign Patents filed	-
7.	Foreign Patents granted	-
8.	Indian Patents filed	-
9.	Indian Patents granted	-
10.	Number of Technologies/Designs and other intellectual products commercialized	-
11.	Number of Technology leads awaiting transfer	-
12.	Research Manpower trained (other than Ph.Ds)	-
13.	Technical Manpower trained	-
14.	B.Tech/ UG projects guided	2
15.	M.Tech/M.Sc./M.Phil projects guided	1
16.	Articles published in magazines/journals	40
17.	Books published, including reprint	42

NATIONAL SCIENCE AND TECHNOLOGY MANAGEMENT INFORMATION SYSTEM (NSTMIS)

The National Science & Technology Management Information System (NSTMIS) division continued its efforts of generating and making available information on resources both manpower as well as financial devoted to scientific and technological (S&T) activi-ties by conducting national surveys both through in-house as well as sponsored studies.

(i) S&T Resources Studies

The national survey for the year 2009-10 for collection of data on resources devoted to research and development activities is under progress. Filled-in questionnaires are being received from various organisations. Data received is under scrutiny for its completeness and consistency. Reminders are being sent to collect information from non-respondents. Clarifications are also being sought from the respondents wherever the information is incomplete or inconsistent.

The national level report based on the above mentioned survey ***'Research and Development Statistics'*** will pro-vide information and analysis in forms and variety like financial and human resources deployed by research institutions/laborato-ries of major scientific agencies, central ministries/ depart-ments, State Government institutions/ departments, research stations and in-house R&D units of public and private sector industries. It includes S&T indicators and their trends such as R&D expendi-ture per capita and as percentage of gross national product, Plan/Non-Plan allocation for S&T, stock of S&T person-nel, stock of scientists, engineers, technicians for selected countries, enrolment, out-turn, patents, etc. for evidence based S&T policy planning.

As a part of the new initiative, ***'Science, Technology,Innovation and Creation of Knowledge (STICK)'*** Programme for the development of innovation indicators in Indian context, the division had involved various stakeholders in evolving appropriate framework to measure the innovation and knowledge creation capabilities of industrial enterprises at the national level. The framework adopts the internationally accepted concepts and definitions on the measurement of innovation. The programme shall lead to policy actions, appropriate incentive structures, international comparisons for planning, and fostering the innovation eco-system of the country.

Some reflections of the pilot innovation survey carried out for a sample of 101 industrial manufacturing and service firms spread across various sectors and locations as a part of this exercise are as below:

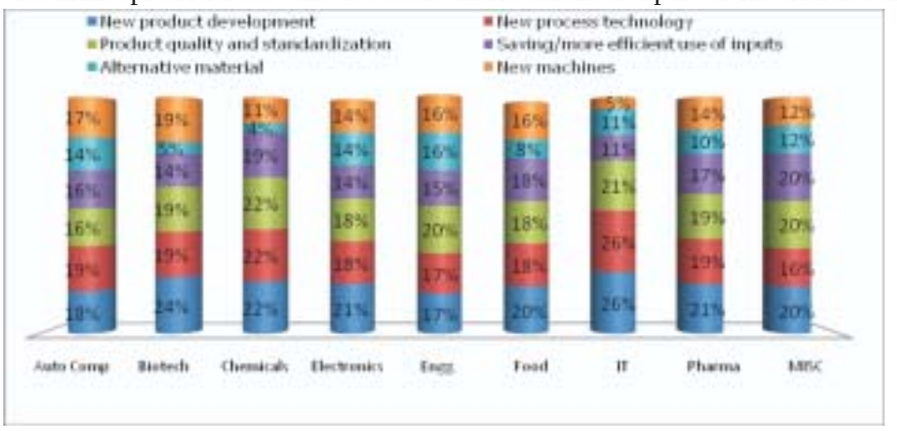


Fig. 6.12: Technological Initiatives

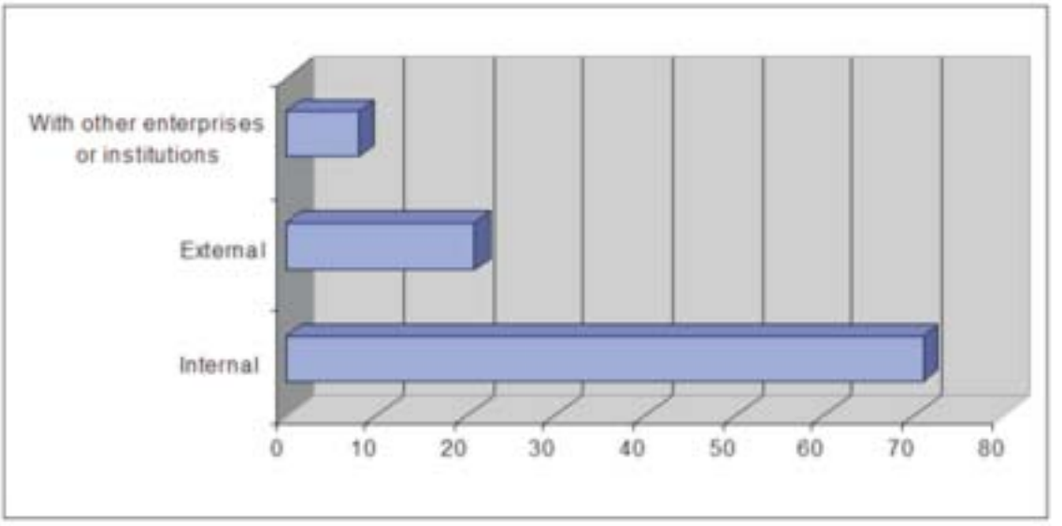


Fig. 6.13: Sources of Innovation

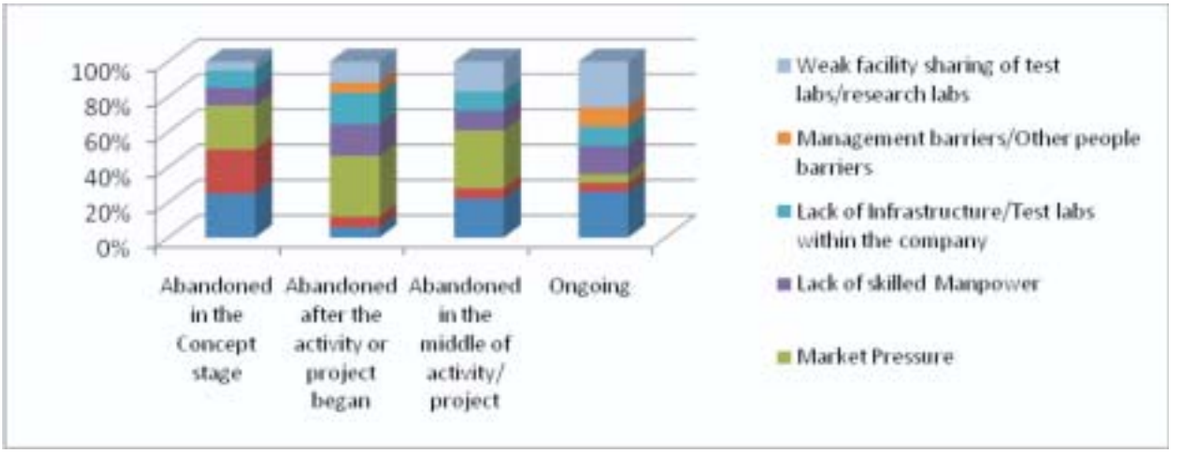


Fig. 6.14: Barriers to Innovation

Based on the learning of the pilot innovation survey, the Division has launched a National Innovation Survey targeting a population of more than 2 lakh enterprises in various industrial sectors spread across 26 states and 6 Union Territories in the country through a statistically valid sampling design.

As a part of the programme, the bulletin entitled '**Understanding Innovation – The Indian Context'** was brought out by the Division (for details see www.nationalinnovationsurvey.in) and the work is in progress for the preparation of National Science, Technology and Innovation (STI) Indicators Report.

Studies commissioned for the development of ***Bibliometric Indicators*** in Indian context (phase-I) based on the two globally popular databases namely SCI, Thomson Reuters and SCOPUS, Elsevier were completed. The studies have provided analysis and trends of India and select comparative countries in terms of research papers published, their share in total world output including the impact factor, highly cited publications, collaboration analysis etc. This would provide the basis for evidence based evaluation and monitoring of scientific research for policy planning.

(ii) Information System/Database Activities

With a view to disseminate information on research and development (R&D) projects for the benefit of different interest groups, the National Science and Technology Management Information System (NSTMIS) division of the Department of Science and Technology (DST) continued its effort to compile information on extramural R&D projects funded by different central S&T agencies. Besides maintaining a computerised database on extramural R&D projects, the Department publishes annually a ***Directory of Extramural Research and Devel-opment Projects*** funded during the year since 1990-91. The directories for the years 2008-09 and 2009-10 were brought out during the year.

The directory for the year 2009-10, twentieth in the series, contains information on 4828 new R&D projects approved by 19 central government departments/agencies. The total approved cost of these projects was Rs.1357.79 crores. Projects in the Engineering & Technology area received maximum financial support (36.37%) followed by Medical Sciences (23.64%) and Biological Sciences (17.31%) and together these received about 77% of the total R&D sup-port. Sixty four percent (64%) of the total support was given to the academic sector comprising of universities, deemed universities and institutes of national importance. The National Laboratories under government received 20% of the total financial support. Among the funding agencies, the extramural R&D support by Department of Science & Technology (DST) was the highest with Rs.447.55 crores followed by Department of Biotechnology (DBT) with Rs.213.96 crores. It is interesting to mention that the women participation in extramural R&D has increased significantly during the last decade.

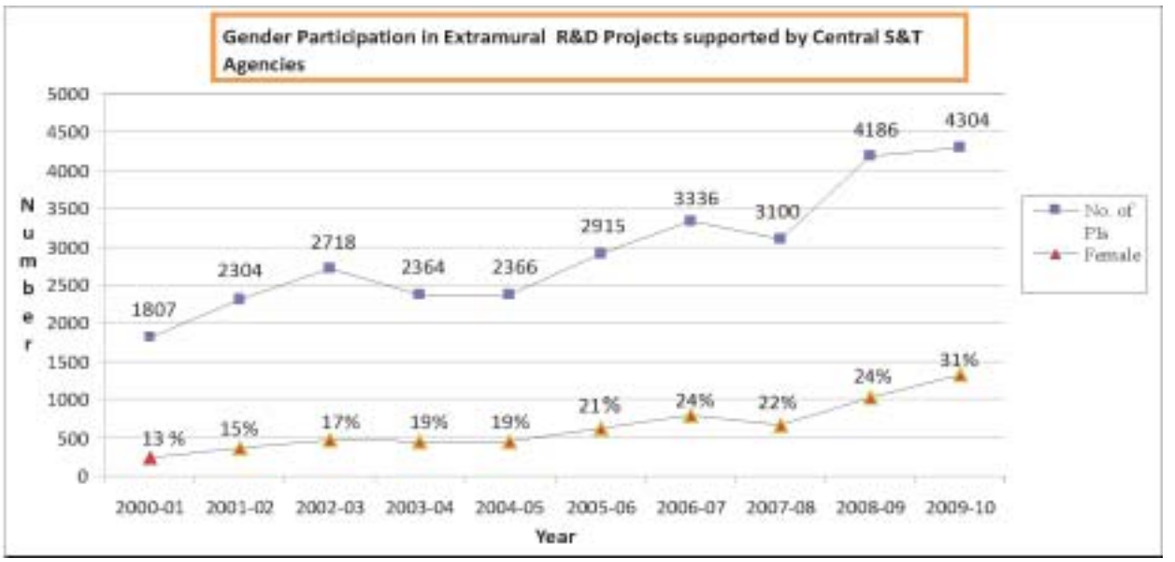


Fig. 6.15

To bring out the above annual directory on time, the work relating to the preparation of **Directory of Extramural R&D projects for the year 2010-11** has been started.

The NSTMIS division of DST has also been analyzing the outcome of these Extramural R&D projects supported by the central government S&T agencies. Report on the analysis of outcome of the extramural R&D projects entitled **"Analysis of Outcome of Extramural R&D Projects during 2000-05 and 2005-2007"** is under progress.

(iii) Sponsored Studies

Apart from the in-house efforts in bringing out the R&D statistics at national level, the NSTMIS division sponsored a number of studies to build databases on S&T investment, S&T manpower availability/deployment/gap and S&T indicators.

The following studies were completed during the year:

i) E-Governance – Institutional capacities and performance: A comprehensive study of India.

ii) Technology based advancement of Ludhiana based textile industries and their role in Indian economy.

iii) Success stories of Indian industries with focus on drugs and pharmaceutical, process engineering and biotechnology.

iv) Developing a subject information gateway in Information Technology (SIGIT)

v) Study on technology support services in special economic zones (SEZs).

(iv) International Collaboration

The Department has actively participated and contributed in the UIS and OECD meetings for the development and revision of standards/concepts/definitions used for collection of Science Statistics and the development of Science & Technology Indicators. The divisional officials also provided expertise to the Republic of Mozambique for creation of Science, Technology and Innovation Indicators under ITEC programme of MEA. The department also provided information for the country on Science & Technology Indicators to UNESCO Institute for Statistics for their publication titled "UIS Statistical Year Book".

NATIONAL ACCREDITATION BOARD FOR TESTING & CALIBRATION LABORATORIES (NABL), NEW DELHI

A. Organization Particulars

1.	Name of the Institute	National Accreditation Board for Testing & Calibration Laboratories (NABL)
2.	Established in the year	1998(Registered under Societies Act)
3.	Number of scientists/faculty / Technical officer	33
4.	Total number of employees	49 (Barring Director who is borne on the strength of DST. All other employees are engaged on contract (45) and Consultants (3))

B. Report on Activities during 2011-12

1. Areas of Focus

Objectives of National Accreditation Board for Testing and Calibration Laboratories (NABL)

1) To promote, implement and maintain an accreditation systems for laboratories in accordance with the relevant national and international standards, suitable for the country and responsive to changing needs.

2) To organise awareness programs on all aspects of laboratory accreditation by various means including seminars, workshops, laboratory –industry – accreditation body meets etc.

3) To provide timely and effective accreditation services to accredited and aplicant laboratories.

4) To undertake appropriate training programs in support of laboratory accreditation and related activities for laboratory personnel, assessors, NABL staffs , proficiency testing service providers, reference materials producers etc.

5) To prepare and maintain database of assessors and experts in different disciplines of calibration and testing and undertake regular monitoring of assessors.

6) To encourage proficiency tests / inter-laboratory comparisons in order to ensure accuracy, reliability, and reproducibility of testing and calibration results.

7) To acquire travelling standards, artifacts, certified reference materials etc for purpose of conducting proficiency testing programmes and measurement audits.

8) To develop and operate mechanisms to deal with complaints against all parties involved in accreditation process as well as appeals against NABL decisions on accreditation.

9) To establish and maintain linkages with international and regional bodies such as International Laboratory Accreditation Cooperation (ILAC), Asia Pacific Laboratory Accreditation Cooperation (APLAC), etc, through active participation in various meeting and activities of such bodies.

10) To undertake all the activities that shall promote bilateral / multilateral (mutual) Recognition Arrangements between NABL and accreditation bodies in other countries for wider acceptance of test results of NABL accredited laboratories.

11) To construct, improve, alter, demolish, or repair buildings and structures as may be necessary or convenient for carrying out the activities of NABL.

2. Major Accomplishments

During the period from April – November, 2011 total number of laboratories accredited by NABL was 223 with details as follows:-

Testing Laboratories: 109

Calibration Laboratories: 42

Medical laboratories: 72

During the F.Y., 330 laboratories are expected to be granted fresh accreditation till 31.03.2012.

3. Important Highlights of 5 Major Programmes

a) Accreditation of laboratories

NABL has accredited 223 laboratories; 109 labs in testing, 42 labs in calibration and 72 labs in medical upto 30.11.2011.
Total number of laboratories expected to be accredited during 2011-12 will be around 330.

b) Proficiency testing and related activities

NABL launched Proficiency Program on 09.06.2011 on World Accreditation day. It is anticipated that NABL will initiate accrediting PT Providers by March, 2012.

c) Training of Assessors and staff / Awareness programmes

14 Assessors Training Programs and 3 Awareness programs on NABL Accreditation in different parts of the country

d) Participation in International Conference / Workshop / Evaluation

NABL officers will participate in about 10 International Conference / Workshop / Evaluation programmes for exposure to new techniques / standards of accreditation related activities.

4. Major and Unique National Facilities created

Strengthening of infrastructure(construction of office building) and purchase of furniture

NABL has initiated construction of its own building in Gurgaon at an estimated cost of Rs.9.34 Crores. The total floor area of building will be around 21,000 sq.ft. Building is likely to be completed by March, 2012.

5. Important collaborations (national and global) established -

Technical Manpower trained 21

NATIONAL GOOD LABORATORY PRACTICE (GLP) PROGRAMME

Governments and industries all over the world are concerned about safety of humans, animals and the environment through use of chemicals (industrial chemicals, pharmaceuticals, veterinary drugs, pesticides, cosmetic products, food additives, feed additives, etc.). Regulatory authorities, the world-over, are continuously engaged in determining the level of risks acceptable to the society and elaborate on scientific inputs and technical data to ensure that risks posed by these chemicals do not exceed the contemplated level of risks.

Good Laboratory Practice (GLP) is a quality system, which has been evolved by the member countries of **Organization for Economic Co-operation and Development (OECD),** concerned with the organizational process and conditions under which non-clinical health and environmental safety studies on the above-said chemicals are planned, performed, monitored, recorded, reported and archived. This system helps to ensure the quality and integrity of safety data (on chemicals) produced by test facilities. The OECD Principles of GLP are internationally accepted.

A **National Good Laboratory Practice (GLP) Compliance Monitoring Authority** was set up in April 2002, under the administrative control of Department of Science and Technology, with the approval of the Cabinet to help Indian industries to obtain GLP-compliance status for their test facilities, so that data generated by these test facilities is acceptable in the countries of OECD. The Government of India has in principle agreed to follow the OECD principles of GLP for environmental and health monitoring of chemical substances. India was invited to be an Observer in the Working Group of GLP in 2003. Since then, a representative of NGCMA has been attending the meeting of the Working Group of OECD on GLP as an Observer. For getting a full adherent status to OECD's Mutual Acceptance of Data (MAD), India was rigorously evaluated by the OECD Working Group on GLP through on-site Mutual Joint Visits in 2008 and 2010.

Some of the major achievements of the Indian GLP programme are given below:

- On March 3, 2011, the Minister for Science and Technology on behalf of Government of India accepted the invitation of OECD Council to become a full adherent to OECD Council Acts related to Mutual Acceptance of Data (MAD) in assessment of chemicals and to join that part of chemicals programme related to MAD, with all of the rights and obligations of OECD member countries.
- Two new test facilities were granted the GLP-compliance status. These include:
  - a) Sa-Ford, Raigad, Maharashtra
  - b) PI Industries R & D Centre,Udaisagar Road, Udaipur, Rajasthan
- Two new test facilities were re-certified. These include:

a) Orchid Research Laboratories Limited, Chennai

b) Advinus Therapeutics Private Limited, Bangalore

- Annual Surveillance inspection of following test facilities was done and their GLP-compliance status was continued for a period of another one year :

  a) IIBAT, Padappai

  b) Jai Resarch Foundation, Vapi

  c) Dr. Reddy's Laboratories Limited, Hyderabad

  d) Gharda Chemicals Limited, Dombivili

  e) Zydus Research Centre, Ahmedabad

  f) NIPER, Mohali

  g) Intox Pvt. Ltd., Pune

  h) Indian Institute of Toxicology, Pune

  i) Himalaya Drug Company, Bangalore

  j) Syngene International Limited, Bangalore

  k) Ranbaxy Research Laboratories, Gurgaon

- The following training courses/workshops/symposiums were organized:

  a) Two Day Intensive Training Capsule for GLP Inspectors on "Toxicology and Quality Assurance" at Advinus Therapeutics Private Limited, Bangalore on February 24-25, 2011

  b) One Day Interactive Meeting on "India becoming fully adherent to OECD and obligations thereof" at India Habitat Centre, New Delhi.

  c) Two Day Sensitization Workshop on GLP at India Habitat Centre, New Delhi on December 19-20, 2011.

  d) Two GLP inspectors of National GLP Compliance Monitoring Authority attended the 10th OECD GLP Training Course at Jerusalem, Israel.

  e) The website of National GLP Programme **"www.indiaglp.gov.in"** has been re-designed and is continuously being updated.

CHAPTER 7

MISSION PROGRAMMES

Out of a total eight National missions on climate change which form a part of the National action plan on climate, two important missions are being speadhesd by the Department of Science and Technology under the climate change programme. These include the National Mission for Sustaining Himalayan Ecosystem (NMSHE) and National Mission on Strategic Knowledge for Climate Change (NMSKCC). These missions envisage building upon and creating synergy amongst existing initiatives of various Ministries and Departments of the Government of India which provide support for research and development in climate change through intra- and extra-mural systems. The missions propose to create linkages with state governments and their establishments/ institutions on climate change related aspects.

The Department of Science and Technology formulated a coordinated research program on **Himalayan Glaciology** during 1986. Since then several researchers, from academia and service organizations, have undertaken observational investigations of glaciological phenomena at few glaciers in the Indian Himalaya.

The **National Mission on Bamboo Applications** structured as a Technology Mission is one of the key initiatives of the Department of Science & Technology, aimed at creating the basis for enlarging the bamboo sector, and with supporting the efforts of the Government of India towards augmenting economic opportunity, income and employment. NMBA's track record in emergency relief shelters with low response and erection time has been widely acclaimed. NMBA has been participating in exhibitions and fairs to make the presence of bamboo felt in various aspects of life and livelihood.

The Mission on **Nano Science and Technology (Nano Mission)** - an umbrella programme - was launched in the year 2007 to promote R&D in this emerging and highly competitive area of research in a comprehensive fashion. During the year 2011-12, Nano Mission continued to record expansion in its activities and also continued to break new grounds in promotion of R&D and human resource development in the field of nanotechnology. A scheme for technology development through Joint Industry-Institution Projects was formulated and launched during the year. India emerged as sixth major player in scientific publications in nano science and technology field during the year 2011-12. Some technology leads from nano mission have been commercialized such as silver coating of textile anti microbial property and ceramics filter for water purification, and thin film coating for solar energy harvesting etc.

The Mission Mode project was initiated in 2007 as 'Reinvigorating Indian Agriculture through S&T'. Over a period of three years the scope of the project widened to Flood modeling, building 3-D terrain model and development of communication equipments. Keeping in view the expansion the project was renamed as '**Mission for Geospatial Applications**'.

CLIMATE CHANGE PROGRAMME

The Climate Change Programme (CCP) is a new initiative of the Department of Science & Technology, Ministry of Science & Technology which is spearheading two out of a total of eight national missions on climate change as part of the National Action Plan on Climate Change (NAPCC). These are: (a) National Mission for Sustaining Himalayan Ecosystem (NMSHE) and (b) National Mission on Strategic Knowledge for Climate Change (NMSKCC).

The board objectives of NMSHE include - understanding of complex processes affecting the Himalayan Eco system and evolving suitable management and policy measures for sustaining and safeguarding the Himalayan eco-system,creating and building capacities in different domains, networking of knowledge institutions engaged in research and development of a coherent data base on Himalayan ecosystem, detecting and decoupling natural and anthropogenic induced signals of global environmental changes in mountain ecosystems, studying traditional knowledge systems for community participation in adaptation, mitigation and coping mechanisms inclusive of farming and traditional health care systems and developing regional cooperation with neighboring countries, to generate a strong data base through monitoring and analysis, to eventually create a knowledge base for policy interventions.

The NMSKCC has been launched with the broad objectives of mapping of the knowledge and data resources relevant to climate change and positioning of a data sharing policy framework for building strategic knowledge among the various arms of the Government, Identification of knowledge gaps, and Formation of global technology watch groups to help accomplish the task of technology selection and prioritization, Networking of knowledge institutions after investing critical mass of physical, intellectual and policy infrastructure resources, creation of new dedicated centres within the existing institutional framework, building international cooperation on S&T for climate change agenda through strategic alliances and assistance to the formulation of policies for a sustained developmental agenda.

The two missions envisage building upon and creating synergy amongst existing initiatives of various Ministries and Departments of the Government of India which provide support for research and development in climate change through intra- and extra-mural systems. The missions propose to create linkages with state governments and their establishments/ institutions on climate change related aspects.

Some of the major initiatives taken up and progress made by CCP in respect of the two missions during 2011-12 are as under-

(a) NMSHE

- Follow up action for obtaining administrative and financial approval of the Mission document: A draft EFC circulated in October, 2010; appraisal process may be complete by March, 2012.
- Begin enrollment of partnering institutions for the mission, mapping of all R&D institutions in the Himalayan region completed
- Initiation of State level consultation on NMSHE with all 12 Himalayan states

- Establishment of bi-lateral mechanism for addressing capacity building in Glaciology- setting up of an Indo-Swiss Joint Working Group

- Initiation of actions relating to establishment of a National Centre for Himalayan Glaciology – Draft EFC circulated, appraisal process may complete by March, 2012.

(b) NMSKCC

- Approval and launch of 11 major R&D projects including two Centres of Excellence in climate Change

- Initiation of action relating to establishment of Knowledge Networks in Climate Change

- Initiation of programmes under Public-Private-Partnerships in key socio-economic sectors relating to climate change.

- Initiation of programme on establishment of Technology Watch Groups in some key areas

- Initiation of action for launch of a programme to set up Professor chairships in climate change

HIMALAYAN GLACIOLOGY PROGRAMME

Glaciology is the study of Snow and Ice in all forms. The Indian Himalaya is one of the largest resources of snow, ice and glaciers which form a source of fresh water for the perennial rivers such as the Indus, the Ganga, and the Brahmaputra. Research in Himalayan Glaciology draws the knowledge of several scientific disciplines associated with Glaciers and the snow cover. Thus, the Himalayan Glaciology program deals with the structure and properties of glacier ice, its formation and distribution, the dynamics of ice flow, and the interactions of ice accumulations with prevailing local weather conditions and regional climate forcings. Glaciological research is conducted in a variety of ways, including in-situ monitoring the length (snout position) changes, ground penetrating radar sounding, ice cores, lateral tunnels, and remote sensing with satellite-borne infrared and multispectral scanners. Thus research and developmental activities in glaciology are recognized as multi-disciplinary and expertise in several subjects.

Recognizing the importance of understanding the behavior of these natural resources, the Department of Science and Technology formulated a coordinated research program on Himalayan Glaciology during 1986. Since then several researchers, from academia and service organizations, have undertaken observational investigations of glaciological phenomena at few glaciers in the Indian Himalaya. The limited available database indicates that while recession of some glaciers has occurred in some parts in recent years, the trend is not consistent across the climatic settings in high altitude mountain ranges. Inadequacy of scientific data is a severe constraint in quantifying the relationship between glaciological processes, climate change and global warming. Thus, in recent years, there is a renewed interest among the multi-disciplinary scientists associated with the Himalayan snow and glaciers.

In order to strengthen the research, development and training activities, the Department has initiated a Centre for Glaciology at Wadia Institute of Himalayan Geology, Dehradun. A detailed project report to establish a 'National Centre for Himalayan Glaciers' in the Central Himalaya with field centres in the western and eastern Himalaya was prepared. Ten (10) glaciers were identified for long-term monitoring the glacier behavior under different climatic settings and also formulated an action plan for human resource development. The Department has organized two training programs to young scientists on filed measurements in the glacier and utilizing the remote sensing technologies with emphasis on Glaciology. During the period 2007-12, about 30 research projects, covering 18 glaciers, have been evolved and supported to investigate the snow cover fluctuations, geomorphological features, paleiogeographic reconstruction, glacier dynamics, snow pack characterization, snow melt runoff, mass and energy balance at the glaciers using in-situ measurements, laboratory analysis and remote sensing techniques. The Glaciers studied, randomly, during the past five years are Dunagiri, Bagni bamak, East Rathong, Gangotri, Chhota Shigri, Naradu, Satopanth/ Bhagirath Kharak, patio, Penslunga, nehnar, Phuche, Changme Khampu, Sonapani, Gaglee, Dokriani, Chorabari and Hamta Glaciers covering from northwest to northeastern parts of Indian Himalaya.

Efforts were made to collate the available scientific publications, reports and multi-disciplinary data bases on select glaciers like Gangotri and Chhota Shigri glaciers in the Himalaya have been undertaken. The technical reports on the Chhota Shigri and Gangotri glaciers present synthesis of various study results and identified the thrust areas for further investigation. Accordingly, initiated planning process to take up integrated, multi-disciplinary, long-term program on Gangotri Glacier towards providing scientific explanation to the issues related to the impact of global environmental change. Also, published the 'Dynamics of the Glaciers in the Indian Himalaya- Status Report and Science Plan'. The document presents the scientific and technical issues towards understanding the processes prevailing at the glacier environment and its influence on the water resources and climate of India. A nationally coordinated implementation plan of the 'Indian Glacier Research Program' is under preparation. The national action plan on Climate Change provide further stimulation towards strengthening research in the inaccessible hostile environmental conditions of the Indian Himalaya with emphasis on exponential growth in understanding the Indian Glaciers, managing their impact on the population during the 12th Plan period.

NATIONAL MISSION ON BAMBOO APPLICATIONS (NMBA)

The National Mission on Bamboo Applications structured as a Technology Mission is one of the key initiatives of the Department of Science & Technology for the Tenth Plan, aimed at creating the basis for enlarging the bamboo sector, and with supporting the efforts of the Government of India towards augmenting economic opportunity, income and employment. NMBA's track record in emergency relief shelters with low response and erection time has been widely acclaimed.NMBA has been participating in exhibitions and fairs to make the presence of bamboo felt in various aspects of life and livelihood. Highlights during the period are;

NMBA has been actively participating in almost all the reconstruction programmes following natural disasters, the latest being construction of 10 community shelters of size 32ft X 20ft with verandah in the Mangan district of Sikkim, as a part of the 'Sikkim Disaster Relief' project. The shelters were erected in a

very short span of time since the earth quake had damaged most of the houses and winters were ahead.

Pre-relief

Post Quake

NMBA also pursued a few other construction projects employing bamboo including fabrication of cold storages at Leh, Barracks in Srinagar, 'Quick Erect shelters for the purposes of army and bamboo derived products such as 'Samboo Vinegar Oil'

Quick Erect Shelters

MISSION ON NANO SCIENCE AND TECHNOLOGY

The Mission on Nano Science and Technology (Nano Mission) - an umbrella programme - was launched in the year 2007 to promote R&D in this emerging and highly competitive area of research in a comprehensive fashion. The main objectives of the Nano Mission are - basic research promotion, infrastructure development for carrying out front-ranking research, development of nano technologies and their applications, human resource development and international collaborations. During the year 2011-12, Nano Mission continued to record expansion in its activities and also continued to break new grounds in promotion of R&D and human resource development in the field of nanotechnology. A scheme for technology development through Joint Industry-Institution Projects was formulated and launched during the year.

BASIC RESEARCH PROMOTION

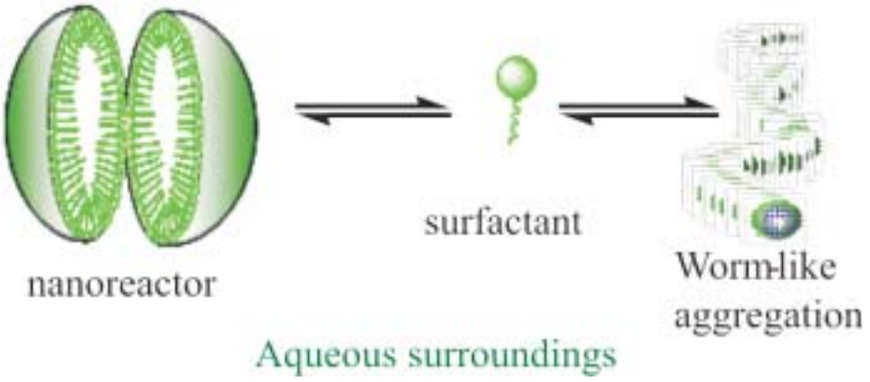
35 new individual scientist-centric R&D projects were funded this year which focused on fundamental scientific studies on nano-scale systems. Some of these projects were on - development of multifunctional biodegradable nanoparticles/nanocrystals for cancer diagnosis and treatment; development of ormosil nanoparticle based gene transfer system for breast cancer gene therapy; studies of structural, electronics and optical properties of composite and core-shell semiconductor nanostructures; fabrication of Mdm2 peptide conjugated gold nanoparticles for targeted therapy of Retinoblastoma; enhancement of luminescent quantum efficiency and magnetic properties of functional nanomaterials and related computational studies; fabrication of nano-agricultural inputs for promoting groundnut productivity and environmental safety; development of suitable nano-ocular formulations for superficial and vitreal fungal infection; nanoscale heterostructures for catalysis and photovoltaic applications; nanoparticles in traditional medicine; development of nano mullite and nano mullite based biocers and their applications; engineering of dual porous polymer nanocomposite scaffolds for tissue engineering; targeted intracellular delivery of metal based anti-cancer drugs using functionalized monolayer protected gold nanoparticles; study of magnetic anisotropy in magnetic nanoparticles, thin films and heterostructures; development of electrochemical immunosensor using functionalized magnetic nanoparticles for detection of tumor markers; nanomechanics of advanced materials; fabrication of magnetic nanostructures employing oblique angle vapour deposition and investigations on their structural and magnetic properties; visco-elastic properties of nanoparticle dispersed liquid crystals; novel solar light driven bismuth sulphide quantum dot-glass nanocomposite photocatalyst for hydrogen generation; nanostructured TiO2 as active support material for the electrocatalysts of the direct methanol fuel cells.

The ongoing R&D projects continued to receive support. Some important achievements reported from the ongoing projects were:

Silver nanoparticle embedded poly vinyl alcohol films were fabricated through a simple in situ process. These nanocomposite films are a few hundred nanometre thick with silver concentrations <10% and the nanoparticles 5 –10 nm in diameter.

Supramolecular assemblies of organic and organic-inorganic hybrids were created to evaluate the nanochannels, to be utilized to create well ordered nanopatterns of different types of nanoparticles and nanomaterials. In cancer theragnostics, three different nanotheragnostic agents based on highly biocompatible materials such as hydroxyapatite, calcium phosphate, iron oxide and titanium dioxide were developed using novel wet-chemical methods under optimized conditions. In Regenerative Medicine, towards hepatic tissue engineering, a 3D scaffold with uniaxial macroporous distribution based on agarose and natural proteins was successfully developed. A facile method to electrospin natural protein, viz., fibrin, without using toxic solvents such as HFIP was also developed and demonstrated for its utility for tissue engineering applications. For cartilage regeneration, a bioactive fibrin-alginate composite nanogel was fabricated, resulting in biocompatible gels with superior control over mechanical properties. Fabrication of self-catalytic GaN nanowires by chemical vapor deposition was done and investigations on interplay of VLS and VS growth mechanism under the influences of reactor pressure were carried out. Paclitaxel delivery to the cancer cells was accomplished by formulating stable and effective drug delivery of paclitaxel using PLGA as a biodegradable polymer for long term treatment of breast cancer. Doxorubicin loaded albumin nanoparticles were prepared uniquely by desolvation technique (pH gradient method) using sodium tripolyphosphate as a cross linking agent. Vertically aligned ZnO nanorods on various substrates such as glass, quartz, silicon

and plastic were grown by a low temperature hydrothermal method. Zinc oxide nanorods on indium tin oxide coated plastic substrates were prepared using electro deposition technique. Zinc peroxide nanoparticles were synthesized at low temperature by hydrothermal method. Titanium dioxide nanotube arrays were synthesized on titanium metal foil by two terminal anodization process. Fluorine doped tin oxide thin films were grown on glass substrates by rf magnetron sputtering which can be used as an electrode in sensor application of metal oxides. Patterned gold film was prepared by simply annealing gold thin film which could be used as a template for aligned growth of nanorods. Surfactant assembled nanoreactors were fabricated in water, ethanol and ethylene glycol and they were characterized by DLS study. Chemo-, regio- and stereoselective vicinal difunctionalization reactions were developed to achieve a number of difficultly accessible halogenated synthons. Novel and new property of hypervalent iodine toward activation of ?-bonds under metal-free reaction conditions and simultaneous difunctionalization of triple and double bonds were reported. Halides were directly transferred to the ?-bonds involving cationic surfactant with absolute regio- and stereoselectivities.



Formation of nanoreactor by self-assembled aggregation

Fingerprint dusting compositions based on nano-sized calcium carbonate or copper particles were formulated and these particles were coated with two types of materials (fluorescent dye or natural hydrophobic substances). With fluorescent dye, weak fingerprints, which are often found at crime scenes, may be enhanced under a light source. With natural hydrophobic substances, fingerprints can be detected on moist and sticky surfaces. This will help in detecting weak and moist fingerprints more effectively.

DEVELOPMENT OF R&D INFRASTRUCTURE

Eight new Thematic Units of Excellence on focused themes namely - Tissue Engineering and Medical Bio-Nanotechnology; Nanomaterial-based Technologies for Automotive Applications; Physics and Technology of Nano Assemblies; Soft Nanofabrication with Applications in Energy, Environment and Bioplatforms; Nanochemistry; Nano Device Technology; Water Purification using Nanotechnology; and Computational Materials Science were established during the year across the country.

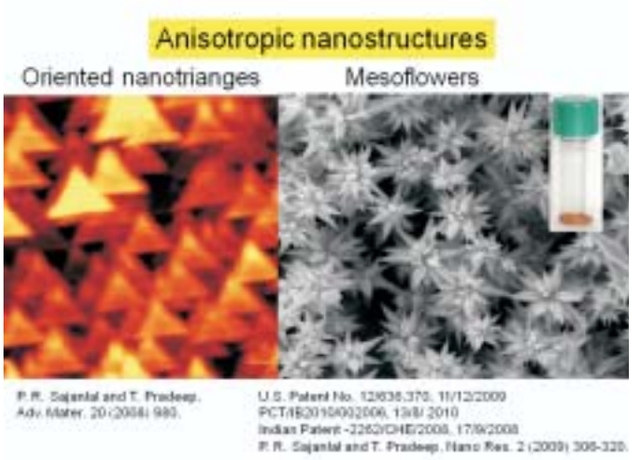
Support to the existing Units/Centres continued. Interesting results were reported from these Units & Centres, some of which are summarized below -

For Conducting Polymer Nano-scaffolds for Sensing of Biomolecules, biologically important analytes like cysteine and vitamin-C were detected by electron transfer via naked eye colorimetric sensing using tailor made water soluble self-doped polyaniline as a substrate. Monomer (N-3-sulfopropylaniline) was

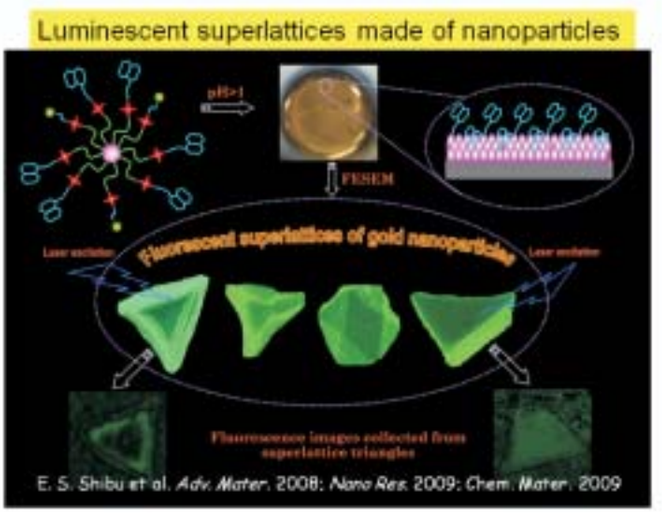
synthesized via ring opening of propane sultone with excess aniline and polymerized in water using ammonium persulfate to obtain green water soluble polymer. For supramolecular LC Materials, the effect of aromatic ð-stacking and van der Waals interactions on the molecular self-assembly of ð-conjugated building blocks was investigated in tailor-made bulky oligophenylenevinylenes. For development of CdTe nanoparticles for hybrid organic photovoltaic devices, highly fluorescent and size controlled CdTe/CdS coreshell nanoparticles were synthesized. Charge transfer in such core shell nanoparticles were studied with fluorescence correlation spectroscopy and time resolved fluorescence spectroscopy. Size dependence of fluorescence blinking process was under investigation. For monodispersed CoFe2O4 and Fe3O4 nanocrystals, a simple strategy to achieve highly monodispersed CoFe2O4 and Fe3O4 nanocrystals was demonstrated by using a strong polar organic solvent for the first time. Simulations of polymer nano-aggregates in fuel cells were performed on triflic acid at different temperatures.

Discovery of halocarbon decomposition by noble metal nanoparticles and the use of this technology for pesticide removal from water was made with introduction of the world's first nanotechnology based water filter.

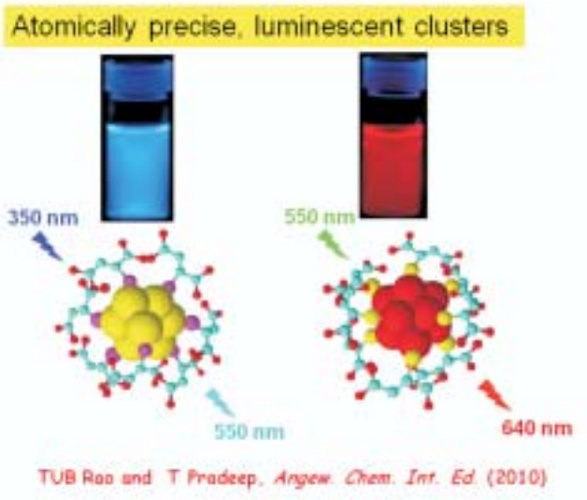
Metal to semiconductor transition in carbon nanotubes by the binding of noble metal nanoparticles was also investigated. Novel anisotropic structures such as nanotriangles and mesoflowers were created with applications in ultralow sensing.



Luminescent, sensing nanoparticle superlattices based on gold nanoparticles.



Synthesis of luminescent, atomically precise noble metal quantum clusters.



HUMAN RESOURCE DEVELOPMENT

Support to ongoing Post Graduate programmes [M.Sc./M.Tech in Nano Science & Technology] continued during the year. The progress of these programmes was reviewed during a Review Meeting.

Post-doctoral Fellowships to attract talented young researchers towards advanced research in Nano Science & Technology continued to be offered through JNCASR-Bangalore. So far, 9 Post Doctoral Fellows have completed their research while 5 are continuing at present.

Support to one Ramanna Fellowship also continued.

One International Conference on Nano Science & Technology (ICONSAT-2012) was organized and support to some other International /National Conferences, Seminars, Workshops etc. was also provided.

INTERNATIONAL COLLABORATIONS

The India-Japan Beamline established at the Photon Factory, KEK, Tsukuba, Japan became a useful and sought-after facility. Scientists and researchers started carrying out experiments using this facility.

The project for gaining assured access to all the beamlines of the PETRA III synchrotron radiation facility and the FLASH facility at DESY, Hamburg, Germany started during the year. PETRA III, being a high energy and nano-size radiation source, is of special significance for Nano Science research and would open up newer areas of research for the Indian scientific community. A MoU with DESY was signed in May 2011 during the visit of the German Chancellor to Delhi. Selection of the first batch of experiments to be performed at PETRA III was also completed.

The Indo-Canada Collaborative Programme started during the year.

DEVELOPMENT OF NANO TECHNOLOGIES AND THEIR APPLICATIONS

Support to ongoing projects in this category continued. Significant progress has been made in these projects. Some important achievements are summarized below:

New developments on Smart and Innovative Textiles at IIT Delhi.

Research on silver nanoparticle based anti-microbial finish and water based self-cleaning nanofinish based on titania nanosol developed earlier continued during the year and the technologies were transferred to Industry. Research on prototype automotive oil filter developed earlier continued during the year. Efforts were made to upscale the technology developed earlier to stablilize Phase Change Material (PCM) formulations.

Various nanofinishes developed for various applications.

New developments at the Nano Functional Materials Technology Centre, IIT-Madras

A cost effective method for production, consolidation and sintering of nanocrystalline oxide powders and production of bulk ceramics was developed. Nanocrystalline diamond (NCD) films/coatings on die-inserts and plugs were performed to increase wear-resistance and durability. A cost-effective method for

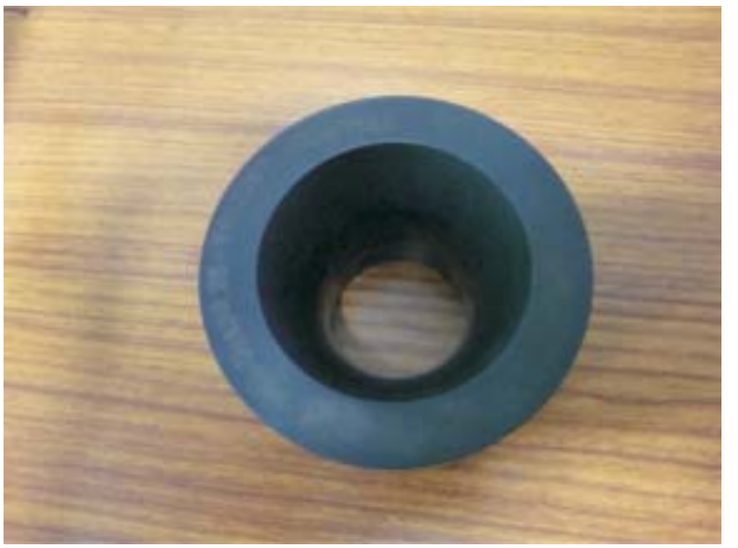
production of large scale and highly pure random and aligned Carbon Nanotubes (CNT) has been demonstrated using CVD technique. Nanostructured multi-drug-delivery system has been demonstrated using carbon nanotubes.

Processing of alloy hydride catalysts by hydrogen decrepitation technique has been performed and design, development and fabrication of a CCVD set-up has been done. Using the set-up, processing of MWNT & SWNT with the same catalysts has been successfully performed.

Nanocrystalline titania has been synthesized using Titanium Tetra Iso Propoxide (TTIP) as the precursor. The process conditions were optimized by changing the flow rates of precursor carrier (Helium), fuel (Methane) and oxidizer (Oxygen). Using the flame reactor, nanocrystalline titania (anatase) has been synthesized using CVS process.

In addition, nanocrystalline alumina (d-phase only), nanocrystalline zirconia (pure as well as yttria stabilized) have also been successfully synthesized. Chemical vapor synthesis has been used to synthesize pure nanocrystalline titania and boron doped, nitrogen modified nanocrystalline titania.

Using HFCVD, WC-Co dies have been successfully coated with nanocrystalline diamond (NCD). The deposited films were characterized using Raman spectroscopy and SEM. NCD coatings showed good uniformity and adhesion to the substrate (preliminary tests done at industry).



Nano Crystalline Diamond (NCD) coated die

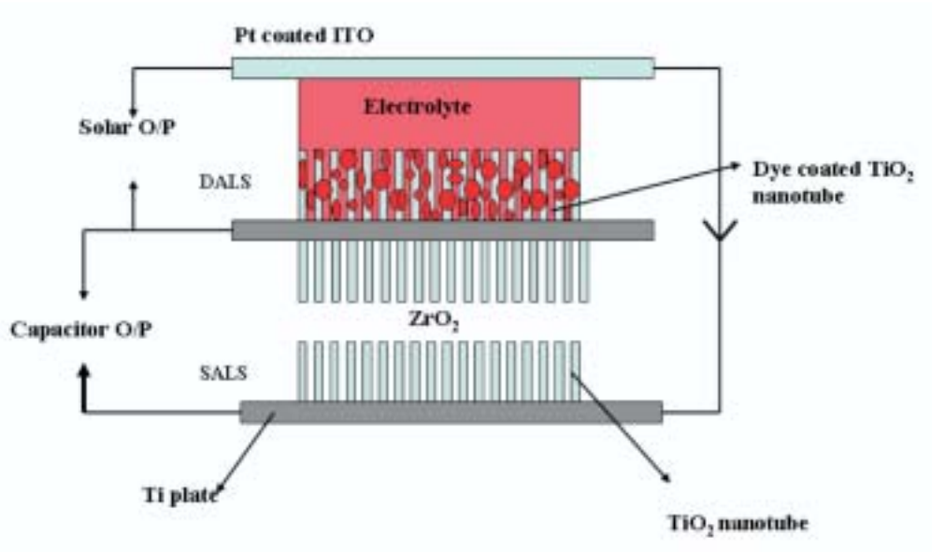
New developments at Amrita Centre for Nanosciences and Molecular Medicine, Kochi

Well-aligned TiO2 nanotube arrays were prepared with good control on the aspect ratio. 1D nanorods of ZnO on TCO substrate was prepared by a simple low temperature electrochemical approach. Metal nanoparticles of different sizes were prepared and were tested for plasmonic resonance assisted efficiency enhancement in DSSC.

Solar cells were fabricated with photo-electrodes made of mesoporous TiO2, TiO2 nanotubes and ZnO nanorods sensitized with ruthenium based dye, quantum dots and a combination of both. For

development of scaffold polymer based electrodes for the DSSC component of the integrated structure, studies were made to develop polyaniline-carbon black composite conductive fiber mats via electrospinning.

Studies were also made for integrating solar cell with super capacitor and research was carried out on high capacitive electrodes. A thin-film integrated device was constructed consisting of photovoltaic layers combined with additional layers to store charge in real-time within the same device. In this design, a dye-sensitised solar cell (DSSC) and capacitor layers were integrated by a double-anodized titanium plate, which consists of TiO2 nanotubes grown on either side by electrochemical anodization. In the absence of light, the cell acts only as a capacitor power source, whereas in the presence of light the device acts as an independent photovoltaic cell cum storage device. The results gave a capacitance of 140 µF cm-2.



Integrated solar cell with capacitor

Studies were made to develop polyaniline-carbon black composite conductive fiber mats via electrospinning.

New developments in the area of Nanotechnology for Biomedical Applications at CCMB, Hyderabad.

Nanoparticle for drug delivery:

The nanoparticle synthesis was done by controlled precipitation of the polymer followed by covalent cross-linking. Antibiotic was loaded in the nanoparticle by adding it in the reaction mix during particle synthesis prior to the covalent cross-linking. The drug release profiling was done over a period of 48 hours by monitoring the absorbance of the released drug. The drug-loaded nanoparticles showed a sustained release profile over the given time period of study.

Lipid formulations for siRNA delivery

Several ternary complexes of lipids/peptides/siRNA have been developed with a view to prepare small particles with cell penetrating property. These formulations were tested for their DNA and siRNA binding ability and nucleic acid protection properties.

Tissue engineering

Growth and differentiation of Human Embryonic Stem cells (hESCs) on metal substrates: Karyotyping was carried out to confirm that no chromosomal abnormalities occurred during culturing. Immunostaining and RT PCR analysis were carried out for the pluripotent markers such as Oct 4, Nanog, Tra1-60, Tra 1-81, SSEA4 etc. In addition to maintaining and differentiating hESCs, several types of metal based substrates have been made for the growth and differentiation of bone and cartilage cells. Chitosan nanoparticles are widely accepted for ophthalmic drug delivery because of their mucoadhesive properties and their biocompatible nature Chitosan nanoparticles were synthesized by using Electrospinning Unit.

New developments at Punjabi University, Patiala.

A totally indigenous system has been designed, fabricated, assembled and operated and found suitable for the growth of Silicon crystals and sheets.

Vacuum Furnace designed and setup.

A linear motion system capable of pulling crystal/sheet at speeds of 0.5-5 cm/min. and up to 1 metre long has been successfully developed with locally available materials. Mechanical slide measuring 2 metre long and a stepper motor with electronic control system have been made locally.

OUTPUT INDICATORS

The cumulative output from various projects/programmes supported under the earlier Nano Science & Technology Initiative (NSTI) and the Nano Mission are summarized below:

Research papers in cited Journals	3935
Research papers in Conferences	1249
Indian Patents filed/obtained	120/24
Foreign Patents filed/obtained	38/11
Ph.Ds produced	670

MISSION FOR GEOSPATIAL APPLICATIONS

The Mission Mode project was initiated in 2007 as 'Reinvigorating Indian Agriculture through S&T'. Over a period of three years the scope of the project widened to Flood modeling, building 3-D terrain model and development of communication equipments. Keeping in view the expansion the project was renamed as 'Mission for Geospatial Applications'.

Under the project entitled 'Development of three dimensional terrain models- Uses for Infrastructure Planning & Development and operational planning of security agencies' the Mission achieved developing 3-D models of the states of Jharkhand, Jammu & Kashmir, Chhattisgarh, Orissa, Bihar, Tripura, Manipur, Nagaland, Meghalaya and Madhya Pradesh. The data developed have been shared with paramilitary forces police like CRPF, BSF, CISF, ITBP, and state Government of Jharkhand, J&K, Meghalaya, Kolkata Police, Tripura Police. Recently the Mission is associated with Government of Nagaland for planning and monitoring of developmental programmes, Government of Manipur and Assam for planning & monitoring of School construction. The Mission is also involved in planning and monitoring of roads under PMGSY for Ministry of Rural Development. During this period this Mission has equipped about 136 units of paramilitary forces with terrain models with operation software.

Under the 'Flood Modeling and Forecast' project, the the Mission is currently involved in flood modeling of Mahanadi and Krishna basins. This will enable warning and forecasting of flood event with possible damage three days in advance of actual event. Besides forecasting damage assessment as well as investing in flood protection works can be done very accurately. Recognizing Mission's capabilities in flood modeling it has been made a member in the Working Group for Flood Management in the Planning Commission for the 12th Plan. Recently the Mission is associate with the State Government of Kerala for modeling and forecast of Meenachil and Manimala rivers. The mission is currently building capacity for flash flood monitoring in Kerala as well as develop an early warning system for Mullaperiyar dam.

Other projects include 'Development of ultrasonic water sensors' with high accuracy, 'Cadastral mapping', 'Tactical Communication Systems' and Software Defined Radios (SDRs)'

CHAPTER 8

S & T PARTNERSHIP BUILDING AND INTERAGENCY PLATFORMS FOR S & T OUT-REACH

The International Division of DST has the mandated responsibility of (i) negotiating, concluding and implementing S&T Agreements between India and other countries; (ii) providing interventions on S&T aspects in international forums. This responsibility is carried out by the Division in close consultation on the Indian side with the Ministry of External Affairs, Indian Missions Abroad, stakeholders in scientific, technological & academic institutions, concerned governmental agencies and with various industry associations in India. DST has been able to strategically leverage 'international collaborative advantage' by building chosen international alliances and partnerships with selected countries that have perceptible outcome these include enhanced R&D outputs, accelerating institutional and human capacity building through international exposure and linkages, enabling new paradigms being practiced by other emerging economies for sustainable adoption by Indian R&D and innovation systems, evolving modalities and mechanisms for seamlessly connecting Indian research with global efforts, absorbing experience of existing global research facilities in fine-tuning existing Indian research facilities, enhancing India's contribution in international mega-science projects.

INTERNATIONAL S&T COOPERATION

Indicative trends in fostering international bilateral cooperation and partnerships during 2011-12 have been as follows:

- Joint research project based networking of researchers under active bilateral S&T programs of cooperation with more than 25 countries including substantive programs with 9 countries;
- Establishment of virtual networked bilateral R&D Centres;
- Dissemination of information and networking through bilateral workshops; symposiums and exhibitions;
- Facilitation of bilateral advanced schools & training programs;
- Bilateral R&D projects involving industrial partners with Canada, France, Germany, Israel, Switzerland and United States;
- Co-investment of resources including funds for symmetric joint research projects and strategic joint initiatives with Australia, Hungary, South Korea, Norway, Switzerland, UK, and USA;
- Execution of New Africa S&T Initiative Program including fellowships, trainings and strengthening of R&D institutions through twinning;
- Support to bi-national S&T Centres under institutional framework: (Indo-French Centre for Promotion of Advanced Research, Indo-German S&T Centre, Indo-Russian S&T Centre and Indo-US S&T Forum);
- Mobility through research fellowships and visitation programs for Indian and foreign young scientists and researchers (HOPE and Lindau Nobel Laureates meetings, DST-ICTP Fellowships for Indian researchers; and Research Training Fellowships for Developing countries: ILTP Fellowship for Russians, Asian Science Camp; CV Raman Fellowships for African Researchers);
- Proactive engagement and participation in international advanced research facilities like FAIR in Germany, Indian beam-line facility at KEK Japan, CERN in Geneva, Elettra in Italy;
- Bilateral programs on Innovation and Entrepreneurship using PPP model with Finland, France, South Korea and USA; and
- International partnerships for joint research and technology development in domains of national priority through engagement with Industry & Engineering Associations (like Technology Summit with Spain as a partner country).

Fig. 8.1: Shri Vilasrao Deshmukh, Hon'ble Minister for Science & Technology and Earth Sciences addressing the participants of Technology Summit & Technology Platform with Spain as Partner country

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Guiding Principles for International S&T Cooperation

DST is able to strategically leverage 'international collaborative advantage' by building chosen international alliances and partnerships with selected countries that can have perceptible yields, such as:

(i) R&D outputs through international alliances which can contribute directly to national R&D priorities and outcomes;

(ii) Accelerating institutional and human capacity building through international exposure and linkages;

(iii) Enable new paradigms being practiced by other emerging economies for sustainable adoption by Indian R&D and innovation systems;

(iv) Evolve modalities and mechanisms for seamlessly connecting Indian research with global efforts particularly in the frontier areas of S&T and in areas addressing global challenges;

(v) Absorbing experience of existing global research facilities in fine-tuning and/or coupling with upcoming or existing Indian research facilities;

(vi) India's contribution in international mega-science projects;

(vii) Empowering developing countries in S&T; and

(viii) Help India to use the soft prowess of S&T as a tool for international diplomacy.

Spectrum of Cooperative Activities undertaken

During the year, DST undertook a spectrum of bilateral cooperative activities such as: (i) Scientific and ministerial missions; (ii) Joint workshops; (iii) Joint research projects; (iv) Support to and creation of Bi-national S&T bodies, (v) Joint R&D centers, (vi) Virtual Networked centers; (vii) Utilization of large scale research facilities abroad; (viii) Advanced training programs; (ix) Participation in international mega-science projects; (x) Contributions to international non-governmental scientific bodies; (xi) Technology summit, industrial fairs, S&T exhibitions; (xii) Fellowships and Visitation programs for both Indian and foreign researchers and (xiii) Promoting institutional partnerships etc.

SALIENT ACTIVITIES CARRIED OUT DURING THE YEAR

New/ Renewal of Inter-Governmental S&T Cooperation Agreements /MoU/ Programs of Cooperation were concluded by India with Armenia, Austria, Australia, Brazil, Bulgaria, France, Germany, Hungary, Italy, Japan, Republic of Korea, Mexico, Myanmar, Russia, South Africa, Sri Lanka; Spain, Switzerland, Thailand, Tunisia, Ukraine and Uzbekistan.

Joint S&T Committee/ Council meetings were held with Australia, Brazil, Bulgaria, Finland, Germany (DST-DFG), Hungary, Japan, Republic of Korea, Mexico, Russia, Sri Lanka, South Africa, Spain, Switzerland, Taiwan, Tunisia and United Kingdom. Governing Body meeting of the Indo- French Centre for Promotion of Advance Research (IFCPAR), Indo-German Science & Technology Centre (IGSTC), Indo-Russian Science & Technology Centre (IRSTC) and Indo-US S&T Forum (IUSSTF) were held during this year.

About 350 Joint R&D projects and over 40 Joint workshops/ seminars were supported. More than 600 exchange visits took place under various bilateral programs for joint research, information exchange and joint use of facilities and seminars/ training schools supported.

New programs of cooperation were initiated with US National Science Foundation (Virtual Centre on Mathematics and Computer Sciences & East Asia-Pacific Internship Program); Indo-US Endowment Fund for Innovation & Entrepreneurship; Indo-US Joint Clean Energy R&D Centre; Finnish Innovation Council; UKERI of UK; Indo-UK Science Networking Program; Leibniz Foundation of Germany; Indo-Hungarian S&T Fund; India-South Korea Joint R&D Fund, ILTP- Phase II with Russia; Fellowship programs with Australia and Korea; Grand Challenges Awards with Australia; Mathematics Institute with CNRS France; Glaciology and Energy Technology programs with Switzerland; Glaciology Program with Norway; Joint Research Projects with Austrian Science Fund; and Joint R&D Projects with Sri Lanka.

New Africa S&T Initiative: Department in partnership with MEA announced the CV Raman Fellowship for African Researchers to work in Indian laboratories under the New Africa S&T Initiative. This initiative is aimed towards capacity building and developing research linkages with African countries through fellowships, training and twinning with African R&D institutions.

Bilateral Research Projects

International interactions through joint collaborative projects with countries mentioned below have been instrumental in accelerating outcome and adding value to national science, technology and innovation

enterprises at large. Spectrum of impact can be gauged from illustrations such as (i) creation of new knowledge and research tools captured in co-authored papers with foreign scientists published in world class scientific journals; (ii) joint patents have been filed with foreign scientists; (iii) project based mobility has provided opportunities to Indian scientists for joining international R&D projects; (iv) absorbing experience of existing global research facilities in fine-tuning and/or coupling with upcoming or existing Indian research facilities; (v) building extended and stable institutional tie-ups with foreign partners to incubate feasibility of and/or scaling up of research, pilot scale production and high tech competence in India; etc.

- **Argentina:** Under the ongoing program of cooperation 10 projects in the areas of structural chemistry, bio-pesticide, health, and food industry were continued to be supported. Exchange visits of nearly 15 scientists from both sides were realized. A new joint call for proposal was announced against which 19 proposals were received. These are under technical evaluation.

- **Armenia:** A new Program of Cooperation in S&T was concluded in October 2011 identifying seismology and astrophysics as priority areas of cooperation.

- **Australia:** Under the ongoing program in 'Competitive Category', 38 Indo-Australian research projects have been supported in the areas of agricultural research, astronomy & astrophysics, microelectronic devices & materials, nanotechnology, renewable energy and marine sciences. 80 exchange visits of scientists took place under these projects. Indo-Australia Joint Symposium on "Nano Materials" was organized in Melbourne. A new call for proposal was announced in the selected areas of astronomy & astrophysics; environment sciences (including climate change research); and nanotechnology. 71 project proposals have been received against the call, which are under technical evaluation.

  Under the Indo-Australia Strategic Grand Challenge Research Fund, 3 Indo-Australian major joint projects in the areas of food sciences and water security were supported. A new reciprocal Fellowship program for young researchers and early career scientists to work in each other's country has been agreed for implementation.

- **Brazil:** The 7th Meeting of the S&T Joint Council was held in August 2011 at Rio-de-Janeiro, Brazil which reviewed the ongoing 19 projects between India and Brazil. This also included the three networked mega projects in the areas of computer sciences & cyber security and health & medical sciences. Mathematics was also added as a new priority area of cooperation. Organization of 7 joint workshops in areas of mutual interest covering marine sciences, mathematics, material sciences, quantum phase transition, complex fluids, bioenergy, neurosciences and stem cell research were approved.

- **Bulgaria:** 11 joint projects in the areas of new materials, water technology, astronomy, microelectronics, health & nutrition continued to receive support from the two sides. Nearly 50 project based exchange visits of scientists from both sides were realized.

- **Finland:** Call for proposal in the area of nano-materials was announced in cooperation with Academy of Finland. Six proposals were selected and supported in addition to ongoing five projects in green chemistry. FinNode-India Centre, a network of Finnish innovation organization was inaugurated at New Delhi in September 2011 through which the new Indo-Finnish program on innovation will be implemented.

- **Germany:** DST-DAAD project based personnel exchange program**:** Support to 20 on-going joint research projects was continued and 10 new projects were approved in the areas of nano-materials, chemical sciences and applied mathematics.

  DST-DFG Program: Support continued for 30 on-going projects and 4 new projects were approved in the thematic area of algorithmic engineering. For the next call the thematic area of applied chemistry has been identified.

  DST-AvH Program: The Indo-German (DST-AvH) Frontiers of Engineering symposium was held in Mumbai in June 2011. This symposium was attended by 35 young engineers from each side to deliberate upon the ongoing cutting edge research across engineering disciplines with the aim to develop new collaborations in promising areas of engineering sciences.

  DST-MPG Partner group program: Seven partner groups were approved in the areas of atmospheric chemistry, plant-insect interaction, tumor specific drug delivery system, cosmology & gravity, mass black holes in gravitational wave window, human genetic diversity, health sciences and evolutionary biology and structure-function relationship in protein machinery.

- **Israel:** Against the new call, 8 projects with application potential were supported in the areas of information technology (imaging sensor and robotics) and solar energy (solar thermal & photovoltaic).

- **Italy:** Call for proposal was made against which 150 proposals were received. 12 joint projects were approved for exchange of researchers and 6 significant projects were approved for support. Under India Trento Program for Advanced Research (ITPAR), 4 new projects were supported in the areas of nano-photonics, computer sciences, material sciences and MEMS. A dual PhD program for students taking part in these projects at the University of Trento and TIFR Mumbai & University of Hyderabad was concluded. In addition, about 40 Indian scientists visited Trieste to perform experiments on Elettra Synchrotron Beam-line.

- **Japan:** Under DST-JST Cooperation, support to 22 ongoing projects in the area of information and communication technology continued. Collaboration with Japan Society for the Promotion of Science (JSPS) was successfully implemented with support of 40 ongoing projects with addition of 22 new projects in the areas of molecular structure, spectroscopy & dynamics; advanced materials including nano-materials; surface and interface sciences including catalysis; modern biology and biotechnology including biomedical sciences; manufacturing; and space science. Nearly 120 exchange visits of scientists were supported. A Mizushima-Raman Lecture was delivered in India by a leading Japanese physicist under this program.

- **Mexico:** 20 ongoing projects in areas of earth and atmospheric sciences, polymer chemistry, astrophysics, new materials, and marine biology continued receiving support. 3 new joint R&D projects in area of computational biology, ICT and polymer chemistry were approved for implementation. These projects have enabled more than 50 exchange visits of scientists from the two sides.

- **Netherlands:** Call for proposal was announced. 5 joint projects in the area of bio-medical devices are being supported. Call for new proposals in thematic areas covering smart grid systems, mathematics, and novel materials have been initiated.

- **Portugal:** 10 new projects in areas such as new materials, smart textiles, microelectronics, mechanical engineering, health and biotechnology were approved for implementation. In addition, 30 on-going projects were continued to be supported.

- **Republic of Korea (South Korea):** Call for proposals were issued in applied areas like transportation engineering, robotics, nutrition & food safety, renewable energy, chemical & biochemical technologies, health & medical sciences, material science & technology, water resources & environment and information technology. 128 proposals were received out of which 15 competitive projects were selected and supported. Additionally, 5 joint ongoing projects were implemented during the year.

- **Russia:** Cooperative activities continued under ILTP Phase I and the DST-RFBR program, under which over 100 joint R&D projects were supported this year in areas covering basic and applied sciences. Fresh call for proposals was made this year and 85 new proposals have been received which are being assessed. New initiative for cooperation was signed to provide technology solutions for fly ash utilization in the Siberian region of Russia.

Fig. 8.2: Secretary DST signing a document to provide Technology solution to Russia for Fly Ash Utilization and Management in the presence of Hon'ble Prime Minister of India and Hon'ble President of Russia

- **Slovenia:** In addition to the 4 ongoing projects that continued to be supported, 9 new joint R&D projects in areas of health & biomedical sciences, metallurgy & new materials, polymer chemistry, mathematics, electronics, and alternate energy sources were approved.

- **South Africa:** A new mega networked project in the area of HIV/AIDS was approved with involvement of multiple institutions on both sides. 15 new proposals and 3 workshops including one on tuberculosis and indigenous knowledge systems were agreed for joint funding. Support to 14 ongoing projects was continued.

- **Spain:** Support to 14 new and 25 ongoing joint research projects in the areas covering renewable energy, information technology (including computer science), health and medical research, life science and biotechnology (including pharmaceuticals), agriculture technology & food processing, nanotechnology continued. Nearly 80 exchange visits of scientists took place under these projects.

- **Sweden:** Continuation of support to 5 ongoing projects in the area of ICT was provided.

- **Switzerland:** Support was extended to the on-going 20 joint research projects and 4 Institutional partnership projects. 11 new projects have been recommended for support in the areas of medical health (including Infectious diseases) and nanotechnology. 6 visits for joint utilization of advanced facilities were also supported.

- **Taiwan:** Support to 31 on-going projects was continued and 10 new projects were approved in the areas of seismology & disaster management, nano-technology, tropical and infectious diseases, natural product chemistry, structural biology; functional genomics & development biology, ICT, renewable energy including storage devices, micro/nano-electronics and embedded systems.

- **Tunisia:** 5 ongoing projects were supported in the areas of medical sciences, materials and biotechnology. Areas for new joint call for proposal have been identified through mutual consultation.

- **UK:** Two new major initiatives were launched between DST-RCUK for supporting joint projects on 'Bridging the rural/urban divide' for providing technological solutions to improve the quality of life of rural inhabitants in both countries; and 'Next generation fuel cell technologies' for application towards renewable and clean energy source.

  The program on India UK Science Networking between DST and Royal Society was renewed under which joint workshops, seminars and meetings would be supported in either country. Under this program, 16 bilateral events have already been supported.

  Under DST-UKIERI program, 25 ongoing projects were continued in the areas of nano-science & technology and advanced materials, biotechnology including stem cell research, telecommunications, climate change and weather forecasting, new energy sources including hydrogen. 70 exchange visits of scientists from both sides have taken place under these projects. DST-UKIERI program was renewed and the new call for proposals has been launched.

- **Ukraine:** 10 new joint R&D projects have been agreed for mutual implementation for the period 2012-14.

- **USA:** Support to 5 ongoing projects continued under the International Materials Network Program of NSF.

  Under the Indo-US S&T Endowment Fund aimed to promote innovation and entrepreneurship the first request for proposals was issued through the Indo-US S&T Forum in two identified areas, namely, 'Healthy Individuals' and 'Empowered Citizens'. 381 Letters of Intent were received from which 32 detailed project proposals were invited. 3 proposals have been approved by the joint Board for the maiden awards under this program.

  The Indo-US Joint Clean Energy R&D Centre was launched in partnership between the Ministry of Science & Technology, Government of India and the US Department of Energy (DOE). This major initiative involves funding of joint projects on a consortia mode involving academia, R&D labs and industry partners from both countries. Under the Partnership to Advance Clean Energy Research (PACE-R) agreed between the two sides, the maiden call for proposals have been announced. A total of 19 projects in the areas of solar energy, second generation biofuels and energy efficient buildings are under consideration.

Fig. 8.3: Hon'ble MOS(S&T and Planning) at the inaugural function of the Indo-US S&T Innovation Summit at New Delhi

- **Vietnam:** Five new joint research projects were approved in the areas of smart antennas for mobile communications and power source converter for AC photovoltaic's etc.

Bilateral Workshops

Nearly 40 joint S&T workshops/ symposia and training programs were supported in India and abroad in partnership with Australia, Brazil, Iceland, Japan, Russia, South Korea, South Africa, Spain, Switzerland, Taiwan, Tunisia and UK. These activities were aimed towards information dissemination, networking and human capacity building and also helped to define the common areas of mutual interest for initiating cooperation with these countries.

Industrial R&D Programs

For ensuring that R&D output is translated beyond the realms of the laboratories and the outcome reaches the market, bilateral initiatives directed towards scaling and commercialization of R&D outputs by providing financial assistance as well as networking with appropriate R&D organizations and industry partners on bilateral level have been initiated with chosen partner countries like Israel, Canada, Germany, Switzerland and United States.

Department had signed an MOU with the Confederation of Indian Industries (CII) for setting up of the Global Innovation and Technological Alliance (GITA) as a non profit society in public-private partnership mode as a vehicle for implementing bilateral Industrial R&D programs with various partner countries. GITA

Joint R&D Centers

Thirteen joint virtual R&D centers with networking between Indian and institutions abroad were continued to be supported. These Centers have been built on complementarity around existing capabilities, strengths and infrastructure towards optimal utilization of resources and also build human capital through seamless networking and mobility. These centers are basically meant for facilitating focused and integrated interaction and collaboration through networking of capabilities and infra-structure between Indian and partner country (Russia, France and Germany) institutions in identified fields of mutual interest so as to leverage each other's strength to address research problems in quick and holistic manner.

Fellowships/Internships

Outgoing Fellowships for Indians:

- 8 students in the area of Chemical Sciences have been deputed to Japan to meet Japanese Nobel Laureates under the HOPE meeting.
- Lindau Nobel Laureates Meeting: 19 students and young researchers in Interdisciplinary areas of Physiology and Medicine were deputed for participation in the Meeting of Nobel Laureates and students at Lindau, Germany during June/July 2011.
- 10 Indian PhD students were awarded fellowships to work in Swiss R&D institutes for up to 12 months duration under Indo-Swiss Research Fellowship program.
- 4 Indian young scientists were supported under DST-MPG Fellowship program to conduct research in Germany.
- 5 young Indian scientists were deputed to participate in 3rd International Youth Forum (INTERRA-2011) at Novosibirsk, Russia in September 2011.
- 28 Indian students participated in 5th Asia Science Camp held at Daegeong, South Korea in September 2011.

Incoming Fellowships for Foreign Scientists to India:

- CV Raman International Fellowship: Second call for CV Raman International fellowship for African researchers was made this year. 122 applications from 18 African nations were received and assessed. 79 candidates were recommended to avail this fellowship in three different categories: Post- Doctoral Fellowship, Visiting Fellowship and Senior Fellowship.

  4 Swiss PhD students were awarded fellowships to work in Indian research.

International Advanced Research Facilities

Facility for Anti Proton Research (FAIR): India continued to be a participating member with share- holding at the Facility for Antiproton and Ion Research (FAIR) at Darmstadt, Germany. Various committees for implementation of the project were constituted with India as a member state. The technical meetings identified those items where India will be contributing in-kind. R&D and prototyping work for some components of FAIR continued during the year.

PETRA III Project at DESY: The project for gaining access to all beam lines of the PETRA III synchrotron radiation facility and the FLASH facility at DESY, Hamburg, Germany started during the year. PETRA III being a high energy and nano-size radiation source is of special significance for nano science research and would open up new areas of research for the Indian scientific community. A MoU with DESY was signed in May 2011 during the visit of the German Chancellor to India. For five years, more than 3500

hours of measuring time at DESY research facilities will be made available to Indian scientists for joint research projects with DESY. Selection of the first batch of experiments to be performed at PETRA III was also completed.

Indian beam-line at KEK Japan: Under the cooperation a dedicated beam line at Photon Factory of KEK, Japan has been built by India with Saha Institute of Nuclear Physics, Kolkata as the coordinating agency. Scientist from SINP-Kolkata, BHU-Varanasi, SNBNCBS-Kolkata, BARC-Mumbai and UGC-DAE- Indore labs has been accessing the synchrotron facility and successfully conducting experiments on the Indian beam-line.

The participation and access to the above facilities was funded under the Nano Mission of the Department.

Bilateral Joint Centres

- **Indo-French Centre for Promotion of Advanced Research:**

  The major focus of the Centre has been the basic research activities. During the period under report, through the competitive funding pattern established by the Centre, 70 research proposals were received, of which 26 have been approved. Core competence development continued in specialized areas through PhD and Postdoctoral students working in IFCPAR projects with Indian and French scientists in the research laboratories of France and India.

  Mobility of students and scientists has been one of the methods adopted for forging and strengthening the collaborative research. During the year, 6 students and 39 scientists have benefitted through the exchange visit programmes of IFCPAR, under various projects.

  The Industrial Research Committee has made special efforts and developed innovative mechanisms to reach out to industry for identification of potential partners who could be linked to research institutions and supported by the Centre for industrial research activities. 3 projects have been initiated and one proposal approved during the year.

  During the year, the Centre has conducted 7 seminars in the areas of Diabetes, IT, Composites, Automotive R&D, Vaccines, Sensors and Nonlinear Optics.

  The Centre will celebrate 25 years of its existence in 2012, a landmark event in the history of the organization. As one of the good models for bilateral cooperation in Science & Technology, between two countries, the Centre has been able to foster, nurture and promote collaborative excellence in Science and Technology.

- **Indo-German S&T Centre:** Indo-German Science and Technology Centre (IGSTC) has been established to support joint industrial projects in PPP mode through networking between research, academia and Industry in the areas of Biotechnology; Energy; Environmental technologies; Health research; and Production Engineering. Four R&D projects with industry participation have been approved. New call for proposal was launched and 35 proposals have been received and are being assessed for award.

- **Indo-Russian S&T Centre:** The Indo-Russian S&T Centre (IRSTC) will pioneer in commercialization of joint research outcomes between the two countries. First meeting of the Joint Committee of the Centre was held at Moscow in December 2011 following which Moscow office of the Centre was inaugurated. India office of the Centre would function in project mode under ARCI, Hyderabad, an autonomous institute of DST.

- **Indo- US S&T Forum:** IUSSTF has a program portfolio for extending support to bilateral symposia & workshops on topical and thematic areas; advanced training schools; public-private networked centers and knowledge R & D networked centers. During FY 2011-12, IUSSTF has supported 30 Indo-US workshops and 4 training programs that had a substantive impact in generating new joint R&D projects in areas of mutual interest across scientific disciplines. To enable Indian and American scientists from academia and laboratories to carry out joint research activities by leveraging already existing infrastructure, 6 new Indo-US Networked Joint Centers (virtual) have been supported, in addition to 12 ongoing joint centers in fields such as biomaterials, healthcare, climate change, nano-materials, machine learning, solar astrophysics, intelligent transportation systems, high-energy physics etc. IUSSTF also implemented several Indo-US fellowship, visitation and internship programs both for Indian and US students and researchers resulting into mobility of more than 90 awardees. The India Innovation Growth Program (IIGP) funded by DST and Lockheed Martin Corporation identified 20 top innovations that have market potential in both the countries. IUSSTF was also entrusted for implementing the Indo-US S&T Endowment Fund for Innovation for which the maiden call was made and three joint projects were approved for award. IUSSTF was also entrusted to serve as the Indian secretariat for the implementation of the Indo-US Joint Clean Energy R&D Centre which will support consortia based projects on a PPP mode in the identified areas of solar energy, second generation biofuels and energy efficient buildings.

INTERNATIONAL MULTILATERAL AND REGIONAL S&T COOPERATION

Indicative trends in fostering India's international multilateral and regional science and technology cooperation and partnerships during 2010-11 have been as follows:

- Multilateral R& D projects involving SMEs/industrial partners (EU);
- Co-investment of resources including funds for symmetric joint research projects and strategic joint initiatives (EU, IBSA);
- Creation / Execution of Institutional Frameworks /Funds with other countries & regional bodies (ASEAN-India Science and Technology Fund);
- Joint research project based two-way mobility of researchers under active multilateral S&T programs of cooperation;
- Getting bright young minds initiated into and to excel in the realm of research through fellowships for Indian and Developing Country scientists (DST-ICTP Fellowships, Research Training Fellowships for Developing Countries Scientists RTF-DCS Program) ;
- Engagement of Industrial & Engineering Associations/Platforms in international partnerships for joint research and technology development in domains of national priority (DST-CII's Global Technology Partnership Forum Meeting, Technology Summit with EBTC as partner);
- National impact through international interactions with minimal investments- International interactions under joint project based visits have been instrumental in accelerating outcomes of national projects. Spectrum of impact can be gauged from illustrations such as:
  - Creation of new knowledge and research tools captured in co-authored papers with foreign scientists published in world class scientific journals;
  - Joint Patents have been filed with foreign scientist;

– Building extended and stable institutional tie-ups with foreign partners to incubate feasibility of and/or scaling up of research and for deployable technology solutions suited to water challenged sites in India;

– Absorbing international experience on creation and management of global research infrastructures and guidelines for internationalization of national research facilities; and

– Project based mobility has provided indirect opportunities to Indian scientists for joining international projects.

DST continued with the execution of its mandated responsibility of:

- Fostering international cooperation and partnerships in accelerating national science, technology and innovation (STI) priorities and leveraging foreign expertise for national STI programs and priorities;
- Building new global and regional alliances and partnership for India's pursuit of strategic partnerships on principle of parity and co-investment of resources and science diplomacy ;
- Negotiating, concluding and implementing India's S&T Agreements at multilateral and regional levels.
- Providing India's interventions on S&T aspects of the multilateral and regional bodies;

This responsibility was carried out by DST in close consultation, on the Indian side, with Ministry of External Affairs; Indian Missions Abroad; Science Counselors posted in Indian Missions located in USA, Germany, Japan, Russia; S&T related Ministries and Sectoral Ministries of Government of India; Indian Scientific Agencies and Indian Science and Engineering Academies. DST continued its engagement with Industrial & Engineering Associations/Platforms in guiding initiatives to leverage international partnerships for joint research and technology development in domains of national priority.

Guiding Principles for International Multilateral and Regional S&T Cooperation

India's S&T relations with international multilateral and regional bodies were guided by the principles including:

- Leveraging international expertise in the form of joint project(s) based visits for (i) strengthening nationally important on-going research programs, (ii) accelerating institutional and human capacity building vital to India becoming a global player in knowledge based economy (iii) reflecting on global practices relevant to technology and innovation based demands and infrastructural requirements;
- Co-investment of resources including funds for joint research projects and strategic joint initiatives involving research entities from industries;
- Absorbing experience of existing global research facilities in fine-tuning and/or coupling with upcoming or existing Indian research facilities;
- India's proactive engagement in creation or addition to international advanced research facilities, as an expression of Indian maturity/competencies; and
- India's leadership in empowering developing countries in S&T.

Salient New Activities Carried Out During The Year

S&T MINISTERIAL MISSIONS

S&T Minister visits to South Africa and Hungry for 39th Carnegie Meeting and 5th World Science Forum

- Hon'ble S&T Minister Shri Vilasrao Deshmukh participated in 39th Meeting of Carnegie Group of Science Advisers to Prime Ministers & Presidents at Cape Town on Nov.11-13, 2011. The Carnegie Meeting represents a network to promote international dialogue amongst science advisers to President and Prime Ministers of G-8 (+5 BRICS nations, Mexico) and European Union with the aim towards making effective use and integration of S&T in diverse sectors of Government's engagements besides providing a platform for triggering informed high-level action on S&T issues of global significance. Hon'ble S&T Minister reflected on India's perspectives on the International Cooperation in STI to address global challenges, Brain & knowledge migration policy, Building S&T capacities in the South Challenges, Opportunities & Strategies.

- Hon'ble S&T Minister also participated in 5th World Science Forum at Budapest on Nov.17-19, 2011. Hon'ble Minister made a India Statement in the thematic Plenary Session "Emerging Powerhouses in Science & Technology (Geographical approach)" reflecting on the changing landscape of Indian science, technology and innovation. He highlighted India investments into R&D, Government declaration 2010-20 as Decade of to promote innovation ecosystem and an innovation agenda focusing on affordable innovation for sustainable and inclusive growth etc. He on behalf of Government of India made an offer to host the World Science Forum in 2017.

Fig. 8.4

MOS(S&T) Visit to China for BRICS Senior Official Meeting and Summer Davos

- Hon'ble Minister of State for S&T, Dr. Ashwani Kumar participated in 1st BRICS Senior Officials Meeting held at Dalian, China on 15 September 2011. He emphasized for stronger collaboration among BRICS countries especially in areas where scientific solutions to common challenges are feasible and said that BRICS countries are in a position to invest both financial and policy resources to address global problems together. He said Government of India is prepare to co-invest US$ 2 Million towards " BRICS STI Fund" to pursue

Fig. 8.5

BRICS STI cooperation activities on some areas of common priorities such as Energy, Water, Health, Natural Disaster Management, ICT, Basic research in emerging areas of S&T, Industrial clusters, especially involving MSMEs to become innovation savvy. He said India is in favor of setting BRICS Framework of STI Cooperation that promotes some common objectives to be overseen by BRICS STI Working Group.

STRATEGIC COOPERATION

INDIA-EU agree to enhance scale, scope and impact of S&T cooperation

The 7th EU-India Joint Science and Technology Steering Committee Meeting was held at Brussels, Belgium, on April 1, 2011 under the co-chairmanship of Mr. R-J Smits, Director General of Innovation and Research (RTD), & Dr. T. Ramasami, Secretary of the Department of Science and Technology (DST) of the Government of India. It was preceded by thematic bilateral meetings and the "India-EU Workshop on Scientific Review of 6 India-EU Computational Materials Science Research Projects" on March 30-31, 2011. Both sides took note of a new dynamic in the cooperation between India, the EU and the Member States particularly in the area of water and bio-resources as a pilot action.

The two sides agreed that DST and DG RTD should prepare a 'White Paper on an India-EU Strategic Research & Innovation Partnership' to be endorsed at the occasion of the 2012 EU/MS-India Ministerial Conference. EU and India agreed to enhance the scale, scope and impact of cooperation focusing in particular on key societal challenges of common interest under the framework of the India-EU S&T Cooperation Agreement.

A letter of intent for enhanced health research collaboration was signed between ICMR and European Commission. This letter confirms the joint intent announced at the previous joint committee meeting of preparing co-funded activity for supporting India-EU research collaboration in the field of cancer and neuro degenerative diseases.

Both sides agreed to launch a new India-EU coordinated call on research & development of deployable solution on water related challenges. Pursuant to this, a joint call was issued on water technology research & innovation with co-investment • 10 million from each side to address select water related challenges pertaining to water purification and water reclamation -reuse through (a) joint research leading to co-development of new knowledge and innovative technologies/products beyond current state-of-art and (b) design-deployment of field-based solutions out of the proven technologies available in Europe for specific water challenged sites in India which are scalable, sustainable and eventually affordable. In response to this call, 18 joint common proposals were received by both sides out of which 4 projects were recommended for funding based on joint scientific evaluation conducted on Dec.5-9,2011.

Further, it was also agreed to launching of a new DBT-EC coordinated call on bio-technological water treatments and reuse in agronomical system with co-investment of • 6 million from each side.

It was agreed to investigate the possibility of setting up an India-EU Working Group to share experiences and explore possible cooperation on "SME Growth, Innovation & Internationalization" within the aegis of India-EU Science & Technology Steering Committee. In addition, the meeting welcomed the creation by India of the Indian Business & Technology Centre-IBTC in Europe. (similar to the EBTC operating in India).

Mid-term Scientific Review of 6 India-EU "Computational Materials Science Research Projects" revealed that (i) 105 scientific papers have been published, with 10 joint papers jointly with EU partners & 2 patents have been filed (ii) balance in mobility of researchers from India and EU was maintained with 57 exchange visits of scientists and 39 project based research staff (iii) these projects are offering useful research attachments in niche areas for 71 PhD /Post-doctoral scholars from India and EU.

India, Brazil, South Africa (IBSA) S&T Joint Working Group agrees to boost the S&T Cooperation

Pursuant to IBSA MoU on Trilateral Cooperation in Science, Technology and Innovation signed on 15 April 2010, 1st meeting of Joint Working Group(JWG) on S&T was organised at Pretoria South Africa during October 14-15, 2011. The JWG reviewed progress of cooperation in the areas of nanotechnology initiative, oceanography & Antarctic research, health sciences and IBSA Satellite (space weather, earth observation and micro satellite). In addition to seven areas of cooperation identified in the MoU, the JWG recommended the inclusion of the area "research and innovation on water related challenges". It was agreed that this would be included in the agenda of the next IBSA S&T Ministerial Meeting. It was also agreed to organize workshop in the areas of Oceanography & Antarctic Research (in Brazil), Health Sciences (in South Africa), IBSA Satellite Technical Meeting (in India). It was also agreed 'in principle' to announce next IBSA Coordinated Call for R&D Proposals in early 2012.

4 IBSA Projects in the area of biomedical sciences were funded besides supporting 1 IBSA Mega-project on Nanotechnology Initiatives.

ASEAN-India S&T Cooperation

The 2nd Meeting of the Governing Council (GC) of ASEAN-INDIA Science & Technology Development Fund (AISTDF) was held on 18 August 2011 in Bangkok, Thailand. The GC approved the effective implementation of ASEAN-INDIA Virtual Centre on Intellectual Property Rights (VIIP), ASEAN-INDIA Virtual Centre on Technology Information and Commercialization (TICC), ASEAN-INDIA Workshop (Technology Mission) on Functional Food, ASEAN-INDIA Workshop (Technology Mission) on Renewable Energy. It was decided that the first announcement of Call for Proposals for Collaborative R&D will be in the Functional Food.

Brazil, Russia, India, China, South Africa (BRICS) Senior Official Meeting on Science, Technology and Innovation Cooperation at Dalian, China

As a follow up of BRICS Sanya Declaration, a Joint Statement for BRICS Science, Technology and Innovation Cooperation was adopted during 1st BRICS Senior Officials Meeting in China (Dalian, Sept 15, 2011). All sides agreed to develop STI cooperation in priority areas including exchange of information on STI policies and programs and promotion of innovation and technology transfer, food security and sustainable agriculture, climate change and natural disaster mitigation, new and renewable energy, energy conservation, nanotechnology, basic research, space, aeronautics, astronomy and earth observation, medicine and biotechnology, water resources and pollution treatment, High tech zones/science parks and incubators, Technology transfer. Further, they agreed for funding of joint projects from resources available to partnering BRICS country. For effective coordination and promotion of cooperation, it was decided that each BRICS country will designate one country coordinator for liaison, defining and exchanging information on potential cooperative project proposals. The five country coordinators will constitute the STI Working Group, which will be responsible for the implementation of initiatives and submit progress reports to the SOM. Further it was also agreed to establish a sub group under the overall BRICS STI Working Group, to

explore the cooperation in pharmaceutical industry. If necessary, other working groups dedicated to special themes or priority areas will be set up.

India participate in 2nd Meeting of Group of Senior Official on Global Research Infrastructure (GSO-GRI) at Cape Town

As a spin-off from the Meetings of Carnegie Group of Science Advisers from G-8 nations, Brazil-India-China-South Africa-Mexico (05 nations) and EU, a mechanism of Group of Senior Officials on Global Research Infrastructures (GSO-GRI) is operating from March 24, 2011 onwards. The 2nd Meeting of GSO-GRI was held at Cape Town, South Africa during November 9-10, 2011). The meeting was chaired by DG Research and Innovation, European Commission. Two scientific officials from India (DST, DAE representatives) were amongst the 24 participants from 12 countries. This meeting deliberated on inter-alia enlisting national facilities that each participating nation wishes to internationalize & the possibility of outlining a "Common Framework for International Cooperation on Global Research Infrastructures" for referencing by scientific community/ S&T ministries world-wide. India offered to open two upcoming national facilities to international scientific community (viz. India-based Neutrino Observatory (INO)- a single sited facility near Madurai in Tamil Nadu & Laser Interferometer Gravitational-Wave Observatory (LIGO)- a distributed sited facility with India as one of the location). Further India put across its positive experience /best practices in accessing and utilizing the existing European Research Facility - Elettra synchrotron at Trieste that is reaping multiple benefits.

INDIA'S ENGAGEMENT WITH UN AND OTHER INTERNATIONAL AND REGIONAL ENTITIES /FRAMEWORKS

India participate in 14th Session of the United Nations Commission on Science and Technology for Development (UN-CSTD)

United Nation's Commission on Science and Technology for Development (UN-CSTD) is a subsidiary body of the United Nation's Economic and Social Council (ECOSOC). The Commission provides the General Assembly and ECOSOC with high-level advice on relevant science and technology issues. The Commission has 43 Member States elected by ECOSOC for a term of four years and India has been re-elected from the Asian Region for the period 2011-2014. DST is the designated national focal point on behalf of Govt. of India on UNCSTD matters. The Commission meets annually and the 14th Session of the Commission on Science and Technology for Development (CSTD) was held in Geneva from 23- 27 May 2011. India representatives from Department of Science and Technology (DST) and National Informatics Centre (NIC) participated in this Session. They reflected Government of India perspective and views on of WSIS outcomes, improvements in Internet Governance Forum and on thematic issues of global importance such as Measuring the impact of information and communications technology for development and Technologies to address challenges in areas such as agriculture and water.

India's Participation in 36th UNESCO General Conference Natural Sciences Sub-Commission at Paris, France on Nov.1-3, 2011.

Indian delegation to 36th UNESCO General Conference, Paris was led by Hon'ble Minister for HRD and it included Secretary MoEs & DST representative (Head IMRCD) for the Natural Sciences Sub-Commission session held on Nov.1-3, 2011 at Paris. National Statement by India made a reference to India's strengths and approach to science-research-education and international cooperation.

The Natural Sciences Sub-Commission session noted inter-alia establishment of UNESCO's High Level Panel on S&T for Sustainable Development; UNESCO's Evaluation Mission for comprehensive review and monitoring of all the operational UNESCO Category II Centres (including those in science). It appreciated the progress made under the Inter-Governmental Oceanographic Commission (IOC) programs including Tsunami Warning Systems & GOOS (Global Ocean Observing system). This Session also recommended formal collaboration of UNESCO with Global Geoparks Network (GGN) - the Network having 87 geoparks across 27 member states and approved establishment of 8 UNESCO Category-II Centres in the field of S&T.

STEPAN (Science and Technology Policy Asian Network) is a network of researchers and institutions in Asia-Pacific region under the auspices of UNESCO. It has currently 20 member countries.

DST officer was deputed from India to the UNESCO sponsored STEPAN workshop entitled "National Innovation systems and their operational strategies and management aspects" held at Colombo, Sri Lanka during 2-3 November 2011 and which was organized by National Science Foundation (NSF, Sri Lanka). A total of 10 STEPAN member countries participated in this workshop and made country presentation on innovation indicators and methodologies involved in innovation capability studies in their country. Presentation on India highlighted the activities of existing national innovation ecosystem entities of our country such as National Innovation Foundation & National Innovation Councils; India's vision and strategy on innovation (XIth Plan Innovation Chapter, India's Decade of Innovation 2010-2011; and India's programs and examples on affordable and inclusive innovations (UID-Aadhar, RTI, Grassroot innovations, Healthcare/ Surgeries, ICT devices). The workshop had special working session on the Assessment of the National Science, Technology and Innovation system as an initiative for the preparatory work of UNESCO's STIGAP (Science, Technology and Innovation Global Assessment Program).

India's engagements with Centre for Science and Technology of the Non-Aligned and Other Developing Countries (NAM S&T Centre)

The Centre for Science and Technology of the Non-Aligned and Other Developing Countries (NAM S&T Centre) is an inter-governmental organisation with 45 member countries. India is a founder member of the Centre and DST as the designated Focal Point for the Centre is paying the annual membership contribution of US$10000 on behalf of India as well as nominating Indian scientists to participate in various activities of the Centre.

During the period 2011–2012, The Centre organised 3 international workshops in Malaysia, Nepal and Nigeria and a hands-on training course in India with participation of 290 scientists and professionals from 32 countries, which included 60 participants from India. 24 Indian scientists made presentations in these events. The 10-day Hands-on Training on 'Energy Audit for Energy Professionals in Developing Countries' was hosted in Mumbai by the Society of Energy Engineers and Managers, India as the Centre's co-organiser, in which the experts from several reputed Indian public and private sector agencies extended their services as the resource persons.The Centre also published 3 technical books during the period, including 11 chapters authored by Indian experts. Three of the co-editors of these books were from India. The Centre initiated a Joint CSIR / CFTRI (Diamond Jubilee) – NAM S&T Centre Fellowship scheme with the Central Food Technological Institute (CFTRI), Mysore of the CSIR under which 3 scientists, one each from Myanmar, Nepal and Sri Lanka affiliated themselves with CFTRI for 6 months duration. Of the remaining three Fellowship schemes of the Centre, an Indian scientist from the School of Environmental Sciences, Jawaharlal Nehru University (JNU), New Delhi has been awarded the NAM S&T Centre -

ZMT Bremen (Germany) Fellowship during the year.During 2011-12, the NAM S&T Centre also successfully completed a 3-year duration multilateral collaborative project on 'Sustainable Rainwater Harvesting and Ground Water Recharge in Developing Countries – HRD and Technology Transfer', partially supported by the Group of 77 (G-77) under its Perez-Guerrero Trust Fund (PGTF) with participation of 18 developing countries. As part of project implementation, the Centre organised a 4 days international workshop at Pune, India during 17-20 August 2009 and also a 6 days Trainers' Training programme at Bengaluru, India during 22-27 February 2010. A 517-pages State-of-the-Art Report was brought out in 2011-12, which includes the Status Reports of the participating countries including the reports contributed by 5 authors from India. Two other chapters of the book, viz. 'RWH & GWR Manual for Rural Areas' and 'Trainers' Manual and RWH Guide' have been contributed by Indian experts.

The Indian Ocean Rim-Association for Regional Cooperation (IOR-ARC), initially known as the Indian Ocean Rim Initiative, is an international organization with 19 member states and is managed by the Secretariat located in Mauritius. This Association disseminates information on trade and investment regimes, with a view to helping the region's business community better understand the impediments to trade and investment within the region. It also has the objectives of promoting sectoral cooperation including S&T, Higher Education, Culture, Defense and Maritime. S&T cooperation falls under the ambit of the Indian Ocean Rim Academic Group (IORAG). India has taken over Chairmanship of IOR-ARC from Yemen for next two years 2011-2013 in the 11th Meeting of the Council of Ministers of IOR-ARC. At the juncture of accepting the chairmanship, 17th Meeting of IORAG was held at Bangalore during Nov.11, 2011. DST along with nominees from CSIR, MoES and NBA (National Biodiversity Authority) participated in the meeting. The agreed minutes of 17th IORAG included offer of three new S&T proposals from India open for participation of interested member countries of IOR-ARC . The three S&T fields being (i)Technology Solutions for Winning, Augmentation & Renovation(WAR) for Water- DST's Initiative (ii) Open Source Drug Development- a CSIR initiative and (iii) Global importance of accessing marine and coastal biodiversity- a NBA initiative.

BIMSTEC (Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation) provides a unique link between South Asia and Southeast Asia**.** This framework aims at creating an enabling environment for rapid economic development, accelerate social progress in the sub-region, promote active collaboration and mutual assistance on matters of common interest. Technology is one of the 14 priority areas covered under BIMSTEC cooperation with Sri Lanka taking coordinating role.

DST deputed a two member team from India for participation in the Second Expert Group Meeting on Establishment of BIMSTEC Technology Transfer Facility (BIMSTEC-TTF) at Colombo during May 9-10, 2011. As recommended by the Meeting, BIMSTEC-TTF will provide a mechanism for the transfer of available technology among the member countries. It would coordinate, facilitate and strengthen cooperation in technology transfer in BIMSTEC region by promoting speedy transfer of available technologies, especially for the micro, small and medium scale enterprises and cross border technology transfer. It will also serve as a repository for information regarding the best practices in the area of technology transfer management, standards, accreditation etc., and to create technology related data-base relevant to the region. As a follow up to this meeting, CSIR India has been designated as the National Focal Point for BIMSTEC-TTF.

MULTILATERAL / REGIONAL S&T PROJECTS / WORSHOPS/TRAINING

- 3 India-EU joint projects in the area of Solar energy including development of noble material for solar cell like dye sensitized solar cell with enhanced efficiency, it fabrication and development; Organic

and Organic-Inorganic Hybrid Solar Cells Optimization of material properties, bulk heterojunction morphology and device efficiencies; Advanced grating for thin solar cell have been implemented in PPP mode with co-funding to the tune of 5 Million Euro from each side.

- 4 IBSA Projects in the area of biomedical sciences were funded besides supporting 1 IBSA Mega-project on Nano S&T.
- 2 India-ASEAN projects were implemented with funding out of ASEAN-India S&T Development Fund-AISTDF viz. India-ASEAN Virtual Institute for Intellectual Property with funding to the tune of Rs. 0.50 Million; India-ASEAN Virtual Centre on Technology Information & Commercialization to the tune of Rs. 0.50 Million besides continuation of support for 5 on-going projects.
- More than 150 exchange visits took place under various on-going multilateral programs(joint research projects, joint workshops, Specialized Schools, Fellowships).
- Continuation of support for 30 on-going CP-STIO Projects;
- Pursuant to 7th India-EU Joint Steering Committee Meeting's decisions, Joint Call for proposal in the area of Water Technology, Research & Innovation was issued. In response, 18 joint common proposals were received by both sides. The India-EU scientific evaluation panel recommended implementation of 4 joint projects limited to available budget.
- 20 Research Training Fellowship for Developing Country Scientists (RTF-DCS Program) supported.

STATE SCIENCE AND TECHNOLOGY PROGRAMME (SSTP)

State Science & Technology Programme (SSTP) formerly known as "*Scheme for Assistance for development of State Councils for Science & Technology*" is the only scheme of the Central Government focussed on the specific objective of promotion of Science & Technology at state level. The scheme, formulated at the instance of Planning Commission, is being implemented by Department of Science & Technology (DST), Government of India since VI plan. The core support and programme support provided under the programme has played an important catalytic role and has encouraged and facilitated State Science & Technology Councils to act as nodal organization for planning, formulating, evaluating and implementing Science & Technology activities at State level. The core support provided by the department has enabled State S & T Councils to equip themselves with requisite S & T manpower and office infrastructure which has contributed to their effective functioning. The programmatic support, on the other hand, aims to demonstrate, through carefully chosen projects, the contributions science & technology interventions can make in development process of the State.

In order to give focused attention to identification and demonstration of S&T projects including field trials, a special mechanism in the form of Core Group on State S&T Demonstration projects is present. The mandate of this Core Group is to facilitate identification of technologies developed in the S&T institutions and to facilitate their field trials and demonstration at a sizeable scale so that benefit of intervention are quite visible in various States. This group, in its two meetings considered 22 new projects in diverse areas of Socio-economic importance and also monitored 78 ongoing projects. The group recommended demonstration of specific indigenous technologies in the fields of bio-fuel, waste management, environment protection, energy efficiency, decentralized energy generation and water purification at appropriate locations.

Major achievements during the 11th plan period

Core Support to State S&T Councils in States

- State S&T structures set up in all the States.
- Catalytic core support provided to State S&T Councils in all the States to ensure requisite S&T capabilities for implementing State S&T programmes
- Support initiated to S&T Councils in Nagaland & Puducherry.
- Initiated efforts for professional development of S&T manpower in State S&T Councils.

Demonstration Projects including Replications of Success Models:

42 demonstration projects were supported such as production and utilization of bio-diesel from non edible oils, biofuel plant installed at Raipur and Bangalore, solar passive housing technology at Manipur, sericulture demonstration plant at J&K, low cost technology for the treatment of domestic sewage in rural areas at four different places, biomass gasifier in Chhattisgarh, plastic and hospital waste disposal plants in five states, iron removal plants in 8 north eastern states, Arsenic remediation technology installed in West Bengal, defloridation plant installed at Mathura, established tissue culture facility and in-vitro propagation of walnut chrysanthemum in Uttarakhand and organic agriculture programme in Sikkim.

S&T Studies and Surveys

The studies and surveys were conducted on various issues such as Mushroom Cultivation at Coimbatore, Global Climate Change viz-a-viz disaster mitigation by Goa State Council, Delineation of potential areas for commercially important medicinal and aromatic plants in different agro-ecological Zones of Karnataka using GIS, Heavy metal pollution of Adyar waters at Chennai, pesticides monitoring in seasonal vegetables and soil of Agra District, popularization of orchid floriculture among rural masses in Tamilnadu, community survey on substance related disorder and organic agriculture in Sikkim.

Information Exchange

Several regional State S&T Councils as well as national meets were organized in different parts of the country. Scientific Advisory Council to Prime Minister had also interacted with these councils under the Chairmanship of Prof. C.N.R. Rao. Brainstorming meeting of Union Minister with State S&T Ministers was also held.

Location Specific R&D and Technology Development

42 new projects were initiated such as Carbon sequestration capacity of mangroves in Kanpur, Cultivation and commercialization of medicinal plants in Assam, Recovery of metals and disposal of E-Waste in Karnataka, Impact of bamboo flowering on ecology in Arunachal Pradesh, Solar powered rodent trap at Arunachal Pradesh, Onshore broiler culture technology for fattening of baby rock lobster at Kanyakumari District, Improvement of economic traits of silmwork at Bangalore, exploration of knitted natural fibre reinforced composites for low-end application, fortification of organic wastes for increasing efficiency of micronutrients, screening of medicinal plants for treating Rheumatoid Arthritis in Tamilnadu and natural dyeing with plants in Manipur.

Some of the important achievements during the year 2011-12 under various activity heads of the programme are enumerated below:

1. Core Support to State S&T Councils

- Core support was continued to the State S&T Councils of 26 States/Union Territories. The support was oriented to S&T manpower to strengthen S&T capabilities of the State S&T Councils to undertake programmes in newer and emerging areas. An amount of ₹ 9.98 crores was provided under this during the year.

2. Demonstration Projects including Replication of Success Models :

Under this programme, technologies developed by national laboratories as well as by State S&T Councils were encouraged for field trials, demonstration and replication. Some of the major achievements were in the following areas:

- **LED based Energy System:** A project on LED based Solar Home lighting system in rural areas of West Bengal was accomplished in village Debipur of south 24 pragana district, West Bengal . Designing of 10, 20 and 30 watt LED based solar home lighting system was done under the project.

- **Environment awareness :** A project on remote accessible rain gauge for measuring rainfall accurately with telemetry capability was initiated in the state of Karnataka. Under the project 20 such units will be installed at different locations in country and their performance would be monitored.

- **Micro Hydel System:** A 2 X 100Kw MH system was commissioned at river Thongleng Rong near Lumpo & Muchut village in Tawang district of Arunachal Pradesh. The project has been commissioned in a decentralized mode.

Fig. 8.6: Micro-hydel turbines at Thongleng Rong, Arunachal Pradesh

- **Natural Resources :** A project was initiated on demonstration of effective and affordable biological agents(Entomopathogenic nematodes and other bio-agents) for the management of white grub menance on sugarcane crop in Western UP.

- **Solar Energy :** A project was initiated on demonstration of effect of Solar Electric Vehicles on society in Mumbai.

3. Information Exchange

An interaction meeting of State S&T Councils/Departments was held on 11-12th July,2011 at INSA, New Delhi. All the state S&T councils/departments presented their view points for strengthening the councils/departments as well as their suggestions on taking up newer challenges of state-centre technology partnerships, technology transfer and other issues relevant to the masses.

4. Local Specific R&D

- **Cultivation and Commercialization of Selected Medicinal Plants for Socio-Economic Upliftment of Samelongso Development Block of Karbi-Anglong(Hill) District in Assam**

  Bharat Jan Vigyan Jatha (BJVJ), Assam had implemented this project under SSTP of DST, Govt. of India during September, 2008 – August, 2011 with a challenge to uplift the socio-economic condition of the tribal people of Karbi-Anglong district of Assam through mass awareness and cultivation of medicinal plants of high economic value. Six medicinal plants viz., *Capsicum Chinese*, *Aquilaria malaccensis*, *Santalam album*, *Emblica officinalis*, *Terminalia chebula* & *Terminalia bellirica* were selected for commercial cultivation and ten medicinal plants viz., *Acorus calamus*, *Asparagus racemosus*, *Garcinia pedunculata*, *Gloriosa superba*, *Homalomena aromatica*, *Kaempferia galanga*, *Oroxylum indicum*, *Piper longum*, *Rauvolfia serpentine* & *Tinospora cordifolia* were selected for conservation. A total of 222 tribal beneficiaries were trained and more than 28,000(approx.) medicinal plant saplings were raised in two community nurseries and distributed all the plant saplings to beneficiaries for their own cultivation.

Fig. 8.7: Beneficiaries after receiving Medicinal plant saplings, Assam

- **Metabolic genotypes as modulators of DNA and Chromosomal damage in persons engaged in quarrying/ stone crushing**

  A database of 29 stone-crushing units and of 275 workers has been made. Presence of respiratory distress in all workes, aberrant reproductive performance in 34% and ill-health in 92% was observed. 60% workers were undernourished (BMI<18.00kg/m^2); and 86% workers were hypotensive (<140/80 mm/Hg). Aberrant pulmonary functions was there in 70%

workers.Chromosomal damage as micronucleated buccal and urothelial cells and in cultured lymphocytes was significantly increased ($p<0.001$) in exposed group.DNA damage was also statistically highly significant ($p<0.001$) compared to that in controls. These preliminary observations imply that workplace exposure (dust) at the stone-crushing units has a significant hazardous effect on the workers leading to genomic instability, respiratory distress and other compromised health conditions.

- **Utilisation of Kudremukh Iron ore tailings for fine aggregate in concrete & mortars**

  Concrete and mortar are consumed in bulk quantities for the construction of buildings, bridges, roads and other structures. Fine aggregate like sand is mined from rivers causing serious environmental hazards. The main objective of the project was to explore the utilization of iron ore tailings as a sand substitute for the mortar and concrete applications. The R&D work showed that iron ore tailings can be used as fine aggregate in mortars and concrete without sacrificing on the strength and other characteristics of mortars and concrete. It is more beneficial to use iron tailings in mortars resulting better bond and compressive strength. The results clearly proved that 50 – 60% of the sand can be replaced by iron ore tailings in mortar and concrete.

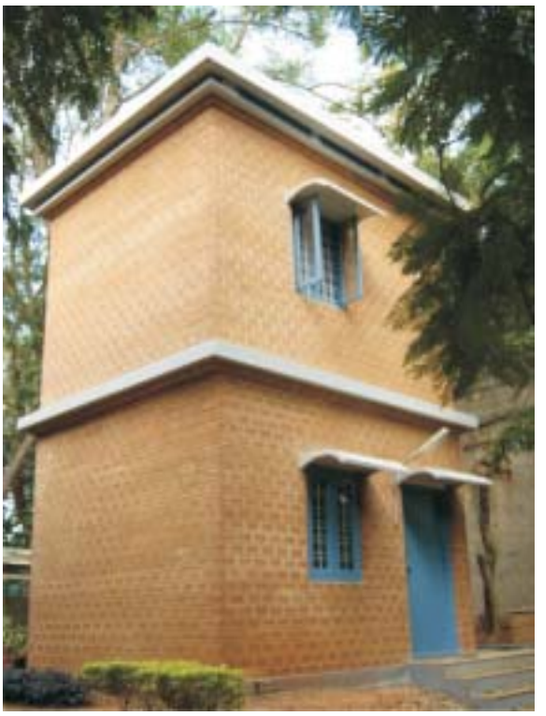


Fig. 8.8: Two storey load bearing masonry building was constructed using iron tailings as fine aggregate at IISc Bangalore.

- **Recovery of metals and disposal of hazardous components in e-waste**

  1) Chemical and biological methods of dissolution of copper, nickel and gold using non-cyanide lixiviants have been developed.

  2) The recovery of copper from the leach solutions has been accomplished using electrodeposition technique, with over 99% purity.

3) A novel biological process using *Acidithiobacillus ferrooxidans* resulted in the generation of gold flakes directly from the printed circuit boards.

4) The recovery of lithium from spent Li-ion batteries has been achieved using carbonate and fluoride lixiviants.

Fig. 8.9: Photograph of gold flakes recovered from printed circuit board

Fig. 8.10: Scanning electron micrograph of *Acidithiobacillus ferrooxidans* bacteria

Major programmes proposed during the 12th Plan(2012-17):

Major programmes	Deliverables/Outcomes
• **Core support**	• Core support to professional S&T secretariat to all State S&T Councils with focus on strengthening S&T manpower in new and emerging areas relevant for State development. • Catalysing programmes/schemes on professional development to ensure requisite S&T capabilities to facilitate joint programmes & collaborative projects. Suitable career advancement of S&T secretariat in State S&T Councils to ensure retention of experienced personnel as well as attract talented S&T professionals.
• **S&T demonstration projects**	• Development of programmes in certain identified key areas/ sectors of relevance to States with the involvement of S&T Councils, concerned Institutions, academia etc. • Support to pilot scale demonstration projects and replication to replicate successful projects of one State S&T Council to other States and demonstrate successful projects of Central S&T Agencies. • Initiating experimental demonstration programme on proven and transferable technologies developed in national labs/ academic institutions.
• **DST- State Council Collaborative S&T Projects**	Based on the recommendation of **All India interaction meeting during 11th and 12th July, 2011** of State S&T Councils and departments, collaborative projects to be initiated on mega scale on centre-state technology partnership.

CHAPTER 9

ADMINISTRATION & FINANCE

RECRUITMENT CELL

Recruitment Cell in this Department is vested with the responsibility of making recruitment to Group 'A' and Group 'B' (Gazetted) scientific and technical posts as recruitment to these posts is exempted from the purview of UPSC. The recruitment to these posts is made by the method of direct recruitment or deputation (including short-term contract) or absorption as prescribed in the Recruitment Rules for the relevant posts.

Recruitment Cell is also vested with the responsibility of in-situ promotion of departmental Scientists under the Flexible Complementing Schemes (FCS) as contained in the Department of Science and Technology Group 'A' Gazetted posts (non-ministerial, scientific and technical) Rules, 2004.

Besides, Recruitment Cell also deals with the proposals regarding recognition of Institutions / Organizations under various Ministries / Departments as scientific and technical for the purpose of introduction of FCS.

During the year, recruitment process has been carried out for one post of Scientist 'C', three posts of Scientist 'D' and one post of Scientist 'G' by direct recruitment in this Department. Recruitment to three posts of Scientific Attache one each in Indian Missions at Moscow , Tokyo and Berlin by transfer on deputation (including short-term contract) basis have also been done.

The Assessment of eligible departmental Scientists (upto level grade 'E') for in-situ promotion under FCS review as on 01.07.2010 has also been done.

STAFF POSITION

DST has a total number of 219 Group 'A' and Group 'B' (Gazetted) Officers. A detailed break up is given below:-

Group	General	SC	ST	OBC	PH	Total
Group 'A'						
Scientific	109	08	02	-	04	123
Non-Scientific	28	01	02	-	-	31
Group 'B'						
Scientific	06	02	01	01	-	10
Non-Scientific	44	08	03	-	-	55
Grand Total						219

TRAINING

Department of Science & Technology, in consultation with DOPT, other Scientific Departments and various organizations initiated an ambitious project of Human Resource Development namely "National Programme for Training of Scientists and Technologists working in the Government sector" for scientific and technical personnel during the X Plan to meet the challenges of national development and international competitiveness in S&T area. Considering the efficacy of the Scheme, the Department has decided to continue it in XI Plan.

During the year 2011-12, 41 training programmes were held. The training programmes were held on various topics as per following table:

Institution	Name of Training Programme/ duration	No. of Programmes
1. Administrative Staff College of India, Hyderabad	Science Administration and Research Management (2 weeks)	2
	Techno-Scientific Management Programme (2 weeks)	1
	Advance Techno-management for Middle Level Scientists (5 weeks)	2
	General Management Programme for senior scientists (2 weeks)	2
	Public Private Partnership for Science & Technology sector (2 weeks)	1
	Innovation Management and Technology Valorisation Programame (2 weeks)	2
2. National Institute of Advanced Studies, Bangalore	Multidisciplinary Perspectives on Science, Technology & Society (2 weeks), National Security (1 week)	1
	Paradigm Shift in Science & Technology for Directors (1 week)	1
3. NABL, New Delhi	Accreditation Management of Laboratories (1 week)	1
4. Lal Bahadur Shastri National Academy of Administration, Mussoorie	Science for Rural Societies Programme for Jr. & Middle level Scientists (2 Weeks)	1
	Technology and Innovation for Rural Development (2 weeks)	1
	Management and Leadership Development Programme (1 week)	2
5. Indian Institute of Public Administration, New Delhi	Capacity Building of Administrative Personnel of S&T Departments (3 weeks)	2
	Advanced Computer Application (1 week)	2
	Cyber Laws and Information Security (1 week)	1

	Citizen Centric Governance	1
	Foundation Trg. Programme for scientists (12 weeks), Cyber laws, Information Security (1 week)	1
6. Wilelife Institute of India, Dehadun	Biodiversity Conservation (1 week)	1
7. Consumer Unity & Trust Society, Jaipur	Technology Diplomacy (1 week)	2
8. Management Development Institute, Gurgaon	Policy and General Management Programme	1
9. Centre for Organisation Development	Integrated Scientific Project Management	1
10. Indian School of Mines University, Dhanbad	A Primer on Geostatistics (1 week)	1
	Ethics and Values (1 week)	1
11. Indian Council of Forestry Research and Education, Dehradun	Climate Change and Carbon Mitigation	1
12. Xavier Institute of Management, Bhubaneswar	Financial Management in Scientific Organization (1 week)	1
13. Indian Institute of Forest Management, Bhopal	Natural Resource and Environment Management (1 week)	1
14. All India Institute of Medical Sciences, New Delhi	Research Methodology (1 week)	1
15. Institute of Management Training and Research, Goa	Communication and Presentation Skills (1 week)	1
16. Technology Information, Forecasting and Assessment Council, New Delhi	IPR and related WTO Issues (1 week)	2
17. The Energy Resources Institute, New Delhi	Advances in Biotechnology (1 week)	1
18. Indian Institute of Foreign Trade, New Delhi	Marketing Scientific Research & Innovation in International Business (1 week)	1
19. Entrepreneurship Development Institute of India, Ahmedabad	Entrepreneurship Development and Management (1 week)	1

Under the Foreign Training Component, 16 junior scientists will be deputed for five days training in Brazil and 25 senior scientists will be deputed for five days training in South Africa during the current financial year.

WOMEN COMPONENT PLAN

Under women component plan '14' training programmes exclusively for women scientists were planned. The training programmes were held on various topics as per following table.

Institution	Name of Training Programme/ duration	No. of Programmes
ASCI, Hyderabad	General Management	1
XIM, Bhubaneswar	Communication and Presentation Skills	1
ASCI, Hyderabad	Project Management	1
IMTR, Goa	Effectiveness Enhancement	1
AHE, Baroda	Science of Living	1
ICFRE, Dehradun	Climate Change & Carbon Mitigation	1
WII, Dehradun	Biodiversity Conservation	1
NIAS, Bangalore	New Technologies & their Implications	1
IIPA, New Delhi	Using S&T to respond to the needs of economically disadvantaged women	1
TERI, New Delhi	Advances in Biotechnology	1
IMTR, Goa	Managing Change in Government Organizations	1
AHE, Baroda	Accountability and Responsiveness in Scientific Organizations	1
IIPA, New Delhi	Harnessing Leadership Among Women	1
AIIMS, New Delhi	Research Methodology	

The Exhibition cell is the nodal Cell for implementation of the Plan Scheme of "National Programme for Training of Scientists & Technologists working in government sector". During the year 2011-12, a number of initiatives were undertaken apart from the routine activities; the list of some additional important activities (which were not normal work) is as under:

i) Arrangements for meetings under National Programme for Training of Scientists & Technologists working in Govt. sector and its Women Component Plan.

ii) Preparation of Data Bank for the training of scientists for exposure visit.

iii) Arrangements for meeting to finalise training programmes under the Training Scheme.

iv) Matter related to organization of training programme for officials of SAARC countries.

Similarly, the Exhibition Cell was assigned a number of additional time bound activities which were generally not a part of their normal work:

i) Coordinating the work related to participation of Department of Science & Technology along with its organizations in the exhibition at during S&T Expo -2011 at Dharamshala during June 2-4, 2011

ii) Coordinating the work related to participation of Department of Science & Technology along with its organizations in the exhibition at "9th Infra Educa -2011, a complete education fair, at Agra, UP during June 18-19, 2011

iii) Evaluation of all the old exhibition material and preparation of new panels of the recent initiatives of the Department to showcase its achievement)

2. It is to mention that officials had to sit beyond office hours and worked on holidays also without any compensation or compensatory leave.

3. In recognition of outstanding contribution and special efforts in implementation of "National Programme for Training of Scientists & Technologists working in government sector" and the Exhibition Cell the following officials associated with Training and Exhibition Cell may kindly be sanctioned an honorarium as indicated against their names, as an incentive for their dedicated work during the financial year 2011-12

i)	Shri Dev Prakash, SO	Rs.2500/-
ii)	Shri Siddartha Dey, PS	Rs.2500/-
iii)	Shri Shayam Kumar, Assistant	Rs.2500/-
iv)	Shri Sanjeev Kumar Sharma, Asstt.	Rs.2500/-
v)	Shri Rajesh Kumar, Peon	Rs.2500/-
vi)	Shri Pawan Kumar Sahu, Peon	Rs.2500/-

4. Provisions of FR 46(b) have been kept in view while recommending the grant of

HINDI SECTION

The Department of Science and Technology continued to make concerted efforts to promote the use of Hindi in official work and to ensure compliance with the provisions of the Official Language Act, 1963 as amended in 1967 and Rules 1976 framed thereunder as also the various orders / instructions issued by the Department of Official Language from time to time with a view to ensure proper implementation of the Official Language Policy of the Government.

DST has a full – fledged Hindi Section consisting of a Joint Director (O.L.) assisted by an Assistant Director (O.L.) and other supporting staff which caters to the need of the Department of Science & Technology and also its Subordinate offices / Autonomous Institutions. Besides monitoring the implementation of the Official Language Policy and the Annual Programme, Hindi Section arranges for in - service training of the staff in Hindi Language, Hindi Typewriting and Hindi Stenography. It also undertakes translation of the material received from various Sections / Desks of the Department from English into Hindi and vice – versa.

For promotion of use of Hindi in this Department and to create conducive environment for the officials to work more in Hindi, various programmes are being undertaken:

- All documents coming under Section 3(3) of the official language Act, 1963 like general orders, notification, cabinet note, annual report and any paper which is to be laid in the parliament were

issued bilingually in both Hindi and English. Letters received in Hindi were invariably replied to in Hindi.

- With a view to encourage original scientific writing in Hindi, DST introduced "Dr. Meghnad Saha Award Scheme". Under the scheme, books written in the year 2006 to 2008 were invited. Another advertisement was published for inviting the entries for Dr. Meghnad Saha awards for the year 2007 and 2008.
- The officers of Hindi Section conducted inspections of Subordinate offices / Autonomous Institutions and 6 sections of the department regarding progressive use of Hindi.
- During the year, quarterly meetings of Departmental Official Language Implementation Committee were organized regularly. Likewise, Hindi workshops were organized to encourage the officers / staff of the department to do their maximum work in Hindi.
- The Hindi Advisory committee has been reconstituted.

Cash Awards and Incentive Schemes

An incentive scheme to encourage officers and employees to do their maximum official work in Hindi is in vogue in the Ministry. Under the scheme, cash awards are given for doing noting and drafting in Hindi.

Celebration of Hindi Pakhwara

Hindi Pakhwara was organized from 14 to 28 September, 2011 in the Ministry of Science and Technology. Various Hindi competitions were organized and the successful participants were given cash awards and certificates.

PARLIAMENT UNIT

The Parliament Unit is assigned with the responsibility of handling entire parliamentary work of the Department. It ensures that the parliamentary work pertaining to the Ministry of Science & Technology is accomplished as per the prescribed schedule and procedures. The Unit maintains liaison with the Ministry of Parliamentary Affairs, Secretariats of Lok Sabha/Rajya Sabha, other Ministries/Departments (including Scientific Departments) with a view to fully discharge the parliamentary obligations of the Ministry of Science & Technology. The Unit also coordinates the visits of the Parliamentary Committees to various scientific institutions which are under the administrative control of this Department.

RTI

A total of 295 RTI applications including 44 Appeals were received for the period of 01-04-2011 to 31.12.2011. All applications have been replied in time by the CPIOs. Appeals have been disposed as per provisions of RTI Act.

PUBLIC GRIEVANCES

A total of 579 grievances were received during the year 2011. Out of which, 387 grievances were disposed of by the different sections/divisions.

CITIZEN CHARTER

To fulfill the aspiration of the Citizens, the Citizen Charter has been implemented in DST.

VIGILANCE CELL

Vigilance Awareness Week 2011

As per the direction of Central Vigilance Commission, the Department observed 'Vigilance Awareness Week' from 31.10.2011 to 05.11.2011.

The Pledge related to the celebration of the Vigilance Awareness Week was administered to the officers and staff of DST and DSIR on 31.10.2011 at 11 A.M. near the Flag-post in DST complex. Dr.B.P. Singh, Sc.'G' and CVO, DST and Dr.R.R. Abhyankar, Scientist 'G' in DSIR administered the Pledge in Hindi and English respectively.

On 01.11.2011, "Just-A-Minute" speech competition and on 03.11.2011, Essay Writing Competition on selected current topics were organized.

The closing ceremony of the Vigilance Awareness Week was held on 04.11.2011 at 03.00 P.M. in Seminar Hall, DST, which was attended by the officers and staff of DSIR. A lecture by Shri Rajiv Verma, Under Secretary, CVC on the topic "Participative Vigilance" and an entertaining and informative cultural programme were organized besides distribution of prizes for the winners of the above mentioned competitions.

Fig. 9.1: Officers & Staff of DST/DSIR are taking Pledge on the occasion of Vigilance Awareness Week, 2011

Fig. 9.2 Officers and Staff of DST/DSIR are taking part in Essay Writing Competition held during Vigilance Awareness Week, 2011

Fig. 9.3: From Left : Mrs.Sushma Jain, Under Secretary (Vigilance), Dr.B.P. Singh, Scientist 'G' & Chief Vigilance Officer, DST, Dr. B. Harigopal, Scientist 'G', Shri Rajiv Verma, Under Secretary, Central Vigilance Commission and Dr.Joyti S.A Bhat, Sc.'G', DSIR during the closing ceremony of Vigilance Awareness Week, 2011 held on 04.11.2011.

Fig. 9.4: A scene from the Street Play **" ¦¨î òÇÐð ¨îð ¸ðÙðõÜð"** organized during the closing ceremony of Vigilance Awareness Week, 2011.

CHAPTER 10

AUTONOMOUS S&T INSTITUTIONS AND PROFESSIONAL BODIES

The Department of Science and Technology nurtures 24 autonomous institutions. These include 15 research institutions, 5 professional bodies and 4 specialized knowledge institutions and S&T service organizations.

The 15 research institutions in the DST family form a very special group from several points of view. Some of these are among the oldest research institutions in the country (including the oldest), some were started by eminent scientists and individuals like Mahendra Lal Sircar, CV Raman, JC Bose, Birbal Sahni and DN Wadia, some are repositories of very old and valuable scientific data, some lead the nation in niche areas like optical astronomy and geomagnetism – and so on. Most research institutions in the DST family are basic research institutions with the exception of ARCI-Hyderabad which has carved a very special place for itself as a premier technology development and transfer organization. These institutions have an impressive portfolio of research publications and awards and honours earned by their scientists.

All the 5 premier scientific professional bodies of the country, viz. INSA-Delhi, IAS-Bangalore, NASI-Allahabad, INAE-Delhi and ISCA-Kolkata belong to the DST family. Most of these are again very old organizations established by eminent scientists and individuals, including the Indian Science Congress Association which enters its centenary year this year. These professional bodies, through their multifarious activities, deliberate on policy issues of national importance related to S&T and help in dissemination of scientific knowledge through journals, meetings, conferences, national and international scientist-exchange programmes. In recent times, they have become important vehicles for special manpower development programmes focused on young students and science teachers in the country.

The 4 specialized knowledge institutions and S&T service organizations – TIFAC, NABL, VP and NIF – are unique in their own ways. TIFAC approaches technology forecasting in different sectors in a very structured fashion involving all stakeholders and also promotes new instruments of technology development and diffusion across the country. NABL is unique in being the national accreditation body for testing and calibration laboratories and Vigyan Prasar innovates on instruments of science communication and popularization. NIF, a recent entrant to the DST family, is a unique body which scouts for grassroots innovations and helps develop them further into viable, technology-backed products or processes.

These institutions, with long and varied history and their variety of activities, occupy a very important place in the S&T promotional agenda of the nation.

MACS' AGHARKAR RESEARCH INSTITUTE, (ARI) PUNE

A. Organization Particulars

1.	Name of the Institute	: Agharkar Research Institute
2.	Established in the year	: 1946
3.	Number of Scientists/faculty	: 39
4.	Total number of regular employees	: 158

B. Report on Activities during 2011-12

1. Areas of Focus:

- Microbiology, Nanobiosciences, Mycology and Plant Pathology, Botany, Genetics and Plant Breeding, Biometry and Nutrition, Chemistry, Geology and Palaeontology, Zoology

2. Major Accomplishments:

- A new high yielding (24.7 q/ha) soybean variety MACS 1188, resistant to major pests and diseases of soybean, suitable for cultivation in Southern zone including Maharashtra, Karnataka, Tamil Nadu and Andhra Pradesh was identified (Figure 1)

- Anti-diabetic potential of zinc oxide nanoparticles was validated in rat model of Type I and Type II diabetes (Figures 2&3)

- Quantum dot based immunosensors using 3D circular microchannels fabricated in polydimethyl siloxane polymers were developed for detection of food borne pathogens viz., *Salmonlla typhimurium* and *E. coli*

- The utility of prototype kit employing molecular recognition element tagged magnetic nanoparticles developed for rapid identification and antibiotic susceptibility testing of microbial pathogens was demonstrated using patient urine samples

- A microbial consortium for enhanced recovery of crude oil from matured/ ageing oil reservoirs with temperatures above 96ºC was developed and implemented in *Oil and Natural Gas Corporation* owned oil fields in South Kadi region, Gujarat. The oil recovery increased by 75% after single injection of the consortium

- The enzymes Cyclodextrin Glycosyl Transferase (CGTase) from *Exiguobacterium aurantiacum*, and collagenase from *Stenotrophomonas* are presumably first reports of from these bacteria. CGTase was demonstrated to be an effective antistaling agent in bread making

- A DBT Centre of Excellence in Epigenetics with ARI as one of the partners was initiated as a five-year multi-institutional initiative. Specific programs at ARI under the CoE are 1) Epigenetics of regeneration in hydra, 2) Transgenic hydra facility for the study of molecular regulation of regeneration and pattern formation

3. Important highlights of five major programmes:

- A new facile method for fabrication of 3D circular microchannels in PDMS was developed
- A prototype kit for rapid identification and antibiotic susceptibility of pathogens from clinical samples was developed and is undergoing extensive trials
- Total of 390 quintal wheat and 146 quintal soybean breeder seed was produced and supplied to seed multiplication agencies
- Endemic and threatened species of *Ceropegia macanii*, *C. rollae*, *C. odorata* and *C. mahabali* were taken up for micropropagation and their re-introduction in the field
- Phylogeny of Indian hydra was established using morphological and molecular markers for the first time (Figure 4)
- Emergence and divergence of Receptor Tyrosine Kinases homologues in hydra was studied by genome-wide screening
- Improvement in the yields of agricultural crops caused by applications of honey bee lures was demonstrated

4. Major and Unique National Facilities created

- Establishment of a large scale hydra facility is in progress.

5. Important collaborations (National and Global)

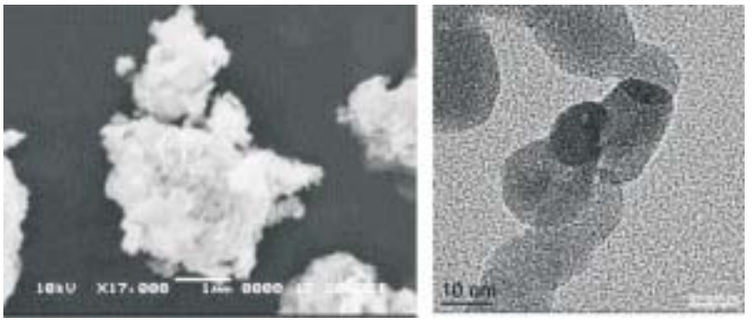
National: National Chemical Laboratories (for Biodegradable plastics/polymer); Sree Chitra Tirunal Institute for Medical Sciences & Technology, Trivendrum (for preclinical trials of Actinokinase enzyme); Computational Research Laboratory, Pune, India; Shivaji University, Kolhapur; *Indian Council of Agricultural Research*, New Delhi; Directorate of Wheat Research, Karnal; *Chaudhary Charan Singh University*, Meerut; *Punjab Agricultural University*, Ludhiana; *Indian Agricultural Research Institute*, New Delhi and Indore; Directorate of Soybean Research, Indore; University of Agricultural Sciences, Dharwad; Central Bee Research and Training Institute, Pune; Deccan College and Research Centre, Pune; University of Pune; National Center for Cell Science, Pune; *Indian Institute Of Science Education And Research*, Pune

Global: International Maize and Wheat Improvement Center (CIMMYT), Mexico; *Commonwealth Scientific and Industrial Research Organisation* (*CSIRO*), Australia; University of Sydney, Australia; The College of Wooster, Wooster, USA; University of Tokyo, Japan; University of Kiel, Germany

C. Important Output Indicators for 2011-12

S. No.	Parameters	Output
1.	Papers in refereed journals	70
2.	Books	1
3.	Chapters in Books	2
4.	Papers in Conferences	36
5.	Number of Ph.Ds. produced	8
6.	Indian patents filed	7
7.	Number of Technologies/ Designs and other intellectual products commercialized	2
8.	Number of Technology leads awaiting transfer	10
9.	Research Manpower trained (other than Ph.Ds)	10
10.	Technical Manpower trained	3
11.	B. Tech / UG projects guided	1
12.	M. Tech / M. Sc. / M. Phil projects guided	24

Figure 10.1 High yielding soybean variety MACS 1188



Figures 10.2 SEM and HRTEM of zinc oxide nanoparticles

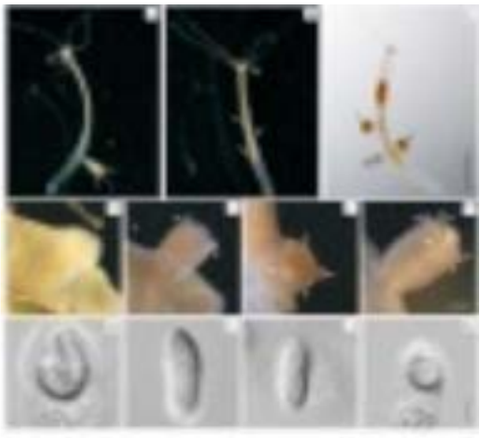


Figure 10.3 Phylogenetic characterization of Indian hydra

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATIONAL SCIENCES (ARIES), NAINITAL

A. Organization Particulars

1.	Name of the Institute	: Aryabhatta Research Institute of Observational Sciences (ARIES)
2.	Established in the year	: 2004
3.	Number of scientists/faculty	: 40
4.	Total number of regular employees	: 104

B. Report on Activities during 2011-12

1. Areas of Focus: The main research interests of Astronomy & Astrophysics division are in solar, planetary, stellar, galactic and extra-galactic astronomy including stellar & quasar variabilities, X-ray binaries, star clusters, nearby galaxies, quasars absorption and emission line studies and inherently transient events like supernovae and highly energetic gamma-ray bursts. Moreover, to strengthen the scientific contribution, the Institute has extended its horizon to theoretical and numerical studies in Relativistic Astrophysics. Research focus in Atmospheric Sciences division is mainly in the lower part of the atmosphere and covers the studies on trace gases and aerosols.

2. Major Accomplishments:

   i. Completion of design of Faint Object Spectrograph Camera (FOSC) instrument for the 360-cm telescope.

   ii. The regular astronomical observations are carried out with the 130-cm telescope at Devasthal.

   iii. The completion of 360-cm telescope mirror and mechanical structure at factory.

   iv. MoU with IUCAA, Pune for development of Integral Field Unit.

   v. Hα post flare loops of 2N/X1.4 class major flare observed on 22 September 2011 from active region NOAA 11302 with 15-cm Coude Solar Tower Telescope.

   vi. The advanced research is being pursued on the study of solar transients/eruptions and magnetohydrodynamic (MHD) waves, and the results are being published in the peer-reviewed international journals (e.g., ApJ, A&A, MNRAS, Solar Physics etc).

3. Important Highlights of 5 Major Programmes:

   (i) The 360-cm telescope mirror figuring & polished completed and mechanical structure of the 360-cm telescope ready at factory.

   (ii) ISRO Environmental Observatory: Observations of aerosols, ozone and its precursors, SO_2, and greenhouse gases are being made. Analysis of these data along with model results and space-borne observations show significant contribution of long-range transport and bio-mass burning in changing background levels over this cleaner region.

(iii) Lidar: A high energy pulse Lidar (Nd:YAG) system has been developed and operational for the measurement of aerosols. It has two modes of operations i.e. Mie and Raleigh covering altitude up to about 80 km.

(iv) RAWEX-GVAX: Observations of aerosols, radiation and meteorological parameters are being made at ARIES using suite of instrument from ARM, DOE, under the RAWEX-GVAX program.

(v) ST Radar: A Stratosphere-Troposphere Radar is being set-up at ARIES. This will be an active phase array operational at 206.5 MHz and will be used for wind measurements with high vertical and temporal resolution.

4. Major and Unique National Facilities created:

(i) The 130-cm telescope and 80-cm Schmidt telescope has been installed.

5. Important collaborations (national and global) established:

(i) Wide field photometry is being pursued around star forming regions and open clusters using the 1.05-m Kiso Schmidt and 1.04-m ARIES telescope in collaboration with Prof. K. Ogura, Tokyo, Japan to study the mass function of low mass stars in the coronal regions of clusters.

(ii) Multi-wavelength studies of star forming regions to study the global view of star formation in these regions, in collaboration with Prof. K. Ogura (Japan), Prof. W. P. Chen (Taiwan), Prof. S. K. Ghosh, Dr. D. K. Ojha (TIFR, Mumbai) are being carried out.

(iii) To search and study the pulsational variability in chemically peculiar stars, a program in collaboration with D. L. Mary of Labratoire Universitaire d'Astrophysique de Nice, France, Dr. Peter Martinez of South African Astronomical Observatory (SAAO), South Africa, Dr. T. Ryabchikova, M. Sachkov of Institute of Astronomy, Russian Academy of Science (INASAN), Russia and N. K. Chakradhari of School of Studies in Physics and Astrophysics, Pt. Ravishankar Shukla University, Raipur, India is being carried out.

(iv) To study the morphology of extragalactic objects, a collaboration with Dr. Joydeep Bagchi of IUCAA, Pune and Prof. Gopal Krishna of NCRA, Pune, is being pursued.

(v) Studies of complex properties of Giant Radio Galaxies are being carried out in collaboration with Prof. D. J. Saikia of NCRA-TIFR, Pune, India and Prof. Oleg V. Verkhodanov of Special Astrophysical Observatory, Russian Academy of Sciences, Russia.

(vi) The bilateral international projects (e.g., Indo-French, Indo-Russian, Indo-US) have been implemented. While, the collaborations and research cooperations are extending over the globe, e.g., with Warwick and Sheffield Universities in U.K.; UMCS, Poland; IZMIRAN and SAI (MSU) in Russia; SRI, Graz in Austria, LMSAL, NASA, and California State University in U.S.A etc. Inspite of various international research cooperations, the national collaborations and projects are also going on with various national institutes as well as universities.

C. Important Output Indicators for 2011-12

S.No.	Parameters	Output
1.	Papers in refereed journals	43
2.	Papers in Conferences	09
3.	Number of Ph.Ds. produced	Awarded – 05; Submitted- 03
4.	Research Manpower trained (other than Ph.Ds)	30
5.	Technical Manpower trained	200
6.	B.Tech/ UG projects guided	10
7.	M.Tech/M.Sc./M.Phil projects guided	5

BIRBAL SAHNI INSTITUTE OF PALAEOBOTANY, (BSIP) LUCKNOW

A. Organization Particulars

1. **Name of the Institute** : Birbal Sahni Institute of Palaeobotany (BSIP)
2. **Established in the Year** : September 10, 1946
3. **Number of Scientists** : 59
4. **Total number of regular employees** : 160 (including 43 Technical, 29 Administrative & 29 Group D staff)

B. Report on Activities during 2011-12

1. **Areas of Focus:**

- Early life, atmosphere and oceans: Evidences from Indian Craton.
- Fossil land plant communities: Morpho-structure, Evolution, Systematics with applications to Biostratigraphy and Palaeoecology.
- Integrative Micropalaeontology, Biopetrology and Organic facies: Relevance to fossil fuel characterization and exploration.
- Multi-proxy parameters for Quaternary palaeoclimate reconstructions, vegetation dynamics, relative sea level changes and anthropogenic influence.
- Polar and Major Planetary Events.

2. **Major Accomplishments:**

Institute is carrying out researches with a commitment to ensure growth in basic and applied aspects of Palaeobotany and allied Earth System Sciences, especially focusing on past plant life and palaeoclimate. The palaeobotanical researches are being conducted right from Archaean to

Recent in age ranging from 3200 Ma to 400 AD, which includes the Archaeobotany and Dendrochronology (tree-ring analysis) for the interpretation of climate change. Emphasis has been laid on deriving knowledge about the diversification of Precambrian life, diversity, distribution and inter- and intra-basinal correlation of Gondwana and Tertiary floras, terrestrial and marine microfossils and their application in solving geologic problems and hydrocarbon exploration, coal/lignite quality and to understand the interaction between the climate and vegetational changes during Quaternary Period.

3. Important Highlights of 5 Major Programmes:

Precambrian Palaeobiology— Recorded bacterial and algal remains from rock sequences belonging to Marwar (Rajasthan) and Singhora (Chhattisgarh) Supergroups. Studied trace fossils from Marwar Supergroup provides definitive evidence of the Cambrian succession for hitherto suggestive Precambrian-Cambrian sequence in peninsular India.

Gondwana Flora— Plant fossils investigated from various Gondwana successions of Satpura, South Rewa, Mahanadi, Pranhita-Godavari, etc. basins have helped in interpreting floristic evolution and palaeoecology of the regions. Studied plant fossils from coal-bearing sequence of Satpura Gondwana Basin suggest that in all likeness flora of Karharbari Formation continued to exist in lower part of Barakar Formation. Recovery of angiosperm and associated floral elements from East Coast helped to note new insights in plant evolution during Cretaceous times in the Indian sub-continent. In addition, analysed palynomorph assemblages from various coal-bearing Gondwana sequences of Singrauli, Sohagpur, Ib-River, Birbhum, East Bokaro, and Godavari valley coalfields for biostratigraphic dating and correlations.

Tertiary Flora— Generated additional data on plant megafossils (from Gujarat, Rajasthan, MP, Uttarakhand, Himachal Pradesh, Manipur and Assam), and micro-remains (pollen, dinocysts, DOM, calcareous algae, etc.– from Kachchh, Rajasthan, north-east and central India, Cauvery Basin, Andaman, etc.) from certain terrestrial and marine Palaeogene horizons in terms of their palaeogeographic, biostratigraphic and palaeoenvironmental significance. The occurrence of some Southeast Asian elements in the fossil flora of Assam indicates that an exchange of floral elements took place between India and Southeast Asia during the Miocene period. Angiospermous pollen are recovered for the first time from the late Albian Grey Shale of Dalmiapuram Formation (Tamil Nadu).

Micropalaeontology & Organic Petrology— The record of high latitude cold water nannofossil forms with warm water taxa and nannoliths indicate mixing of warm and cold water currents in Jaisalmer Basin during late Cretaceous time. Studied dinocyst/ palynofacies assemblages from Mahadek Formation, Cherrapunji area (Cretaceous-Palaeocene) shows specific levels of well-preserved cyanobacteria followed by dinocyst dominated horizons indicative of fluctuating tidal flat and shallow inner neritic depositional conditions. Certain Gondwana coals from Godavari valley and Tertiary lignites from Cauvery and Cambay basins have been evaluated for their categorization in relation to economic suitability, besides depositional patterns.

Quaternary Palaeoclimate— Studies have been carried out to understand the climates through palynological/palaeobotanical proxies, i.e. pollen, tree-rings, phytoliths, phytoplankton, Archaeobotany, etc. The data generated from south-eastern MP, Assam, Mahanadi Delta, Godavari Delta, Karawar Coast, Arabian Sea, etc. has been utilized for the interpretation of spatio-temporal climatic changes covering major time span of the Quaternary Period. Pollen record is interpreted to understand the evolution of mangrove vegetation in relation to sea-level and concurrent climatic fluctuations around the Chilka Lake (Orissa). Tree-ring samples of *Cedrus deodara* have been analysed from six sites of Garhwal Himalaya and prepared their chronology, ranging between 272 and 594 years. Enhanced and added more palaeo-ethnobotanical finds from ancient Ahichchhatra, District Bareilly (UP); revealing advanced agricultural practices in this region of Ganga Plains during Chalcolithic and Early Historic times.

Polar Palaeoclimate Research— The large former glacial lakes and their sediments are described from the Schirmacher Oasis region of Antarctica. The water bodies were present during the late Quaternary (~13-3 ka BP) and have reduced in size by negative water balance. Studied mineral/ environmental magnetic analyses in the dry lacustrine/ sediment fills of the Schirmacher Oasis indicates 6 phases of climatic fluctuation between 13-3 ka BP. Detailed studies of the Ny-Alesund trench (Arctic) sediments have revealed significant data regarding the late Quaternary climate and sea level changes, which were regional in nature. In addition, Institute participated in India's Arctic Programme for field related and Quaternary palaeoclimatic studies.

4. Major and Unique National Facilities created:

The calibration for C-14 dates is being carried out as per available latest softwares extending the calibration to about 50,000 yrs BP.

5. Important collaborations (national & global) established:

Multidisciplinary and multi-institutional research activities with Institutions in India and abroad have been continued in several spheres. Institute is working in close unision with abroad institutions like Institute of Botany, Chinese Academy of Sciences, Beijing; Institute of Geosciences, University of Sao Paulo and Guarulhos, Brazil; University of Texas, USA; Institute of Geosciences, Russian Academy of Sciences, Moscow; and with Indian institutions like WIHG (Dehradun), GSI (Kolkata), NIO & NCAOR (Goa), University of Jammu, etc.

International Programme

This scientific programme is aimed to assimilate the valuable palaeobotanical data available at BSIP with international experts of different disciplines. Their further examination and interpretation in global perspective will result into world class research. Under the programme, following eminent experts visited BSIP— Prof. Robert A. Spicer (of UK), Prof. Martin J. Head (of Canada), Prof. Valentin Krassilov (of Israel), and Prof. David L. Dilcher (of USA).

C. Important Output Indicators for 2011-12

S.No.	Parameters	Output
1.	Papers in refereed journals	91
2.	Books	1
3.	Chapters in Books	4
4.	Papers in Conferences	4
5.	Number of Ph.Ds. produced	8
6.	Foreign Patents filed	NA
	Foreign Patents granted	NA
7.	Indian Patents filed	NA
	Indian Patents granted	NA
8.	Number of Technologies/Designs and other intellectual products commercialized	-
9.	Number of Technology leads awaiting transfer	-
10	Research manpower trained (other than Ph.Ds.)	5
11.	Technical Manpower trained	3
12.	B.Tech./UG Projects guided	2
13.	M.Tech./M.Sc./M.Phil projects guided	4
14.	Other Products/Indicators	
	Help to industry	1
	Collaborative research	12
	Consultancy services (in Carbon dating, SEM & Coal Petrology)	40

BOSE INSTITUTE (BI), KOLKATA

A. Organization Particulars

1. Name of the Institute : Bose Institute

2. Established in the year : 1917

3. Number of scientists/faculty : 61

4. Total number of regular employees : 220

B. Report on Activities during 2011-12

1. **Areas of Focus** : Physical, Chemical and Biological Sciences, both Basic and Applied Research

2. **Major Accomplishments** :

Significant accomplishments have been made in the following Institutional Programmes :
Improvement of Plants: Biotechnological, Genomic and Proteomic Approach
Protein Structure, Function and Engineering
Bioinformatics and Computational Biology
Molecular Medicine
Microbial Genomics and infection Biology
Development of Systems Biology
Basic and Applied Problems in Physical and Environmental Sciences
Integrated M.Sc.Ph.D. Programme in Life Sciences
Rural Biotechnology Programme for mushroom cultivation preservation and spawn production

3. **Important Highlights of 5 Major Programmes**:

- **Improvement of Plants: Biotechnological, Genomic, and Proteomic Approaches**

  DNA fingerprinting of Curcuma land races growing in Manipur; Development of Curcuminoid and antioxidant potential associated DNA market; Large scale production of transgenic pineapple with a novel encapsulation based antibiotic selection; The ddNTP sensitive DNA polymerase enzyme from plant system, Salinity Stress in rice Cultivars and Biochemical & Molecular Analysis of Fruit Ripening; Resource survey analysis of wild gene pool with reference to seeds; Differential profiling of genes induced on challenge with *Alternaria brassicicola* in resistant *Sinapis alba* and their comparative expression pattern in susceptible *Brassica juncea ;* Improvement of aromatic rice; Application of Biotechnology in medicinal plant studies; Studies on airborne allergenic pollen grains and spores: Biochemical, clinical and molecular approach; Search for salt-tolerance genes/ proteins from *Porteresia*; Towards search for MYMIV- resistance genes/proteins in *Vigna mungo*; Development of antibiotic resistant marker free insect resistant plants; Production of stable population of "*Rorippobrassica"* lines; Genetic Diversity Analysis of Rice Landraces of West Bengal; Resource survey analysis of gene pool with reference to seed; Molecular Documentation and Bioprospecting of Plant Diversity in Eastern and North Eastern India; Production of hybrid mushroom strains

- **Protein Structure, Function and Engineering**

  Chaperone-Mediated Inhibition of Tubulin Self-Assembly**;** RecA-mediated cleavage of » cI repressor; Structural Studies on proteins involved in the lysis-lysogeny switch of phage; lambda Patterns in protein structure and conformation; Analysis of electrostatic interactions in protein-protein complexes; Role of N-terminal region in chaperone activity of α-crystallin**;** Analysis of electrostatic interactions in protein-protein complexes; Electrostatic aspects of tRNA and DNA protein interactions; Molecular dynamics simulation of the unfolding of antifreeze protein; Analysis and design of peptides with cis peptide bonds: Pro-Pro-Xaa sequence motifs; Conformational studies on the plug domain of protein translocon channel SecYEG; Protein-nanoparticle interaction ; Stabilization of quaternary structure of að-crystallin by Zn^{+2}

- **Molecular Medicine**

  Structural and functional characterization and physiological significance of a stimulator protein of Mg^{2+}-independent Ca^{2+}-ATPase isolated from goat spermatozoa; Characterization of a low molecular mass stimulator protein of Mg^{2+}-independent Ca^{2+}- ATPase : effect on phosphorylation-dephosphorylation, calcium transport and sperm cell motility; Immunomodulatory roles of novel Triterpenoid compounds during experimental visceral leishmaniasis; Amphotericin B reg Julates the host immune response in visceral leishmaniasis reciprocal regulation of protein kinase C isoforms; Anti-leishmanial role of Ara-LAM from non-pathogenic strain of mycobacteria; Studies on the mechanism(s) of naturally occurring bio-active molecules in pathophysiology; Curcumin restores tumor-induced loss of T-effector cells and normalizes T-regulatory cells via down-regulation of TGF-β in tumor cell; Resistance-to-apoptosis switchover: A molecular approach towards cancer chemoprevention; Cancer management by dietary phytochemicals: A mechanistic approach; Resistance-to-apoptosis switchover: A molecular approach towards cancer; Targetted immunoregulation of host to ameliorate tumor-induced immunosuppression; Marine Biotechnology research; Development of alternative herbal medicines to combat cancer and other autoimmune diseases in human; Resistance-to-apoptosis switchover: A molecular approach towards cancer chemoprevention

- **Microbial Genomics and Infection Biology**

  Chromosome replication and segregation in yeast; The cell cycle of Entamoeba histolytica; Characterization of bacteriophage proteins and construction of S. aureus reporter tool; DNA Trajectory in a Mycobacterial plasmid origin complex;

  Wag31, a chaperone-like protein that protects mycobacteria under oxidative stress; Early secreted antigen-6 (ESAT-6) of M. tuberculosis modulates interleukin-12 release from macrophages by suppression of NF-kappa B activation ; The mycobacterial protein FipA is phosphorylated by PknA and is required for cell division under oxidative stress; Helicobacter pylori antigen, HP0175 activates epidermal growth factor receptor (EGFR) in gastric epithelial cells in a Toll-like receptor 4-dependent; Penicillin-binding protein 1* (PBP1*)of *Mycobacterium tuberculosis* as a regulator of cellular morphology; Nucleotide metabolism-related genes of mycobacteriophage of the L5 family; Complete degradation of phthalate ester by a bacterial consortium; Kinetics of phenanthrene degradation by a *Staphylococcus* sp.

- **Basic and Applied Problems in Physical and Environmental Sciences**

  Studying the physics of superheated liquids using superheated drop detectors; Investigations on theoretical aspects of Compton scattering; Interdisciplinary Physics/Systems Biology; Quantum Phase Transitions and Entanglement; Foundations of Quantum Mechanics and Quantum Entanglement; Study of Cosmic Rays with active and passive detectors; Ac conductivity and scaling behaviour in complex perovskite oxides; Electronic structure and ground state property of perovskites; Effective Model study of Signatures of phase transition; Airspace environment of Eastern Himalayas and global change; Synthesis of condensed heterocycles and development of green chemistry; Induced Mesomorphism in

Cholesterol Ester Mixtures; Local access of global quantum information; Cosmic Ray simulation studies

4. **Major and Unique National Facilities created** :

Proteomics & Genomics Centre; Centre for Astroparticle Physics & Space Science; Bioinformatics Centre.

5. **Important collaborations (national and global) established:**

National collaboration with a number of Research Institutions and Universities and International Collaboration with countries like USA, Germany, Switzerland, France, Japan, Israel etc are in progress. Bose Institute has been invited to become a collaborating institute for the ALICE programme at CERN, Geneva. Bose Institute is also the sole Indian shareholder in the Facility for Antiproton and Ion Research (FAIR) at Darmstadt, Germany.

C. Important Output Indicators for 2011-12

S.No.	Parameters	Output
1.	Papers in refereed journals	650
2.	Books	1
3.	Chapters in Books	10
4.	Papers in Conferences	50
5.	Number of Ph.Ds. produced	15
6.	Indian Patents filed	3
7.	Research Manpower trained (other than Ph.Ds)	215
8.	Technical Manpower trained	12
9.	B.Tech/ UG projects guided	6
10.	M.Tech/M.Sc./M.Phil projects guided	24

CENTRE FOR SOFT MATTER RESEARCH (CSMR), BANGALORE

A. Organization Particulars

1. ***Name of the Institute :*** Centre for Soft Matter Research (Formerly Centre for Liquid Crystal Research)

2. ***Established in the year***

The Centre was established in 1991 and was taken over in 1995 as an autonomous institute under the Department of Information Technology. The Centre was taken over by the Department of Science and Technology (DST) in 2003. It was renamed as Centre for Soft Matter Research (CSMR) w.e.f. 1.9.2010.

3. ***Number of scientists/faculty :*** *8 + 5***

** (1 Scientist of Eminence, 1 Emeritus Scientist, 2 Visiting Professors, 1 Research Associate)

4. ***Total number of regular employees:*** 21 + 21## = 42

(5 Senior Scientists on different Fellowships + 16 regular Ph.D. students)

B. Report on Activities during 2011-12

1. ***Areas of Focus :*** The Centre was established to focus on basic and applied research in liquid crystals. Now, Centre has broadened its scope in Soft Matter to include polymers, gels, membranes and so on.

2. ***Major Accomplishments*** :

- Enhanced magnetic properties of solution deposited $BiFeO_3$ thin films with ZnO buffer layer.
- Smectic morphology in bent-core nematics driven by static fields.
- Dimer-like mesogens – new class of liquid crystals.
- Electro and Magneto rheological effects of organo-gels and composites doped with ferronanoparticles.
- Some new results on ferroelectric materials at high pressures.
- First observation of enhancement of the bent elastic constant upon photoisomerization.
- Direct observation of photoflexoelectric effect.
- Synthesis of discotic tris(N-salicylideneamines)s [TSANs].
- Synthesis of magneto-responsive organic (spin) molecules.
- Growth of ZnO nanorods for photodiode and memristive applications.
- Structural, magnetic and magnetotransport behaviour of ZnO doped $La_{0.67}Sr_{0.33}MnO_3$ compounds.
- Piezoresponse force microscopy results on compositionally graded multilayer films of lead magnesium niobate-lead titanate.
- Dynamics of À-twist circular loops surrounding planar domains in nematics.

Number of publications during 2011-2012 : 26 (till 10.12.2011)
Ph.Ds awarded during 2011-2012 : One
Popularization of science, the faculty has given about 25 lectures at various schools/ colleges (till 10.12.2011).

3. ***Important Highlights of 5 Major Programmes*** :

- ***Enhanced magnetic properties of chemical solution deposited $BiFeO_3$ thin films with ZnO buffer layer :*** Magnetic properties of $BiFeO_3$ films deposited on Si substrates

have been studied. Our magnetic measurements reveal that the magnetization of $BiFeO_3$ has increased by more than ten times in $BiFeO_3$/ZnO/Si film compared to $BiFeO_3$/Si film, indicating the major role played by ZnO buffer layer in enhancing the magnetic properties of $BiFeO_3$, a multiferroic material. This enhancement is possibly due to lattice mismatch induced strain and oxygen vacancies, leading to nano-sized polycrystalline grains which destroys the antiferromagnetic spiral spin structure. The enhancement is very useful to utilize the room temperature multiferroicity of $BiFeO_3$ for technological applications (Figure1).

- ***Smectic morphology in bent-core nematics driven by static electric fields:*** Remarkable morphological changes occur under an increasing electric field. Half-strength disclinations of opposite topological charge evolve within the flexostructure rendering the wavevector orientation degenerate in the layer plane. Dipolar and quadrupolar topological defect patterns, lead finally to fan like objects. The morphological equivalence between the periodic flexoelectric state and a layered lattice can be attributed to a much lower energy of bend type distortion.

- ***Dimer-like mesogens – new class of liquid crystals:*** They are synthesized by covalently tethering cholesterol with salicylideneamine core through an É-oxyalkanoyloxy spacer of varying length and parity. In all the three even-parity spacer series, the variation in the length of the terminal tail influences the thermal property. Notably, the N* and SmC* phases exist over a wide thermal range; interestingly, the latter phase exhibits ferroelectric switching behavior.

- ***Electro and Magneto rheological effects of organo-gels and composites doped with ferronanoparticles :*** Liquid crystal gels doped with ferronanoparicles of varied geometrical shapes were investigated. We find faster electro-optic response and anomalously large Frank elastic constant in anisotropic gels. The Frank bend elastic constant increases by two orders of magnitude indicating the mechanical rigidity of the gels.

- ***Some new results on ferroelectric materials at high pressures :*** We have measured thermal variation of spontaneous polarization (Ps), coercive voltage (Uxc), and rotational viscosity (γ_ϕ) of a ferroelectric liquid crystal (10PPBN4) as a function of applied pressure. The material having a high value of Ps exhibits a trend reversal. Interestingly, the trend reversal feature becomes more dominant as the pressure is increased. This behaviour is well described by a model developed for materials exhibiting a sign reversal in Ps.

4. ***Major and Unique National Facilities created*** : —

5. ***Important collaborations (national and global) established***:

National: Collaboration with Bharat Electronics Limited (BEL), Raman Research Institute (RRI) and Indian Institute of Science (IISc).

Two research projects undertaken: Two SERC Projects.

Global: Collaboration with Research Institute for Solid State Physics and Optics of the Hungarian Academy of Sciences, Hungary under INSA-Hungarian Bilateral Exchange Programme.

Collaboration with Bulgarian Academy of Sciences under DST Indo-Bulgarian Joint Bilateral Programme

Other Collaborations with Kent State University, USA, Tokyo Institute of Technology, Japan and so on.

C. Important Output Indicators for 2011-12

S.No.	Parameters	Output
1.	Papers in refereed journals	26
2.	Papers in Conferences	4
3.	Number of Ph.Ds. produced	1
4.	Research Manpower trained (other than Ph.Ds)	4 (from other institutions)
5.	Other Products/ Indicators **Given at schools/colleges under popularization of science**	25 lectures

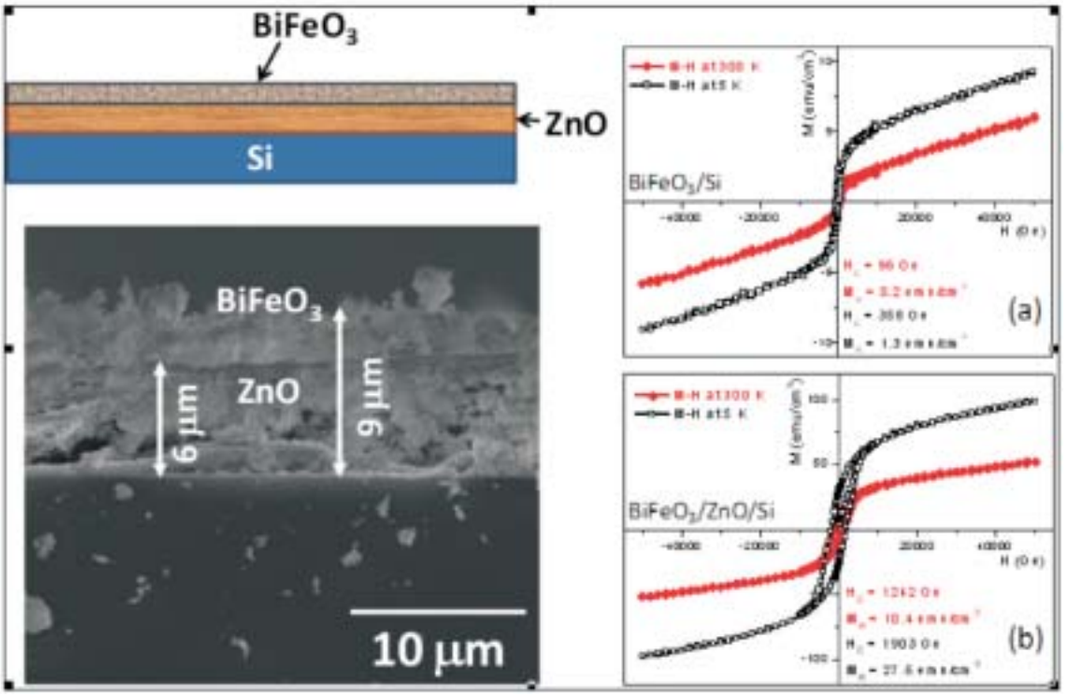


Figure 10.4 : Schematic and SEM cross-section images of $BiFeO_3$/ZnO/Si film (left). Magnetization, M versus magnetic field, H data of the films (right). The figure (b) shows 10 times enhanced magnetization compared to (a).

INDIAN ACADEMY OF SCIENCES (IAS), BANGALORE

A. Organization Particulars

1.	Name of the Institute	: Indian Academy of Sciences
2.	Established in the year	: 1934
3.	Number of scientists/faculty	: - Nil -
4.	Total number of regular employees	: 42

B. Report on Activities during 2011-12

1. Areas of Focus

:a)Publication of the following

11 scientific journals:

1 Journal of Chemical Sciences

2 Proceedings, Mathematical Sciences

3 Journal of Earth System Sciences

4 Sadhana(Proceedings in Engineering Sci)

5 Pramana – Journal of Physics

6 Journal of Biosciences

7 Bulletin of Materials Science

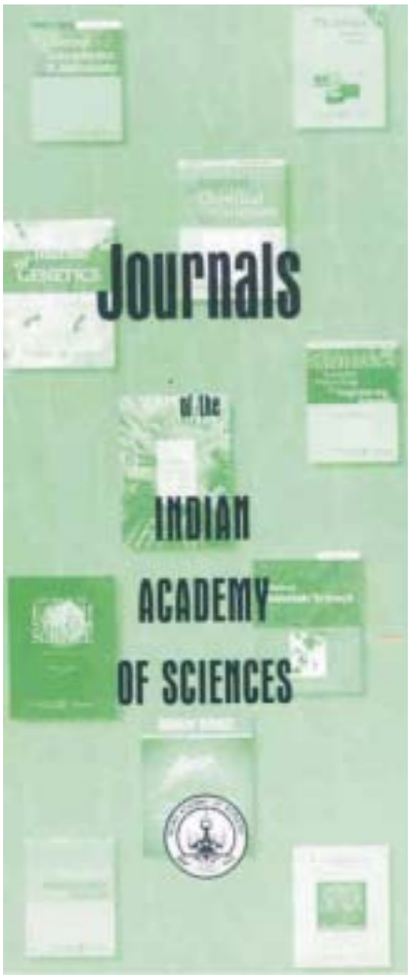
8 Journal of Astrophysics & Astronomy

9 Journal of Genetics

10 Resonance – Journal of Science Education

11 Current Science (in collaboration with the Current Science Association)

b)Recognition of excellence by conferring Fellowships to scientists
c) Science Education Programme for students and teachers
d)Repository of Fellows' publications
e) Conducting Mid-Year and Annual Meetings of Fellows, Public Lectures by visiting scientists etc



2. Major Accomplishments

:Has published over 1700 papers (12368 printed pages) in its 11 journals in the year 2010

3. Important Highlights of 5 Major Programmes:

There is a steady increase in the number of summer fellowships offered to students and teachers over the years. Likewise, the number of Refresher Courses and Lecture Workshops conducted are also increasing.
The impact factors of all its 11 Journals are evident to the fact that the journals are visible worldwide.
The number of downloads for full text of articles published by the Academy are on the rise.
The Repository of Fellows which was launched this year has registered over 80000 hits.

4. Major and Unique National Facilities created

- Not applicable –
:

5. Important collaborations (national and global) established:

The Academy is collaborating with the other two national science Academies INSA, New Delhi and NASI, Allahabad in its activities under the Science Education Programmes.

C. Important Output Indicators for 2011-12 : NIL

Fig. 10.5 The inaugural session of the 76th Annual Meeting of the Academy held at Goa during 12-14 November 2010

INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE JADAVPUR, (IACS) KOLKATA

A . Organization Particulars

1. Name of the Institute : Indian Association for the Cultivation of Science
2. Established in the year : 1876
3. Number of scientists/faculty : 75
4. Total number of regular employees : 253

B. Report on Activities during 2011-12

1. Areas of Focus:

IACS carries out basic research under four umbrella areas- Molecular Science, Material Science, Theoretical Sciences and Biological Sciences.

2. Major Accomplishments:

(a) Wide variety of nano-particles and nano-composites based on ZnO, CdS, CdTe, polymer, gold and silver, carbon nanotube developed and their application as light emitting diodes, photovoltaic (solar energy) devices, in organic electronics, as sensors of toxic ions and in drug delivery, in magnetic force microscope and their optical, magnetic and dielectric properties explored. Optical properties Si-quantum dots in oxide, nitride and carbide matrix, amorphous silicon germanium solar material synthesized using plasma CVD.

(b) Bio-active gel and inorganic materials for water purification, green chemistry and CO_2 sequestering (to alleviate global warming).Synthesis of organic and inorganic molecules, ring-closing metathesis, organo-boranes, -silanes, -stannanes, metal-organic frameworks, crystal engineering, vanadium mediated organic transformations, metal helicates, bio-mimetic iron complexes asmodel for non-heme iron enzymes, “click” chemistry.

(c) Under DST intensification of research in high priority area (IRPHA) program a centre for femtosecond laser and single molecule spectroscopy created: distribution of diffusion coefficient in lipid vesicles and ionic liquid and effect of ionic liquid on conformational dynamics of protein. Spectroscopic properties of weakly bound complexes by matrix isolated and jet-cooled laserspectroscopy. DNA-anticancer drug interaction studied by atomic force microscopy.

(d) Computational biology of micro-RNA biochemical pathways in stem cells and cancer stem cells. Quantum approaches from first principles applied to nonlinear dynamics. Quantum chemical theory for nano-materials, DNA dodecamer, hydrogen storage, organometallic catalysis and industrial chemistry.

(e) Ballistic transport of Dirac fermions in bilayer graphene, Braneworld models of cosmology, light gravitinos and dynamical breaking of R-parity in Large Hadron collider, phase diagram of ultracold atoms.

3. Important Highlights of 5 Major Programmes:

(a) Synthesis of complex natural products, novel reagents,green chemistry, metallo-enzymes,chemicals for cleaning environment

(b) Nano-sensor, nano-particle based light sources and solar energy devices, organic electronics, carbon nanotube based drug deliver, Crystal engineering and supra-molecular chemistry

(c) Application of single molecule spectroscopy in conformational dynamics of protein and heterogeneity of diffusion, DNA-drug interaction using atomic force, bio-mineralization.

(d) Computational biology and stem cell, quantum Brownian motion and spatio-temporal instability in reaction-diffusion.

(e) Large Hadron Collider related physics (gravitinos, breaking of R-parity), Theory of transport and deformation of graphenes,

4. Major and Unique National Facilities created:

(a) Centre for ultrafast Laser Spectroscopy and Microscopy (IRHPA)

(b) Ultra High Resolution Electron Microscope (FEGTEM- 200KeV)

(c) Laser Raman Spectrometer with microscope

5. Important collaborations (national and global) established:

(a) National - 02

(b) Global - 07

C. Important Output Indicators for 2011-12

S.No.	Parameters	Output
1.	Papers in refereed journals	440
2.	Papers in Conferences	101
3.	Number of Ph.Ds. produced	42
4.	Foreign Patents filed	01
5.	Foreign Patents granted	01
6.	Indian Patents filed	03
7.	Indian Patents granted	01
8.	Research Manpower trained (other than Ph.Ds)	56
9.	B.Tech/ UG projects guided, summer fellows	15
10.	M.Tech/M.Sc./M.Phil projects guided (Integrated Ph.D.)	13
11.	Citations	9000
12.	Average Impact factor per paper	3.4
13.	h-index of institute	84

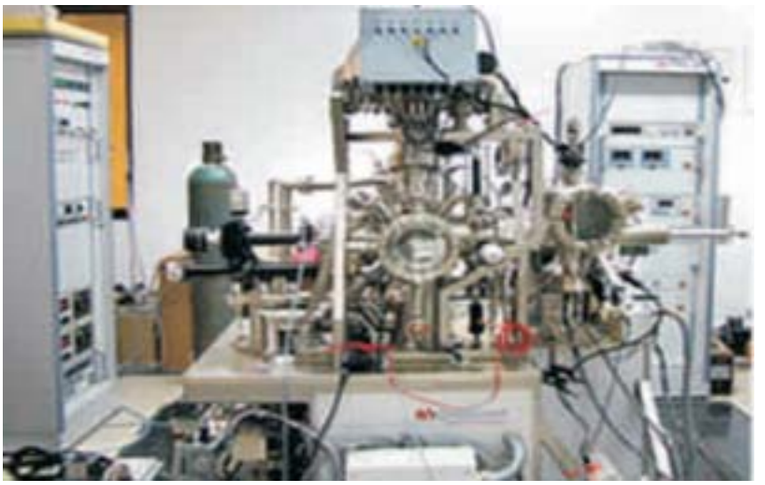


Fig. 10.6

INDIAN INSTITUTE OF ASTROPHYSICS (IIA), BANGALORE

A. Organization Particulars

1.	Name of the Institute	: Indian Institute of Astrophyiscs
2.	Established in the year	: 1971
3.	Number of scientists/faculty	: 64
4.	Total number of regular employees	: 310

B. Report on Activities during 2011-12

1. Areas of Focus : Solar Physics, Stars and Stellar Systems, Cosmology, Astronomical Instrumentation

2. Major Accomplishments :

(a) The engineering model of UltraViolet Imaging Telescope (UVIT) was successfully tested, which means the design of the instrument meets the requirements. The flight model of the payload will be fully assembled and tested after which the payload will be delivered to ISRO for integration with the spacecraft and further testing. (b) Detailed Project Report of National Large Solar Telescope (NLST) was prepared together with a Detailed Site Characterization Report. (c) Towards technology demonstration of Giant Segmented Mirror Telescope (GSMT), design of prototypes of some components was completed and industries identified for fabrication.

3. Important Highlights of 5 Major Programmes:

a) **Solar Physics:** Investigations continued in different areas dealing with the solar interior, surface layers, chromosphere and coronal regions. Data from space platforms (SDO, Hinode, SOHO, PROBA2), solar eclipse expeditions of IIA, and observations facilities of the Institute at Gauribidanur and Kodaikanal were analyzed. Theoretical modeling of various processes was carried out.

b) **Stellar Physics:** Observational as well as theoretical studies were conducted on formation, evolution and final stages of stars. An important accomplishment was the discovery of a significant number of Lithium rich stars through a careful survey of a large sample. Isotopic ratio of carbon in these stars is being studied to gain insight into the mechanism of lithium production. Several supernovae were studied in detail, revealing diversities in the phenomena at the final stage in the life of a star, which could be due to the initial conditions, presupernova evolution, or aspheric explosion. The diversity in Type Ia supernovae is of additional importance to calibration of supernovae as cosmological distance indicators, and a typical member of one subclass was monitored for the first time in great detail, providing information useful for such calibrations.

c) **Stellar Systems:** Studies of stellar systems included star clusters in our Galaxy, evolution of our Galactic star system through identification and study of a large number of very old stars, satellites of our Galaxy, nearby galaxies, and active galaxies up to a large distance. One Ph.D. thesis presented detailed information on the structure of the Magellanic Clouds and the history of star formation in these satellites of our Galaxy. Another thesis studied star formation in Blue Compact Dwarf Galaxies and showed that they are not undergoing star formation for the first time as generally believed. Apart from theoretically modeling the processes around active galactic nuclei, observations led to discovery of intermediate mass black holes in a few low surface brightness galaxies which is not expected from the current models of growth of these black holes.

d) **Space Instrumentation:** The UVIT telescope will be handed over to ISRO by the end of the year following integration and tests at the MGK Menon Laboratory for Space Sciences, IIA. Preparations for operation and utilization of the telescope following its deployment in space aboard ASTROSAT are proceeding. Aditya-1 project has been initiated. A small balloon experiment has been initiated this year in order to gain experience in testing small payloads in suborbital space.

e) **Ground-based Facilities:** Detailed Project Report on NLST was completed. Work on the development of a high resolution fiber-fed spectrograph for the 2-m HCT progressed well with the detailed design completed. The site survey activities in Ladakh were intensified with day time conditions being monitored for NLST project apart from the nigh-time conditions at Hanle. Necessary instrumentation and analysis techniques were developed. The detailed site characterization report proved that Merak by Pangong Tso provides world class conditions for solar observations, Hanle being a close alternative site. Technology demonstration activities related to participation in the international Thirty Meter Telescope project were initiated during the current year, and Indian industries were identified for developing prototypes of components planned to be provided as in-kind contributions from India. This exercise will facilitate development of National Large Optical Telescope (NLOT) indigenously.

4. **Major and Unique National Facilities created :** Steps were taken towards several major national facilities. UVIT is nearing completion, Aditya-1 project is initiated, NLST DPR is submitted, technology demonstration for GSMT and NLOT projects is proceeding. Upgradation of facilities at different observatories is continuing.

5. **Important collaborations (national and global) established:** IIA is collaborating with all major institutions in the country both in science and development area. The NLST project is led by IIA as a national project while the GSMT participation is undertaken with joint responsibilities. IIA is providing expert advice to the ARIES 3.6 m DOT project, and collaborating with TIFR, BARC and SINP on very high energy gamma-ray astronomy at Hanle, through which HAGAR telescope array is already functioning, and some civil works of MACE project have been completed. IIA is also collaborating with TIFR on near-infrared instrumentation for current and planned facilities: a state of the art instrument, TIRSPEC will be commissioned at HCT early next year. HCT continues to be in great demand nationally and internationally, Ongoing global collaborations between scientists include several countries: Japan, Taiwan, Korea, Russia, and several counties in Europe and the Americas.

C. Important Output Indicators for 2011-12

S.No.	Parameters	Output
1.	Papers in refereed journals	148
2.	Books	-
3.	Chapters in Books	2
4.	Papers in Conferences	46
5.	Number of Ph.Ds. produced	4
6.	Number of Ph.D. students	33
7.	Indian Patents filed	-
	Indian Patents granted	-
8.	Research Manpower trained (other than Ph.Ds)	6
9.	Technical Manpower trained	26
10.	B.Tech/ UG projects guided	32
11.	M.Tech/M.Sc./M.Phil projects guided	10
12.	Public Outreach (talks, articles, workshops, science day, open house etc)	several

INDIAN INSTITUTE OF GEOMAGNETISM (IIG), NAVI MUMBAI

A. Organization Particulars

1. Name of the Institute : Indian Institute of Geomagnetism (IIG)
2. Established in the year : 1971
3. Number of scientists/faculty : 38
4. Total number of regular employees : 203

B. Report on Activities during 2011-12

1. Areas of Focus : Geomagnetism and Allied Fields

2. Major Accomplishments :

IIG has the mandate to carry out basic and applied research in Geomagnetism and allied fields. IIG has established various facilities to measure the geomagnetic field, atmospheric and ionospheric parameters, etc at its two regional centres at Equatorial Geophysical Lab (EGRL) at Tirunelveli, Dr. KS Krishnan Geomagnetic Research Lab (KSKGRL) at Allahabad, its eleven magnetic observatories located in different parts of India and at the Indian Antarctic stations in Maitri and Bharati. The Institute organized a workshop on "**Growth of Geomagnetism: Challenges and Opportunities in the Next Two Decades**" at IIG on 12-13th December 2011.

During 2011-2012: Near real time transmission of digital data, from six observatories, has commenced; this is an important step for now casting of space weather. A new experiment setup to probe Transient Luminous Events (TLE's) like Sprites, Jets, Gigantic jets, etc. above powerful thunderstorms has been started to understand TLE's and lightning electrical discharges and its effect on near Earth space environment and to see if Earthquake precursor signatures are seen in VLF signals.

Upper atmospheric investigations at EGRL were carried out with the optical and radio remote sensing experiments along with a variety of satellite data sets. From the coordinated observations of equatorial plasma bubbles (EPBs) made with the all-sky airglow imager, photometer, VHF radar and ionosondes it appears that the coexistence of both large-scale wave-like structure and **S**udden **S**tratospheric Warming events has the potential to trigger EPBs.

The magnetic susceptibility map of Mumbai city discriminated polluted and non polluted areas at large scale from road dust sample analysis. Based on the Palaeomagnetic and rock magnetic investigations on oriented samples of dolerite dikes of Haludpukar and Onlajorito regions, Singhbhum Craton, dykes ages were assigned as 2200 Ma and magnetite was identified as the major magnetic mineral in the studied samples. 2 D inversion of resistivity profiles data from Sindhudurg district of coastal Maharashtra demarcate two potential groundwater reservoirs.

3. Important Highlights of 5 Major Programmes:

Institute participates regularly in the Indian Scientific Expeditions to Antarctica and conducts multi-technique experiments to monitor geo-space environment. Various sensors are installed at

Indian Antarctica Base, Maitri, to study geomagnetic field in sub-auroral region and GEC. Fluxgate magnetometer is operated at the Indian new base, Bharati, in austral summer to study geomagnetic field variations observed poleward of the auroral oval. The Institute participated in the First Indian Scientific Expedition to the South Pole. Using magnetic data from Bharati in conjunction with those at the near conjugate station Hornsund, in approximately the same meridian, clearly brings out the interhemispheric asymmetry so far as the strength of the substorm is concerned. Since the substorms were triggered poleward of auroral region, the standard AE indices did not monitor such substorm activities.

At EGRL, there has been an important technological breakthrough; a nonmagnetic EMI/EMC shelter serving as a Faraday cage at very low frequencies (<50 kHz) that is equipped with ac calibration coil system for the routine testing and calibration of induction coil/search coil sensors and for studying the frequency response of magnetometers has been deployed. A state-of-the-art calibration system for induction magnetometers, a major experimental facility and a major asset for future space missions, is a valuable addition to the infrastructure being built up for development of space-borne instrumentation at the institute. Engineering models of the electric and magnetic field probes chosen for the SENSE mission have already been tested in the lab and their frequency responses studied.

Theoretical studies using the Sagdeev pseudo potential method, arbitrary amplitude electron acoustic solitons have been studied in an unmagnetized plasma having cold electrons and ions, superthermal hot electrons having kappa distribution and an electron beam. The results show that inclusion of an electron beam alters the Mach number for which electron-acoustic solitons can exist and also changes their width and electric field amplitude. For the auroral region parameters, the electric field amplitude and width of the solitons are found to be comparable to the observed value.

High resolution aeromagnetic data was utilized to derive the basement configuration over the Kutch rift basin covered by Runn of Kutch (salt flats), Banni plains (grassland) and sediments. The analysis was able to bring out signatures of several hitherto unknown subsurface sedimentary basins, dykes, faults and intrusives.

In NE Himalaya, from GPS studies, three distinct regions with high compressive strain rate distribution are delineated along thrust zones. Two of these correspond to the transpressive zones, where Tista lineament and Kopili fault transversely converge at MCT and transgresses into the MBT/MCT in Sikkim and Bhutan Himalaya.

4. **Major and Unique National Facilities created :**Petromagnetic Laboratory started at KSKGRL, Allahabad and Environmental magnetic lab augmented at head quarters.

5. **Important collaborations (national and global) established**: National Atmospheric Research Lab, Gadanki, Center of Exploration Geophysics, Osmania University, Geology Department, Allahabad University, BHU, Varnasi, GFZ, Tuebingen University, Germany and National Space Institute, Technical University of Denmark.

C. Important Output Indicators for 2011-12

S. No.	Parameters	Output
1.	Papers in refereed journals	54
2.	Books	1
3.	Chapters in Books	1
4.	Papers in Conferences	63
5.	Number of Ph.Ds. produced	3
6.	Research Manpower trained (other than Ph.Ds)	14
7.	Technical Manpower trained	3
8.	B.Tech/ UG projects guided	3
9.	M.Tech/M.Sc./M.Phil projects guided	54
10.	Other Products/ Indicators (to be specified by adding rows to this Table)	
	a. Workshops organized	2
	b. Survey conducted for other organizations	1
	c. Externally funded Project sanctioned	1

INSTITUTE OF ADVANCED STUDY IN SCIENCE & TECHNOLOGY (IASST), GUWAHATI.

A. Organization Particulars

1. **Name of the Institute** : Institute of Advanced Study in Science & Technology (IASST)
2. **Established in the year** : 1979; Taken Over By DST (GOI) in 2009.
3. **Number of scientists/faculty** : 18
4. **Total number of regular employees** : 67

B. Report on Activities during 2011-12

1. **Areas of Focus:**

Nonlinear Phenomena of Plasmas, Waves and Instabilities in Dusty Plasma, Plasma Processing, Polymer Liquid Crystal, Synthesis of Nanomaterials, Plasma Polymerization, Stochastic Process, Distribution Theory, Fuzzy Mathematics, Summability Theory, Image Processing, Exploration of Biodiversity in N.E. region, Ecobiological Study of flora and fauna, Abatement of Hydrocarbon pollution in oil contaminated soil, Medicinal plant, Seri-biotechnology.

2. **Major Accomplishments:**

a. Investigation of collective processes in laboratory dusty plasma and Nonlinear Phenomena in Multicomponent Plasma.

b. Development of RF Plasma polymerization process for deposition of hard transparent and corrosion resistant coating on Bell metal and surface modification of Muga silk fibres and possible applications.

c. Nanostructured alumina deposition at low temperature on bell metal by RF magnetron sputterings.

d. Studies on the discharge characteristics of pulsed plasma system for synthesis of conducting polymer films and development of nanocomposite organic-inorganic based materials.

e. Development of Liquid Crystalline Polymers.

f. Surface self-assembly and constructive nanolithography enroute to polyaniline based nano devices.

g. A new notion of generalized difference for sequence spaces have been introduced and applied for the investigation of different classes of sequences.

h. Fuzzy C-means for image processing of PAP Smear image of cervical cancer.

i. Different types of Bernoulli vacation models have been studied for different situations.

j. Phyto assisted bioremediation of oil contaminated soil for abatement of hydrocarbon pollution in soil.

Significant reduction of hydrocarbon (TPH) has been achieved in experimental and field conditions.

- Aquatic biodiversity recorded and reported in high altitude watershade of Arunachal Pradesh.
- Exploration and study of faunal biodiversity in Assam.
- A skin ointment developed from medicinal plants against fungal infection and a base material for ointments from plants has been filed for patent.
- Hypolipidaemic / antioxidant activities of some medicinal plants of this area have been established.

3. Important Highlights of 5 Major Programmes:

a. Investigation of collective processes in laboratory dusty plasma

b. Basic experiments on waves in multicomponent plasma.

c. Production of (i) Low temperature and low density plasma, (ii)Positive ion –negative ion plasma.

d. RF plasma polymerization process for surface modification of bell metal and Muga fibre, Fabrics.

e. Synthesis of Organic-Inorganic Nanocomposite thin films by plasma based technique.

f. Fabrication of Nanopatterns, Monolayer assembly.

g. Contact Electrochemical Replication of Hydrophilic_Hydrophobic Monolayer Patterns.

h. Extensive study of the role of solvent in the dispersion and assembly as nanochains of hydrophilic coated magnetic nanoparticles.

i. Investigation of metal coated polymer nanowire as chemical sensing material.

j. Development and Synthesis of Liquid Crystalline Polymers.

k. Synthesis of Poly vinyl borate-12 complex membrane in nano fine state, Poly 2-Venylpyridine

- Computational Image Processing:Studies on some pattern recognition and machine learning methods related to cancer data and development of algorithm based on Pearsonian system of curves.

4. Major and Unique National Facilities created:

Material Science Division is aiming to create a National Centre for Basic Plasma Research at IASST.

The Mathematical Sciences Division is carrying out investigations on application of functional analysis in summability theory and applied stochastic process. Automation of PAP Smear image of cervix cancer for detection and staging of cancer.

5. Important collaborations (national and global) established:

National: Bhabha Atomic Research Centre, Mumbai; ICSIT Kolkata; ISI Kolkata; IISc, Banglore; Saha Institute for Nuclear Physics, Kolkata; The Energy Resource Institute (TERI), New Delhi; IIT, Kharagpur; Gauhati University, Guwahati; Manipur University, Manipur; National Institute of Nutrition, Hyderabad; J S S University, Mysore; Central Silk Board, Ministry of Textile, Govt. of India; AIIMS, New Delhi.

Global: University of Illinois at Urbana Champaign, USA; Yokohama University, Japan; University of Wuerzburg, Germany; Institute of Space and Astronautical Science, Sagamihara, Japan; University of Ulster, School of Biomedical Sciences, Northern Ireland, UK; Padova University, Italy; Stazione spermente la seta, Milano, Italy; Shanghai Second Medical University,China; Collaborated with the faculties of different Institutions from USA, China, Botswana, Turkey, UAE.

C. Important Output Indicators for 2011-12

S.No.	Parameters	Output
1.	Papers in refereed journals	34
2.	Chapters in Books	2
3.	Papers in Conferences	38
4.	Number of Ph.Ds. produced	4
5.	Indian Patents filed	1
6.	Number of Technologies/Designs and other intellectual products commercialized	1
7.	Research Manpower trained (other than Ph.Ds)	23
8.	Technical Manpower trained	20
9.	B.Tech/ UG projects guided	10
10.	M.Tech/M.Sc./M.Phil projects guided	5

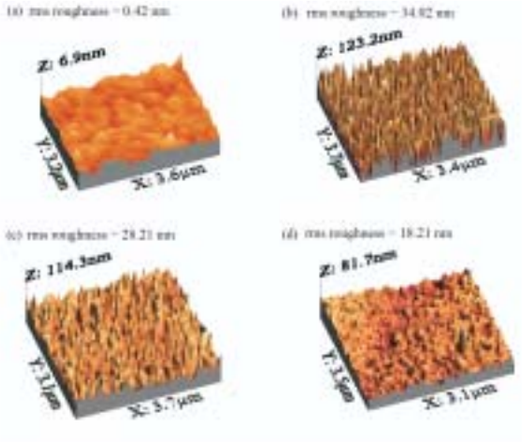


Fig. 10.7: Atomic force micrograph of untreated (a) and Ar plasma treated Muga silk fiber at various RF power (b) 20 W (c) 40 W and (d) 60 W.

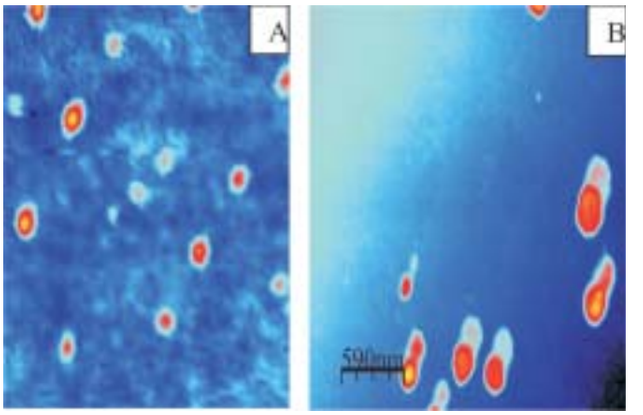


Fig. 10.8: AFM image showing AG nanoparticles bounded to mercaptoundecanoic acid stabilized CdS nanocrystal.

INTERNATIONAL ADVANCED RESEARCH CENTRE FOR POWDER METALLURGY AND NEW MATERIALS (ARCI), HYDERABAD

A. Organization Particulars

1. **Name of the Institute:** International Advanced Research Centre for Powder Metallurgy and New Applications (ARCI)
2. **Established in the year:** April 01, 1997
3. **Number of Scientists:** 69
4. **No. of Regular Employees:** 165

B. Report on Activities during 2011-12

1. Areas of Focus: Nanomaterials, engineered coatings, ceramic processing, laser processing of materials, sol-gel coatings, fuel cell technology, carbon materials, solar energy materials and automotive energy materials

2. Major Accomplishments:

a) Developed a simple, cost effective and scalable process for preparing pure rutile titania nanoparticles of 15nm size;

b) Micro Arc Oxidation (MAO) technology has been successfully adapted to continuous coating with necessary controls. A novel process modification developed to enhance fatigue life by MAO coating, by 10-15 times that of bare substrate;

c) Laser –MIG hybrid weldability studies have been carried out on Reduced Activation Ferritic Martensitic Steels (RAFMS), a recently developed indigenous material for ITER test blanket module applications. Process optimized for welding 12 mm thick plates in single pass

d) Detonation spray coating for improved performance of propeller shaft seals used for special applications

e) Synthesized nanocrystalline inorganic fullerene-like (IF) as well as nanosheets of tungsten disulfide (WS_2) by a novel route

3. Important Highlights of 5 Major Programmes:

a) Iron based cerametallic cookies for heavy duty clutch applications: (NMITLI, CSIR sponsored project): Developed process for making iron based cerametallic cookies on actual component from both blue dust and iron powder using an indigenously designed and fabricated prototype special purpose hot press. Dynamometer testing is in progress.

b) Fuel cell technology: Development of a 30 kW PEM fuel cell using modular approach is in progress.

c) Cathodic arc PVD technology:: Cutting tools have been coated with super hard nanocomposites coatings and 5 axis high speed CNC has been commissioned for performance evaluation.The technique has been tried for multilayer coatings for solar thermal application as well.

d) Solar Energy Materials: A pilot facility to fabricate CIGS PV panels of size 30 x 30 cm is being established.

e) Automotive Energy Materials: A full-fledged pilot facility capable of manufacturing Li-ion batteries of all sizes and capacities relevant to varied applications, ranging from electric bike to heavy duty bus is under establishment. Simultaneously research on new and novel materials for the anode, cathode and electrolyte is taken up. Work initiated on development of next generation of hard and soft magnetic materials for motors for electric/hybrid vehicle.

4. Major and Unique Facilities Created:

Aerogel Synthesis Facility, Pressure Slip Casting Facility, Horizontal high energy ball mill capable of producing 4 kg of nanostructured material, induction plasma facility for synthesizing nanopowders

5. **Important Collaborations (National and Global) established**: New Collaborations with the following organizations have been established in material processing and related areas

National: NAL, BDL, BHEL, CIPET, CSIO, Ceradecor India Ltd, Clutch Auto Ltd, DRDO, HAL, Hoganas India Pvt Ltd, ISRO, IGCAR, L&T, NEI, Redson Engineers Pvt Ltd, Tata Motors, Tata Steel, Thermax, Ultratech Cement, University of Hyderabad

Global: Fraunhofer-Germany, General Motors-USA, Grenoble INP-France, IMI-NRC Council-Canada, PACT-France, SUNY-Stony Brook USA

f) Important Output Indicators during 2011-12

S.No	Parameters	Output
1.	Papers in Refereed Journals (SCI)- Calendar year 2011	**64**
2.	Books	**—**
3.	Chapters in Books	**—**
4.	Papers in Conferences (with or without proceedings)	**32**
5.	Foreign Patents filed	**—**
6.	Foreign Patents granted	**—**
7.	Indian Patents filed	**5**
8.	Indian Patents granted	**—**
9.	No.of technologies transferred / applications developed / products supplied	**8**
10.	Number of Technology leads awaiting transfer	**15**
11.	Research Manpower trained (No. of SRF/ JRFs)	**17**
12.	Technical Manpower trained (Employees/Fellows deputed for training / participation in workshops etc)	**49**
13.	B.Tech/ UG projects guided	**27**
14.	M.Tech. / M.Sc./M. Phil. projects guided	**32**
15.	Invited presentations/lectures in Workshops, Symposia etc	**86**
16.	Number of current Ph..D Scholars (Non-ARCI)	**18**

INDIAN NATIONAL SCIENCE ACADEMY (INSA), NEW DELHI

A. Organization Particulars

1. Name of the Institute: Indian national Science Academy
2. Establishment in the year 1935
3. Number of Scientists/Faculty Nil
4. Total Number of Regular Employee: 67

B. Report on Activities during 2011-12:

1. Areas of Focus: Science Promotion & Recognition of Scientists

2. Major Accomplishments: Election to Fellowship of eminent Indian & Foreign Scientists, Bilateral Relationship with Foreign Science Academies, Summer Research Fellowship for Science Students, Research Projects under History of Science Programme, INSPIRE project of DST, Publications.

C. Important output Indicators for 2011-12

The Academy during the period 2010-2011, nurtured and promoted scientists and scientific institutes to achieve excellence in research through various programmes detailed under:

1. SCIENCE PROMOTION

Supported Research Professorships (5) named after distinguished Indian Scientists, Senior Scientists (59), Honorary Scientists (65), Visiting Fellowships (10). Associated / sponsored (91) scientific meetings i.e. seminars / Symposia / Conference / Workshops within the country under the Science Promotion programme.

YOUNG SCIENTIST RESEARCH PROGRAMME

11 Research projects of Young Scientist Medal awardees (below 35 years of age) were supported.

2. RESEARCH IN HISTORY OF SCIENCE

During the year the Commission recommended 11 new projects and renewed 22 on-going projects covering various topics like history of cannons, metals and metallurgy, mathematics and astronomy, ecology and forestry, art and architecture, etc.

3. INTERNATIONAL COUNCIL OF SCIENCE (ICSU) AND OTHER IMPORTANT SCIENTFIC MEETINGS

As an adhering organization in India and on behalf of the nation, Academy discharged its responsibilities of adherence to ICSU. The Academy facilitated participation of Indian scientists at the following Congresses / General Assemblies held abroad.

- SCOSTEP 12 (Scientific Committee on Solar Terrestrial Physics) in Germany during July 12-16, 2010 – 2 Scientists supported by INSA.
- IUTAQM (International Union of Theoretical & Applied Mechanics) General Assembly in Paris, France during July 16-19, 2010 – 3 members delegation supported by INSA.
- World Pharma 2010 in Denmark during July 17-23, 2010- 2 scientists supported by INSA.
- 38TH COSPAR (committee on Space Research) Scientific Assembly at Bremen, Germany during July 18-25, 2010 – INSA Supported 14 scientists.

- XXXI SCAR (Scientific Committee on Antarctic Research) Open Science Conference at Buenos Aires, Arentina during Jlu 30- August 11, 2010 – INSA supported 5 scientists.

During 2010-2011, the Academy supported about 72 Scientists forsuch ICSU programme and about 395 Scientists for other important scientific meetings under NON-ICSU programme through CICS (earlier CCSTDS).

4. INTER-ACADEMY EXCHANGE PROGRAMME

During the year 2010-2011, 72 Indian scientists were deputed abroad to work and share their experience in academic R&D institutions and hosted 90 overseas scientists to work in Indian Institutions under various bilateral exchange programmes.

5. PUBLICATIONS

INSA brought out following publications during the year :

- IJPAM (*Indian Journal of Pure and Applied Mathematics)* - 6 issues
- Proceedings INSA - 4 issues
- IJHS *(Indian Journal of History of Science)* - 4 issues
- INSA News
- Annual Report in English & Hindi
- Biographical Memoir *(covering 11 memoirs)* – 1 issue
- Year Book
- Fellowship Nomination Books

The back volumes as well as the latest issues of all journals published by the Academy are also made available online at the official website of the Academy.

6. LOCAL CHAPTER / POPULARISATION OF SCIENCE

16 Local Chapters of INSA deliberates on various issues relating to Scientific policy, social impact of science, and planning in science and technology, besides various services i.e. lectures, seminars for the benefit of Scientists and school children.

7. INFORMATICS

The Informatics Centre encompasses (i) Library – the information resource center supporting scholarly information resources and information needs, (ii) Computer facility for facilitating a whole range of IT-related services of the Academy.

Citation analysis based on CD-ROM database of Science Citation Index, Science information notes, current awareness and abstracts are provided free of charge to scientific community and interested groups. Academy receives about 500 scientific and technical journals under exchange arrangements and has collection of about 15,000 books covering History and Philosophy of Science, Science Management and Science Policy.

8. **CENTRE FOR INTERNATIONAL CO-OPERATION IN SCIENCE (CICS), CHENNAI.**

CICS (earlier known as CCSTDS), Chennai's is mandated to spread the spirit of science and technology co-operation among developing societies. The center functions under the auspices of the Indian National Science Academy (INSA) with grant obtained from the Department of Science & Technology, Government of India.

During the period 2010-2011, grant of Rs.50.00 lakhs was released. The activities pursued during the period ranged from providing support to scientists from developing countries to work in research institution in India, partial travel fellowship to Indian Scientists to attend International Conferences abroad, organized series of lectures, etc.

9. SCIENCE & SOCIETY

Under the science & society programme, the Academy endeavours to address issues pertaining to science and techonoloy that are of relevance to the society. Some of the initiatives are :

- Science education programme
- Study group for preparation of evidence-based well-considered documents and topical seminars of social relevance to initiate enthusiasm and positive discussion amongst the scientific community and influence science policy.

INTER ACADEMY PROGRAMME ON SCIENCE EDUCATION

The Indian National Science Academy, in August 2006 established the Science Education Panel to initiate and oversee the Science Education Programmes undertaken by the Academy for School and College students. The panel, jointly in association with Indian Academy of Sciences, Bangalore and the National Academy of Sciences of India, Allahabad sponsored a variety of activities that are aimed at strengthening for Higher Education in Science and encouraging the young students to take science as a career. The activities undertaken are:

- **Summer Research fellowships for students and teachers :**
- During the year 2010, 1550 students and 72 teachers availed the fellowships.
- **2-week All India Refresher Courses for teachers :**
- 18 Refresher courses were held during April 2010 to March 2011.

1. Lecture workshops for students and teachers :

47 workshops were held during the year ended 31st March 2011.

National Science Day Celebration

National Science Day was observed on 28th February 2011 at INSA auditorium. Dr. KrishanLal, President, INSA extended a warm welcome to all the participants of National Science Day and also gave a brief introduction regarding National Science Day. Over three hundred studentsalongwith teachers participated in the celebration. Dr. T.Ramasami, FNA, Secretary, DST delivered a lecture on "Green Chemistry – The Way forward for a Sustainable World'. He discussed the life and achievement of Professor

CV Raman and also narrated inspiring incidents of the lives of the great scientists like Madame Courie, Michael Faraday. He described green chemistry as an essential tool for solving the problems of pollution. The green chemistry aims to replace what is not eco benign. He talked about the disposal problems of the element chromium and described a technology breakthrough by mobilizing selectively 100% of chromium so that it can be disposed in any system. He emphasized that the next generation agro technology should be green agro technology and also motivated the students by narrating different incidents of innovation at an affordable price and in this context mentioned about Indian Jaipur foot which is cheaper than prosthetic foot in USA. He highlighted The INSPIRE programme of DST and encouraged the students to make use of this excellent initiative of the Government of India and advised them to take up science as a career. He finished his talk with the following epilogue.

Fig. 10.9: Secretary DST, Dr T Ramasami addressing the audience in the INSA auditorium

"Nature made the molecules that made the man
Through many experiments, but made him well;
But the man learnt the use of molecules to live better
And made many more and new molecules
Both in quantum and in speed
Spending more energy and atoms than
What Nature had used to make the same
Alas to discover Mother Earth slowly turning less green
Ere it was too late, he turned to chemistry again
But this time with a color that seemed green"

Science Academies' Joint Science Education Panel

Science Education Programme

The Academy, in August 2006 established the Science Education Panel to initiate and oversee the Science Education Programmes undertaken for School and College students. The panel is chaired by Professor SC Lakhotia, FNA and presently includes Professor N Sathyamurthy, FNA, Vice President,

Professor ML Munjal, FNA, Vice President, Professor Alok Bhattacharya, FNA, Vice President, , Professors Alok. K Gupta, FNA, Professor LS Shashidhara, FNA, Professor ChanchalDasgupta, FNA, Professor JP Khurana, FNA and Professor NibirMandal, FNA. The panel, jointly, in association with Indian Academy of Sciences, Bangalore and the National Academy of Sciences of India, (Allahabad), sponsored a variety of activities that are aimed at strengthening of Higher Education in Science and encouraging the young students to take science as a career.

1) Summer Research fellowships for students and teachers: Under this programme, specific proposals are invited from students and teachers for the work they propose to undertake during the two month long Fellowship. The announcement for the Summer Research Fellowship Programme 2011 appeared in the websites of all the three academies in October 2010. Over 18000 posters were mailed to colleges, universities and other institutions all over the country. The last date for submission of applications was 31 December 2010. A total of 14478 applications were received. Subjectwise break-up on the number of applications received is listed below.

Summer Research Fellowships 2011 Consolidated List		
	Students	Teachers
Agricultural Science	181	9
Life Sciences	4136	225
Chemistry	1701	152
Earth and Planet Sci.	687	13
Engineering Incl. Computer Sci.	5150	151
Mathematics	443	38
Physics	1436	126
Total	13734	744
Grand Total	14478	

Six specially constituted Selection Committees drawn from the Fellowships of all the three academies met in January 2011 over 3 days in Bangalore to select candidates for the programme. Although over 1900 candidates were shortlisted by the selection committees, fellowships could be offered only to about 1550 candidates, due to inadequate number of guides particularly in engineering sciences.

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH (JNCASR), BANGALORE

A. Organization Particulars :

The Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bangalore, is a premier research institute in the country, established in the year 1989 in the birth centenary year of Pandit Jawaharlal Nehru, by the Department of Science and Technology (DST) with the objectives to pursue and promote scientific research and training at the highest level in the frontier and interdisciplinary areas of science and engineering. The Centre is a deemed to be university. Prof C N R Rao was the founder of the Centre. Prof V Krishnan succeeded him. Prof M R S Rao is presently the President. There are **43** Faculty members and **73** non-teaching staff at the Centre.

B. Report on Activities:

The focus of research in each of the Units is: **The Chemistry and Physics of Materials Unit** is involved in the interdisciplinary area of materials science research, with the primary goal to design and understand the structure, properties and phenomena associated with advanced inorganic, organic and hybrid materials. During the year 2010-11, researchers in the field of molecular dynamics have developed the low frequency dynamics of room temperature ionic liquids which has been characterized by using atomistic and b initio molecular dynamics simulations, as well as using large scale, normal mode analyses.

As *new initiatives*, researchers have undertaken computational work on various aspects of carbonic acid in both its gas and crystalline phases. With the development of Micro Brillouin spectroscopy setup, a first of its kind in India, the ability to get Brillouin spectra from a few micron samples has been demonstrated which is used to study the Nanotubes in device geometry to understand electron phonon coupling and its involvement in conduction in these systems.

New Chemistry Unit works on the interdisciplinary aspects of chemical science that are actively pursued at the interface of chemical biology, chemical science and materials science. The specific areas of research are organic-inorganic hybrid materials, stimuli responsive/supramolecular polymers, chiral nanotechnology, organic synthesis, biomaterials, organic and supramolecular chemistry, antimicrobial agents, drug delivery systems, patternable polymers, conducting polymers, theoretical chemistry, carbon and oxide based materials and catalysis.

Evolutionary and Organismal Biology Unit mostly does empirical research, both in the laboratory and in the field, using a combination of experimental tools from evolutionary quantitative genetics, molecular genetics, neurobiology, developmental biology, animal behaviour, and population biology. The research, which is largely unique in the Indian context, has contributed significantly to understanding of diverse aspects of evolution, ecology and behavior.

Geodynamics Unit (GDU) : Identification of belts where sudden and swiftly occurring geological pheno-mena often destabilize the natural configuration of life and threaten the balance of ecosystems, is the principal objective and the main thrust of activities.

Research in **Molecular Biology and Genetics Unit** spans diverse areas of biology with emphasis on biomedicine. The current areas of research are: infectious diseases; cancer genomics; chromatin organization and transcription regulation; stem cells and cardiovascular development; molecular basis of human genetic disorders and mechanism of chromosome segregation. The year has recorded a significant progress in several areas with discoveries like research was carried out in the area of

deafness-causing genes, by identification of a locus, DFNA59 for prelingual, profound, sensorineural hearing loss at chromosome 11p14.2-q12.3.

At **Theoretical Sciences Unit**, the understanding of the diversity of the physical world is used to predict new phenomena, design new materials and gain fresh insights in interdisciplinary areas. For this, the techniques of theoretical physics and chemistry are used. The density functional theory has been used to study and design novel materials, with a special focus on surfaces and nanomaterials.

Engineering Mechanics Unit pursues research on a variety of topics where fluid mechanics and heat transfer play a critical role in providing insight into various phenomena. Research in the area of aeronautical fluid dynamics has continued on novel wing plan forms for turboprop aircraft for which an international patent has been filed and the designs have been registered. Researchers have also studied in the area of instability of vortical flows and proved that a light-cored vortex can be unstable and a heavy cored vortex can be stable for certain density gradients.

International Centre for Materials Science has ongoing research programmes on Solid-State Lighting, Surface Physics, Polymers, High-Resolution Electron Microscopy, Soft Condensed Matter and Chemistry of Materials. This facility houses specialized instrumentation maintained and run by experts. ICMS is in the process of expanding its facility by installing additional equipment like SQUID Magnetometer, Thermal Gravimetric Analysis (TGA) system and Inductively Coupled Plasma (ICP) system. A research programme on "***Hydrogen Energy and Artificial Photo-synthesis***" has been also initiated. ICMS has launched a new annual international lecture series i.e., "***Sheik Saqr Materials Lecture***".

In **Centre for Computational Materials Science** research is carried out in the broad area of computational materials science, using a variety of analytical and computational tools.

Major Accomplishments: This has been an year of significant scientific discoveries made by the faculty and students; to name a few, *Prof. C.N.R. Rao's group* along with the group of researchers led by *Prof. Umesh V. Waghmare* have found a new way to go around the tough challenge that scientists and industries face while trying to store hydrogen in a solid matrix. The group has devised a unique storage medium — extremely thin graphite flakes called *Few-Layer Graphene* — which can capture the gas and release it upon heating or ultra-violet irradiation.

Prof. G.U. Kulkarni and B. Radha (Ph.D. student) have developed a simple, inexpensive direct micromolding method for patterning Au nanocrystal superlattices using an elastomeric stamp hosting microchannels.

Dr. Subi J. George (NCU) and Dr. M. Eswaramoorthy's group (CPMU) have designed highly fluorescent novel hybrid hydrogels by mixing clay materials with fluorescent dye molecules.

US Patent is granted to *Prof. Tapas Kumar Kundu, Selvi BR, Kishore AH, Mantelingu K* for their invention related to ellagic acid (TBBD) and its derivatives as site-specific inhibitor of histone methyltransferase, especially CARM1 arginine methyltransferase. The Indian Patent Office has granted Patent (No. 245033) to JNCASR and the University of Mysore, for the invention "Derivatives of 4,6-Disubstituted 1,2,4-Triazolo-1,3,4-Thiadiazole, A Process and Uses Thereof", inventors being *Prof. Tapas Kumar Kundu, Dr. Varier R.A., Mr. Shivananju N., Dr. Basappa, Prof. Rangappa K.S.* The invention reports anti squamous cancer (cervical and oral) specific compounds having tremendous potential to be used as lead molecules.

A deafness-causing gene locus, DFNA59 for prelingual, profound, sensorineural hearing loss at chromosome 11p14.2-q12.3 was identified.

In CCMS, a large program written in Fortran90 to carry out normal mode analyses of a bulk condensed system was developed successfully.

Important collaborations established: A Coordination Agreement has been signed for a collaborative project under the Seventh Framework programme of the European Community for the project "Modeling of Nano- scaled Advanced Materials Intelligently (NONAMI). A Memorandum of Understanding (MoU) between Bhabha Atomic Research Centre (BARC) and JNCASR has been signed for the project on Development of Test Facility for different studies. The Centre has also signed MoUs for collaborative research with Raja Ramanna Centre for Advanced Technology (RRCAT); GE India Technology Centre; Shell (I) Ltd; Intel Technology India Pvt. Ltd; Sasya Gentech Pvt. Ltd; CSTEP; iCeMS (Japan).

C. Important Output Indicators:

Publications : 293 papers were published in around 135 peer-reviewed high-ranked journals. Average impact factor was **3.97**. 14 Books and book chapters were also credited by the faculty members along with 4 international conference papers.

Academic & Fellowship activities : There is a steady increase in the number of research students pursuing various academic programmes. During the year, 72 students (51 students for M S / Ph D and 19 students for Integrated Ph D) and 2 for Post Graduate Diploma in Materials Science were admitted. Now the total strength is 217. 18 students were awarded PhD, 4 students with M S (Engineering) and 9 with M S (Int. Ph D) degrees.

For the Summer Research Fellowships programme, 82 fellowships have been utilized in 2010. 87 fresh fellowships were awarded in 2011. For POCE, 10 meritorious students were offered the fellowship. Under POBE, 10 candidates were offered fresh fellowship. The POCE and POBE students who have completed their 3-year projects successfully were given Diploma (Chemistry and Biology respectively).Ten candidates from R&D institutions have been offered Visiting Fellowships for 2010-11. Seven candidates from R&D institutions were offered Visiting Fellowships for 2009-2010. Eight candidates joined DST Postdoctoral Fellowships in Nanoscience and Technology – 3rd series.

Intellectual Property : Five patents were obtained during the current year of the total 87 applications filed (India-29, PCT-18, USA-22, EPO-9, Japan-3, South Africa-2, Australia-1, Brazil-1, Vietnam-1, China-1). Most of the applications are under prosecution/examination. Twenty one patent applications for 14 inventions were approved. Of these, 5 Indian Applications, 12 National Phase Applications (USA-7, Europe-3, Japan-2), and 4 International Patent Applications under PCT have been filed.

The Centre has so far licensed 7 inventions including 4 inventions during this year. A few of the inventions are at various stages of commercialization.

Prof C N R Rao has been offered the KFUPM Chair Professorship by the King Fahd University of Petroleum & Minerals, Saudi Arabia, awarded with Dhirubhai Ambani Life Time Achievement Award 2010 by Institute of Chemical Technology, Mumbai and EDGE Award for leadership in education for the year 2011. Prof P Rama Rao, the Chairman of the Council of Management has been awarded *Padma Vibhushan* by the Government of India. Prof R Narasimha has received the prestigious

Kamal Kumari National Award for Science and Technology, 2009. Prof. Swapan K. Pati and Prof. Umesh Waghmare have been awarded Shanti Swarup Bhatnagar Prize for the year 2010. Dr. A. Sundaresan has been awarded the prestigious CRSI bronze medal for the year 2011. Prof Amitabh Joshi has been awarded with Lakshmipat Singhania National Leadership Awards – Young Leader in Science and Technology for the year 2010. Prof G U Kulkarni has been honoured with MRSI-ICSC Superconductivity and Materials Science Annual Prize, 2011. Prof N Chandrabhas has been felicitated with the prestigious Sir C.V. Raman Young Scientist Award of the Karnataka State. Dr M Eswaramoorthy has received MRSI Medal in Materials Science and Dr Tapas Kumar Maji has been chosen Young Investigator in the field of Chemical Sciences by the Journal Chemical Communications, 2011, published by Royal Society of Chemistry. Other prestigious awards which were bagged by our faculty members are Dr T Govindaraju with Innovative Young Biotechnologist Award (IYBA) 2010; Dr Meheboob Alam with DAE-SRC Outstanding Research Investigator Award in 2010 and Dr Ganesh Subramanian with INAE Young Engineer Award, 2010. In addition, many faculty members have been elected for the fellowships like Indian Academy of Science Fellowship, Indian National Science Academy Fellowship, Ramanujan Fellowship, etc.

The Science Outreach Program has become an important academic component of the Centre. The C N R Hall of Science and Education Technology Unit conducted various programmes for children in their endeavour to popularize science among the young students. Prof C N R Rao delivered lectures at various places in the country followed by multimedia presentations on Learning Science. Education Technology Unit has been actively involved in the concept, development and production of multimedia CDROMs and books especially for school students and teachers in various disciplines of science. The Six CDROM titles in Kannada developed in the ETU are: Rasayanshastrada Arivu (Chemistry), Bhugola Parichaya (Geography), 'Vignyana Kaliyona' samputa 1, 2, 3 & 4 (Learning Science series). ETU has undertaken a project for translating the book 'Understanding Chemistry' in Kannada. The Unit has also taken up the project of assembling 200 College chemistry Kits for training teachers in its use and distribution to Colleges from all over Karnataka. Teachers/students workshops/programs in different subjects like Physics, Chemistry, Biology, Nanoscience were organized during June-December 2011.

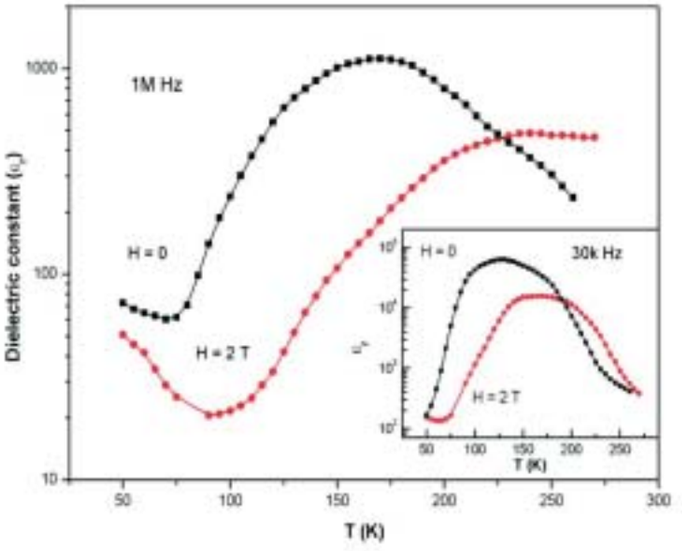


Fig. 10.10: Magneto-electric effect in charge-ordered multiferroic $Pr_{0.6}Ca_{0.4}MnO_3$

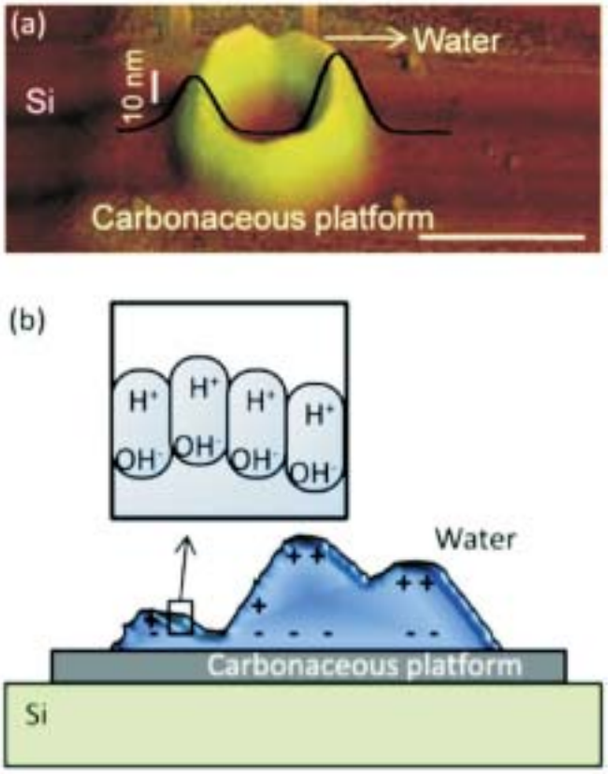


Fig. 10.11: Electrocondensation and evaporation of attoliter water droplets: Direct visualization using AFM
(a) The topography image and corresponding height profile of a water pattern showing unusually sharp morphology (Scale bar, 2 ¼m).(b) AFM tip-induced charge and polarization contribute to the anomalous droplet shapes and the evaporation characteristics observed (N Kurra, A Scott, GU Kulkarni, Nano Research, 2010)

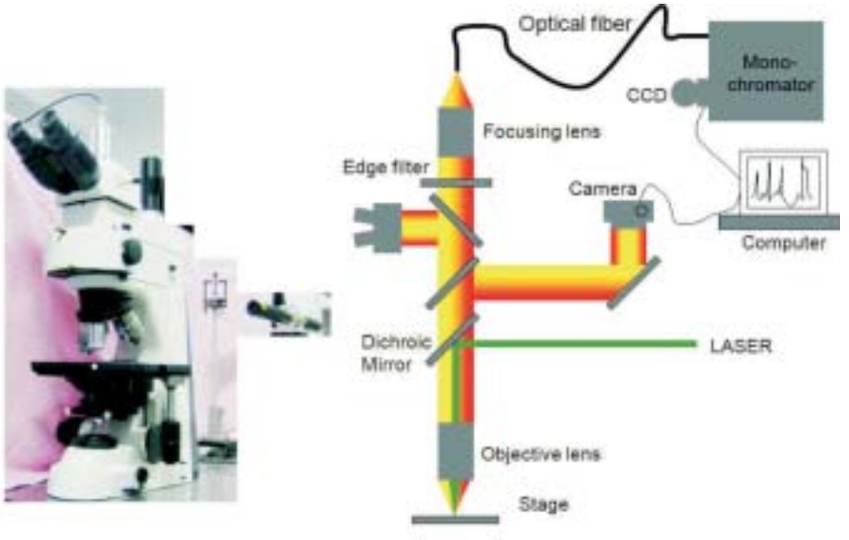


Fig. 10.2: Micro-Raman setup for SERS experiments [Indian Patent Application No. 00787/CHE/2008]. Custom Built Micro-Raman Spectrometer developed in Light Scattering Laboratory. The specification of this spectrometer in terms of resolution, throughout and sensitivity matches with the high end Raman Spectrometers such as LabRam HR800, with the added advantage of being portable, flexible and economical.

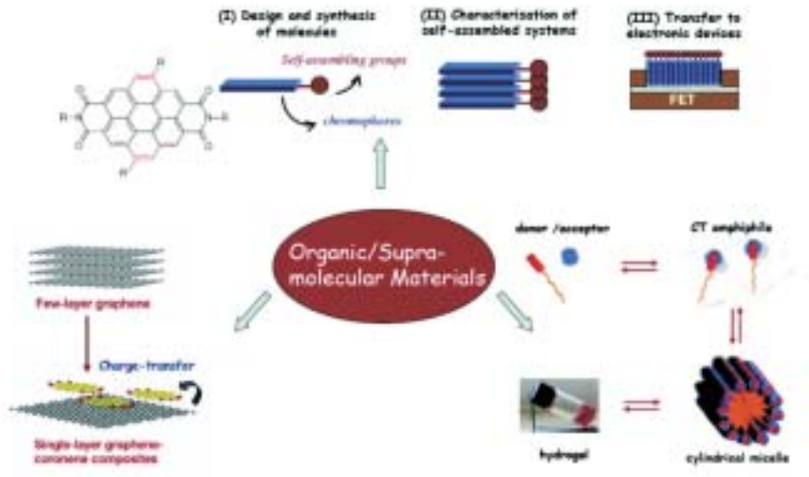


Fig. 10.13: Nuggets of Research at Supramolecular Chemistry Lab

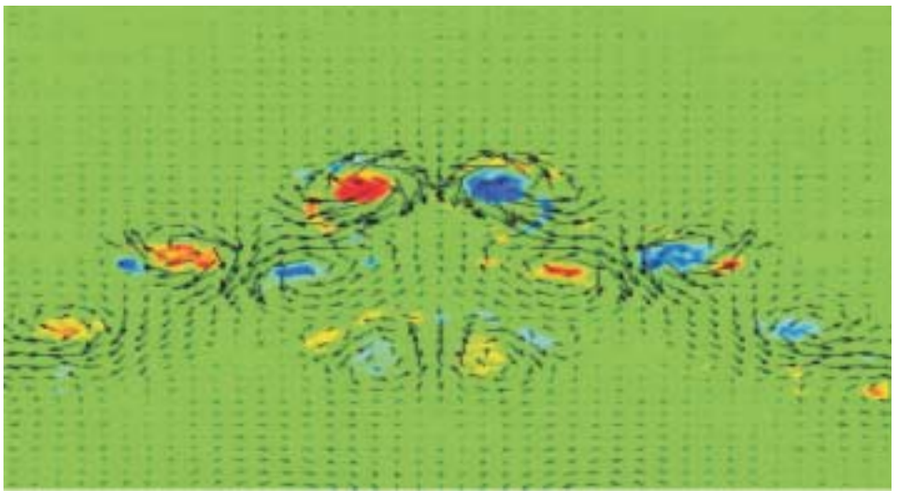


Fig. 10.14: Flow-field in flapping flight

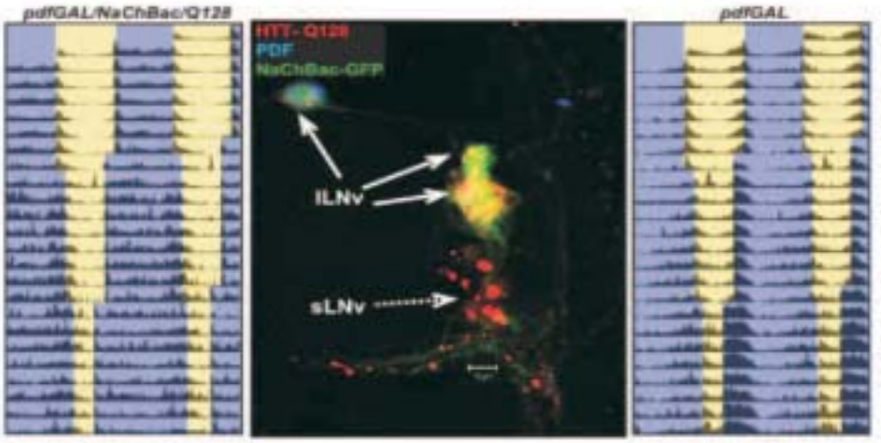


Fig. 10.15: Expression of pathogenic human HUNTINGTIN (HTT) protein and voltage gated ion channel NaChBac (GFP-tagged) in circadian clock neurons of *Drosophila melanogaster*.

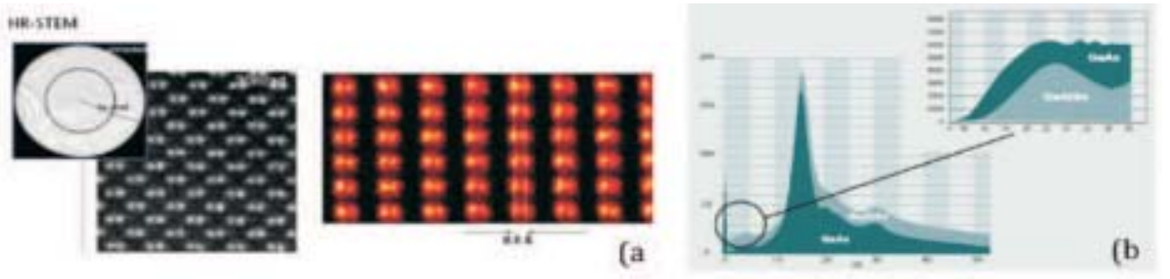


Fig. 10.16: (a) Cs corrected HAADF-STEM image on Si <110> (left) and Ge <112>(right), (b) after subtraction of the zero-loss peak, band gap thresholds can be measured as well as the energy shift due to the AI doping in AlGaAs (courtesy to FEI).

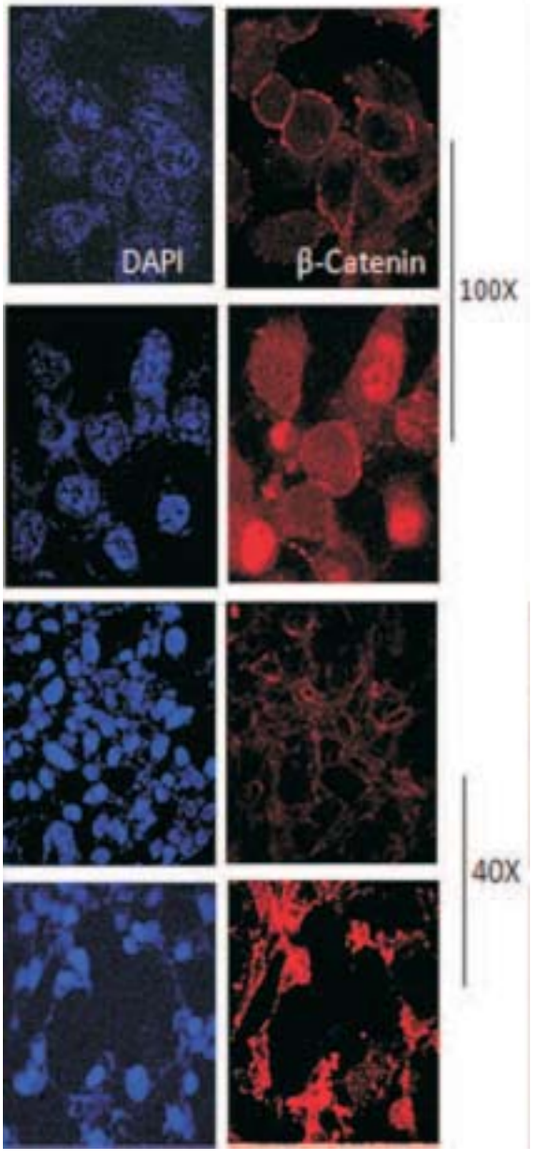


Fig. 10.17: Localization of B-Catenin in mrhl down regulated cells

RAMAN RESEARCH INSTITUTE (RRI), BANGALORE

A. Organization Particulars

1.	Name of the Institute	: RAMAN RESEARCH INSTITUTE
2.	Established in the year	: 1948
3.	Number of scientists/faculty	: 51
4.	Total number of regular employees	: 205

B. Report on Activities during 2011-12

1. Areas of Focus : Astronomy and Astrophysics, Light and Matter Physics, Soft Condensed Matter and Theoretical Physics

2. Major Accomplishments :

The ongoing research programmes of the Astronomy and Astrophysics, Soft Condensed Matter, Light and Matter Physics and Theoretical Physics groups were continued with members formulating and solving problems on their own and in collaborations with PhD and other visiting students.

Major experimental developmental activities continued: they included (a) fabrication and installation of 50 MHz receivers on GMRT antennas, (c) carrying out observations using wideband receivers, built by RRI, and installed on the US Green Bank Telescope and interpretation of data obtained, (d) analysing pulsar data collected from the E-W wing of the Decameter Wave Radio Telescope at Gauribidanur, (d) the Murchison Wide-field Array (MWA) (e) designing and constructing new broadband receivers for the Ooty Radio Telescope, (f) development of low-cost robust 15m parabolic dish antennas, (g) hardware design and development for a 3m sub-mm wavelength radio telescope, (h) development of an X-ray polarimeter in collaboration with the Indian Space Research Organisation (ISRO) and (i) participation in the Large Area X-ray proportional counter (LAXPC) for the ASTROSAT – a satellite mission of ISRO for multi-wavelength astronomy.

3. Important Highlights of 5 Major Programmes:

The Institute's participation in the Murchison Wide-Field Array (MWA), which is an international project between the US, Australia, New Zealand India.

The Institute's participation in the design, development, construction of SKA-Low systems; field-testing and commissioning – towards an aperture array of antennas on the ground. This is again an international project in partnership with UK, Netherlands, France, Italy & Australia forming an SKA-Low consortium.

The Institute's project on X-ray polarimeter in collaboration and cooperation with the Indian Space Research Organization.

Creation of experimental infrastructure for exploitation of research potential by the Soft Condensed Matter. This included acquisition of High Resolution Micro Raman Spectrometer, NMR Spectrometer, Field Emission Scanning Electron Microscope and other equipment.

Setting up of five quantum optics laboratories, which are on the verge of completion and doing productive experiments

4. **Major and Unique National Facilities created** : Not applicable

5. **Important collaborations (national and global) established**:

a) Murchison Wide-field Array: Collaboration between US consortium, Australian consortium and Raman Research Institute to build a low-frequency radio telescope in Murchison shire of Western Australia.

b) With Indian Institute of Science on the "Development of Cryogenic Cooling System for Radio Telescope Receivers".

c) With Indian Space Research Organization – Satellite Navigation, X-ray Polarimeter.

d) With TIFR-NCRA, collaboration on modernization and building new receivers for the Ooty radio telescope and the Giant Meter-wave Radio Telescope.

e) With Imperial College, London under the Royal Society British Council Joint Project Grant on "Quantum Dynamics of Causal Sets".

f) With Southern Federal University, Russia under Indo-Russian (DST-RFBR) Collaborative Program on "Metal mixing and the search for missing baryons in the Universe".

g) TWAS_UNESCO Associateship Scheme at Centers of Excellence in the South.

C. Important Output Indicators for 2011-12

S.No.	Parameters	Output
1.	Papers in refereed journals	89
2.	Papers in Conferences	8
3.	Number of Ph.Ds. produced	11
4.	Foreign Patents filed	7
	Foreign Patents granted	2
5.	Indian Patents filed	9
6.	Research Manpower trained (other than Ph.Ds)	4
7.	Technical Manpower trained	2
8.	B.Tech/ UG projects guided	71
9.	M.Tech/M.Sc./M.Phil projects guided	57

S.N. BOSE NATIONAL CENTRE FOR BASIC SCIENCES (SNBNCBS), KOLKATA

A. Organization Particulars

l.	Name of the Institute:	S. N. Bose National Centre for Basic Sciences
2.	Established in the Year:	1986
3.	Number of scientists/faculty:	32
4.	Total number of regular employees:	53

B. Report on Activities during 2011-12

1. Areas of Focus:

- Consolidate gains and focus on areas where we can make impact.
- Make serious effort to enhance output.
- Build infrastructure both research and physical.
- Promote team building and collective research.
- Strengthen the visitor and associateship programme, as per original mandate.

In the 11th plan period most of the activities were focused on the following major areas:

2. Major Accomplishments:

New materials Development including nanomaterials, nanodevices and Related Condensed Matter Sciences: (Theory, Experiment and Simulations). Including new sub-programmes:

- Establishment of liquid He facilities and related experimental facilities for low temperature experiments.
- Extension of nanofabrication and device fab facility including clean room facility

Collective and emergent behaviors in quantum mesoscopic and classical systems (Theory) including new sub-programmes:

- Thermodynamics of small system
- Black holes and nonextensive thermodynamics

Integrated PhD Programme (Advanced human resources development)

Extended visitor and Linkage Programme (outreach and linkage activities)

Faculty performance enhancement scheme (FPES) and Internal and Network projects, Professional Development Fund (Performance enhancement/human power development/research networking)

B. Major Physical infrastructure:

- Continuation, extension and completion of work started in 11th Plan:

- G+8 Laboratory, Computational facility and Science Seminar Complex.

B.2 New construction activities:

- Transit Accommodation and dinning room complex with other common facilities.
- Installation of 100KW grid integrable solar energy units.

3. Important Highlights of 5 Major Programmes:

(a) Physics of nanomaterials including application-specific materials development.

(b) Advanced computational materials science including soft condensed matter.

(c) Interface of biology and condensed matter physics including fluctuation and stability of biomolecules, DNA-protein interactions and biomolecular recognition in physiological conditions, biology of extreme conditions, and application of ultra fast spectroscopy in biomolecules and quantum effects in fast molecular and non-adiabatic process.

(d) Collective behavior in quantum and classical condensed state including driven systems, ultra cold quantum gases and spin transport through Quantum wires.

(e) Theoretical work on black holes and its cosmological consequences and astro-chemistry. Selected problems in Quantum field theory.

4. Major and Unique National Facilities created : Time and Space resolved Kerr Effect Measurements (major facility)

5. Important collaborations (national and global) established:

Project Title	PI / Co – PI	Funding Agency
" Understanding Physics and Chemistry of novel material using NMTO Wannier Functions "	Dr. T. Saha Dasgupta	Indo-GermanFP/2004(40)
DST/PM/08-09/02 – "Functional Oxides"	Dr. Priya Mahadevan	DST (Joint Research Proj)(Indo Taiwan Prog)
DST/BC/08-09/10 -"Astrophysical and cosmological implication of noncumulative space time"	Dr. Biswajit Chakraborty	DST (Indo SA Jt. Proj)INT/SAFR/P3(11)/2009
DST/AB/09-10/18 –"DYNAMAG: Advanced Computational Studies of Dynamic Phenomena in Magnetic Nano-Materials"	Dr. Anjan Barman	DST & European CommissionINT/EC/CMS (24/233552) /2008(i)
DST/AB/09-10/27 -"Spin wave and domain wall dynamics in vertical magnetic nanowires (DST-UKIERI)"	Dr. Anjan Barman	DSTDST/UKIERI/SA/P-2 /2008
DST/TSD/09-10/37 -"MONAMI – Modeling of NANO – Scaled Advanced Materials Intelligently"	Dr. Tanusri Saha Dasgupta	DST (Int Div)INT/EC/MONAMI (25/233513)/ 2008 (i)
SRC/TSD/09-10/38 - "Magnetism in organic materials"	Dr. Tanusri Saha Dasgupta	Swedish Research Council(SRC)
" Design and Fabrication of Nanomachined Thermal Sensors using FIB (DST – UKIERI)"	Prof. A.K. Raychaudhuri	DSTDST/UKIERI/SA/P-29/09

Project Title	PI / Co – PI	Funding Agency
" Contacting 3D electrodeposited nanowires: new opportunities for sprintonics technology (DST – UKIERI)"	Dr. Kalyan Mandal	DSTDST/UKIERI/SA/P-13/09
EICOON – Euro Indo forum for nano materials research coordination & cooperation of researchers in sustainable energy technologies	Prof. A.K. Raychaudhuri Dr. Sugata Mukherjee	University of Twente
DST/AKR/10-11/53 –"Investigation of strain-dependent magnetization dynamics and electronic transport in magnetic oxides for spintronics and signal processing applications"	Prof. A.K. Raychaudhuri	DST-DAAD (Indo-German)INT/FRG/DAAD/ P-210/2011dated 9-7-2011
DST/AKR/10-11/55 –"Electroresistance in single crystals and thin films of mixed valence manganites"	Prof. A.K. Raychaudhuri	DST (DST-RFBR)(RUSP-1183)

C. Important Output Indicators for 2011-12:

Sl. No.	Parameters	Output
1.	Papers in refereed journals	120
2.	Books	1
3.	Papers in Conferences	17
4.	Number of PhDs. Produced	6
5.	Research Manpower trained (other than PhDs)	4
6.	B.Tech/ UG projects guided	23
7.	M.Tech/M.Sc./M.Phil projects guided	6

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES & TECHNOLOGY (SCTIMST), TRIVANDRUM

A. Organization Particulars

1. Name of the Institute : Sree Chitra Tirunal Institute for Medical Sciences & Technology., Trivandrum
2. Established in the year : 1980
3. Number of scientists/faculty : 131
4. Total number of regular employees : 937

B. Report on Activities during 2011-12

1. Areas of Focus : Biomaterials Research and Development Product Development, Technology Transfer and Industrial Linkages; Quality Management Systems, Testing and Technical services; Patient care and Public Health

2. Major Accomplishments :

- Technology transfer of three products – Potting compound, Injectable Calcium Phosphate Cement for dental applications and Bioactive composite ceramics for orthopedic applications to the industry.
- Products entering into the clinical evaluation phase – modified tilting heart valve, Intrauterine device, ECG electrode
- Steady increase in the demand for testing services, calibration services also extended to external clients.
- Second batch of joint M.Tech Clinical engineering graduating in Dec 2011 and 2nd batch of M Phil (Biomedical Technology) programmes commenced

3. Important Highlights of 5 Major Programmes:

- Signing of technology transfer agreement for:the know how for potting compound with M/S NAL Medical devices India Private Limited, Cherthala; Injectable Calcium Phosphate Cement for dental applications &Bioactive composite ceramics for orthopedic applications with M/S IFGL Bioceramics, Kolkota for the commercial production.
- Confidentiality agreements signed with M/s Lifecare Innovations Pvt Ltd, M/s International Stem cell Services Ltd & M/s Arjuna Natural extracts Limited
- Research and development in biomaterials is in progress on :

  Nano porous bioceramic substrates for drug delivery, A new gene delivery vector (pullulan-PEI-transferrin) for potential application in the treatment of Gliomas, development of quantum dots for medical applications, development of Polycaprolactone scaffolds for small diameter vascular grafts, development of Light Cure unit for TPO based dental composites, development of a Dura Substitute by Electrospinning, radiopaque polymers for biomedical applications
- A steady increase in the tests enquired and offered. More than 420 test requests were accepted from external customers during April – November 2011.
- Inauguration of Stroke ICU on 10th March 2011

4. Major and Unique National Facilities created:

Facility for nano/microparticle based biomaterials - advanced drug delivery systems (FADDS)

The objective of the programme was the extension of SCTIMST's expertise in nanoparticle development, physico-chemical characterization and *in vivo-in vitro* correlation studies. Studies were performed on applications of these nanoparticles towards VEGF or/and bFGF growth factors loaded nanoparticles for Angiogenesis; developing oral heparin nanoparticles, developing growth factor loaded wound healing sponges towards burn cases and nanoceramic based porous fillers for bone tissue engineering. Applied research on understanding the process of absorption and *in vitro - in vivo* correlation of nanoparticle formulations and studies on selected bhasma

preparations were done. Therapeutic gene delivery approach for product development was attempted.

5. Important collaborations (national and global) established:

Exploratory dialogues with the following partners were initiated during the time period:

- Reliance Lifesciences, Mumbai
- With M/S Lifecare Innovations Pvt Ltd, Gurgaon
- With M/S International Stemcell Services Ltd, Bangalore

C. Important Output Indicators for 2011-12

S.No.	Parameters	Output
1.	Papers in refereed journals	113
2.	Books	2
3.	Chapters in Books	4
4.	Papers in International Conferences	65
5.	Number of Ph.Ds. produced	6
6.	Foreign Patents filed	Nil
7.	Foreign Patents granted	Nil
8.	Indian Patents filed	14
9.	Indian Patents granted	Nil
10.	Number of Technologies/Designs and other intellectual products commercialized	3
11.	Number of Technology leads awaiting transfer	3
12.	Research Manpower trained (other than Ph.Ds)	92
13.	Technical Manpower trained	68
14.	B.Tech/ UG projects guided	Nil
15.	M.Tech/Mpharm/M.Phil/MPH/DPH projects guided	48

Fig. 10.18: In patient service automation 5 December 2011

Fig. 10.19: Inauguration of SCTIMST Web Site - Online Recruitment on 21 October2011

Fig. 10.20: Inauguration of Patient Information KIOSK

Fig. 10.21: National Epilepsy Day 2011

Fig. 10.22: World Stroke Day 2011

Fig. 10.23: World No Tobacco Day 2011

Fig. 10.24: Inauguration of Stroke ICU on 10th March 2011

Fig. 10.25: Annual Convocation 2011

WADIA INSTITUTE OF HIMALAYAN GEOLOGY (WIHG), DEHRADUN

A. Organization Particulars

1.	Name of the Institute	: Wadia Institute of Himalayan Geology Dehra Dun
2.	Established in the year	: June 29, 1968
3.	Number of Scientists/faculty	: Scientists -62
4.	Total number of regular employees (Sanctioned)	: 208

B. Research Profile of the Organization

1. Areas of Research Focus :

The Institute has been given the mandate to carry out geological and geophysical investigations of the Himalaya – the youngest and loftiest mountain system on Earth which plays a critical role in climate modulations. The research activities of the institute have been grouped into five mission

mode projects that are implemented through long term and short term projects. The main emphasis is to study Himalayan river systems, glaciers, earthquake precursors and landslides.

2. Major Research Accomplishments (2011-12) :

a. The linkage between Himalayan rivers, in terms of valley aggradation and incision, and climate change during Late Pleistocene - Holocene, has been established

b. The waxing and waning rates of the Chorabari and Dokriani glaciers have been measured

c. Establishment of Multi Parametric Geophysical Observatory has made a major impact in earthquake precursory studies in the Himalaya

d. Based on the identification of rodent fossils from Lower Siwalik of Ramnagar (J&K), the First Appearance of Datum of *Sivapithecus* has been revised to 13.2 Ma

3. Important Highlights of 5 Major Research Programmes (2011-12) :

- Petrochemical studies of granitoid rocks from the eastern part of Kumaun region suggest that the leading edge of India represents an active arc during Late Paleoproterozoic times.
- The intra-crustal low velocity zone (IC-LVZ) beneath Ladakh within a depth range 15-35 km has been identified. The presence of IC-LVZ and high Poisson's ratio in the crust signifies to the presence of partial melt or aqueous fluids or both.
- Nannofossils have been recovered from the Upper Bhuban Formation, Mizoram, Northeast India, and probably it is for the first time that Nannofossils from the Surma basin are recorded. These Nannofossil assemblage suggest a hemipelagic depositional setting for the Upper Bhuban Formation of Mizoram
- The preliminary results of Geothermal springs and associated river waters collected from, the Main Central Thrust (MCT) zone of the Himalaya show that there is a strong variation from -8.5‰ to +4.0‰ $_{(PDB)}$ indicating the varied sources of their origin.
- A new methodology has been developed based on temporal gravity and solid earth deformation studies to understand the dynamics of alluvial pore space fluid in the Doon valley when it subjected to distant large or great magnitude earthquakes.
- More recently, a moderate (M~6.9) earthquake which triggered in Sikkim, India on September 18, 2011 is being monitored by WIHG by installing eight broadband seismographs in & around the epicentral region. The studies are aimed at to understand the size and orientation of the fault plane for the 2011 Sikkim, India Earthquake (M=6.9) from the aftershock observations
- Successfully interfaced ICP-MS with a 213nm Laser Ablation system: Optimized for trace element analysis. This technique can potentially be integrated with XRF to complement each other in providing complete analysis of silicate rock samples with single sample preparation.

4. Major and Unique National Facilities created (2011-12) :

A new Luminescence Reader with single Grain attachment is added to OSL Lab

5. Important collaborations (national and global) established (2011-12) :

— Signed MoU with University of Petroleum & Energy Studies, Dehra Dun

— Collaboration with Archeological Survey of India is in process

— Initiation of the collaboration with Open University, United Kingdom, Earth Observatory Singapore and University of Alabama, USA.

C Important Output Indicators (2011-12)

S.No.	Parameters	Output
1.	Papers in refereed journals (till Dec. 2011)	31
2.	Chapters in Books	1
3.	Papers in Conferences (and other non-SCI papers) (till Dec. 2011)	9
4.	Number of Ph. Ds. produced (submitted)	4
5.	M.Tech/M.Sc./M.Phil projects guided	15
6.	Research Manpower trained (other than Ph.Ds)	55
7.	Awards and Honours	
	• Indian Geophysical Union has selected Dr. Pradeep Srivastava for the Award of Krishnan Gold Medal for the year 2011.	
	• Prof. A.K. Gupta, Director has been elected as Fellow of the Indian National Science Academy, New Delhi (INSA)	5
	• Dr. Rajesh Sharma and Dr. D.R. Rao were elected as Members of the National Academy of Sciences, India (NASI)	
	• Dr. A.K. Singh has been awarded 'BOYSCAST' fellowship by the DST, Government of India for conducting advanced research work at the Department of Earth and Environmental Sciences, The Open University, Milton Keynes, U.K.	
8.	Workshops/Seminars organized • Organized Workshop on "Himalayan Glaciers and Community Responsibility" during September 26-27, 2011 • Organized Indo-Iceland Workshop on "Earthquake Prediction" during October 21-22, 2011 • Organized International Conference on "Indian Monsoon and Himalayan Geodynamics" during November 2-5, 2011	3

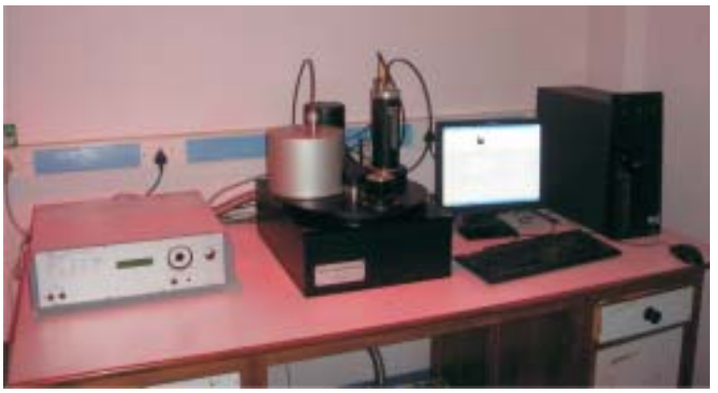


Fig. 10.26: Figure TL/OSL Laboratory at WIHG, Dehra Dun

INDIAN NATIONAL ACADEMY OF ENGINEERING (INAE), NEW DELHI

A. Organization Particulars

The Indian National Academy of Engineering (INAE), founded in 1987, comprises India's most distinguished engineers, engineer-scientists and technologists covering the entire spectrum of engineering disciplines. INAE functions as an apex body and promotes the practice of engineering & technology and the related sciences for their application to solving problems of national importance. The Academy provides a forum for futuristic planning for country's development requiring engineering and technological inputs and brings together specialists from such fields as may be necessary for comprehensive solutions to the needs of the country. It is the only engineering Academy in India. INAE is a Member of the International Council of Academies of Engineering and Technological Sciences (CAETS).

B. Report on Activities during 2011-12

(a) Seminars/Conferences - The Academy organizes Symposia/Seminars/ Workshop/ Conferences at national/international levels on topics of national importance. Based on the deliberations, INAE invariably brings out policy recommendations for suitable follow-up action by the concerned Ministry/Department/agency(ies).

The following Seminars/Workshops/Conferences were organized by INAE during the year 2011-12.

(i)	INAE-ATSE Workshop on "Energy Efficiency"	- April 11-12, 2011 at New Delhi
(ii)	Sixth National Frontiers of Engineering Symposium (NatFOE6)	- Sep 2-3, 2011 at Hyderabad
(iii)	National Conference on Development of Technologies in DOS – Successes, Spin offs and New Opportunities	- Dec 16-18, 2011 at Thiruvananthapuram
(iv)	MOS-AK/GSA India2012 International Workshop on Device Modeling of Microsystem	- March 16-17, 2012 at Noida

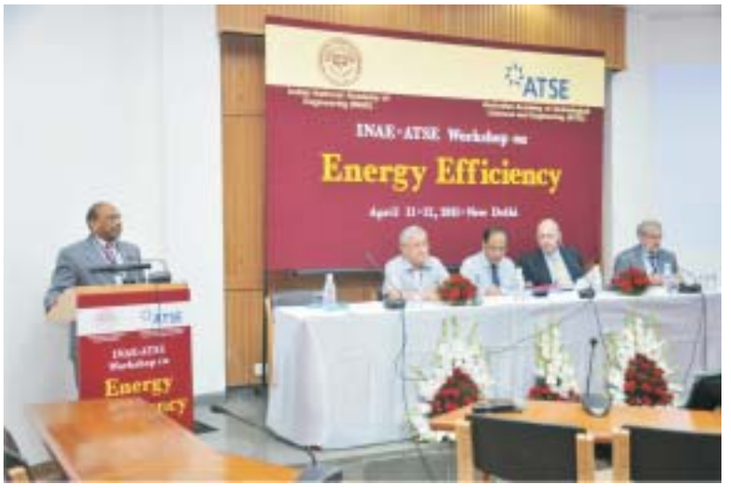


Fig. 10.27: INAE-ATSE Workshop on "Energy Efficiency" held on April 11-12, 2011

(b) Academia-Industry Interaction - *AICTE-INAE Distinguished Visiting*

***Professorship Scheme* -** The Indian National Academy of Engineering (INAE) launched a Distinguished Visiting Professorship (DVP) Scheme jointly with All India Council for Technical Education (AICTE) in 1999. As per the objectives of the scheme; the Distinguished Visiting Professor is required to deliver lectures on the state-of-art of Industry, industrial ambience and R&D needs of the industry to the students and faculty of technical institutions; guide student projects/ theses of interest to industry. The Scheme has received very enthusiastic response from industry and engineering institutions over the years.

(c) International Affairs - 19th CAETS Convocation and Annual Meeting - The CAETS (International Council of Academies of Engineering and Technological Sciences) Council Meeting and Convocation on "Engineering Analysis and Management to Reduce Risks" hosted by Mexican Academy of Engineering was held during June 27-July 1, 2011 at Mexico City. INAE delegation participated in this event.

(d) Promoting Excellence in the Field of Engineering

(i) *Life Time Contribution Award in Engineering 2011* - This award is given to an eminent Indian citizen who has made most distinguished contributions in the field of Engineering / Engineering Research / Technology, which have brought prestige to the nation and regarded as landmarks of technological development of the country. Dr. VS Arunachalam, Chairman, Centre for Study of Science, Technology and Policy (CSTEP), Bangalore and Mr. SS Chakraborty, Managing Director, Consulting Engineering Services (India) Ltd., New Delhi were selected for the year 2011.

(ii) *Prof. Jai Krishna and Prof. SN Mitra Memorial Award 2011* - These awards are given to an eminent engineer, engineer-scientist or a technologist for Academic and scholarly achievements in any discipline of technology/outstanding research. Dr. Dipankar Banerjee, Professor, Department of Materials Engineering, Indian Institute of Science, Bangalore and Dr. RK Sinha, Director, Bhabha Atomic Research Centre, Mumbai were selected for the year 2011.

(iii) *INAE Young Engineer Award 2011* - Instituted in 1996, INAE Young Engineer Award is given for excellence in design and technology transfer, innovative development and engineering research. Ten candidates were selected for INAE Young Engineer Award 2011.

(iv) *Innovative Student Projects Award 2011* - The Academy has instituted 'Innovative Student Projects Award' since 1998 to identify innovative and creative research projects undertaken by the students at three levels, B.E./ B.Tech, ME/ M.Tech and Ph.D in Engineering Colleges. Six theses at doctoral level, five at master's level and nine projects at bachelor level were selected for conferment of Innovative Students Project Award 2011.

(e) Research Studies - The Academy undertakes studies on important/topical national issues each year. The objective of such study is to prepare a comprehensive/exhaustive document covering review of existing international and national technological and commercial aspects, analysis of options, future trends and specific implementable policy/recommendations and methodology for execution. The following studies are under progress.

(i) Technologies for Healthcare Sector in India

(ii) Impact of R&D on Chemical Industry – Current Status and Future Strategies. (iii) Impact of R&D on Indian Mining Industry Performance – Identifying the new priorities and strategic initiatives

(iv) Research Study on Impact of R&D on Indian Steel Industry– Current Status and Future

(v) Study on "Assessment of Civil Engineering Inputs for Infrastructural Development"

Fig. 10.28: A copy of the Report being formally handed over to Dr. R Chidambaram, PSA to the Govt. of India during a meeting held in his office on May 24, 2011.

(f) INAE e-Newsletter - This monthly electronic newsletter contains engineering and technology updates and aspects of frontiers of engineering as well as the news regarding INAE activities.

(g) INAE Forums - One of the important objectives of the Academy is to assist the Government from time to time in formulating policies on critical technical issues. For this purpose, three forums have been constituted – INAE Forum on Engineering Education, INAE Forum on Microelectronics and INAE Forum on Energy. These forums enable giving inputs to policy makers, institutes of higher learning & research, industries, etc.

(i) Forum on Microelectronics - This Forum has the mandate to address all issues related to Microelectronics and to appropriately network with other agencies concerned with this area. MOS-AK/GSA India2012-International Workshop on Device Modeling of Microsystem is being organized by INAE during March 16-17, 2012 at Noida as one of the activities of the forum.

(ii) Forum on Energy - Keeping in view the importance of energy issue, an INAE Forum on Energy has been constituted recently. A Report on "Deployment of Low Emissions Technologies for Electric Power Generation in Response to Climate Change" was prepared during November 2010 by a Working Group comprising selected member academies of CAETS - Indian National Academy of Engineering, acatech, Canadian Academy of Engineering, Engineering Academy of Japan, South African Academy of Engineering and The Royal Academy of Engineering, UK.

(h) The Fellowship - Twenty five Fellows and four Foreign Fellows were elected during the year.

C. Important Output Indicators for 2011-12

The following important publications have been brought out during the year 2011-12.

a) Annals of INAE - The Annals of the INAE contains the text of the lectures delivered by Life Time Contribution Awardees; Professor Jai Krishna and Prof. SN Mitra Memorial Awardees, newly elected Fellows of the Academy and INAE Young Engineer Awardees.

b) Monograph of Heritage Buildings" in Thiruvanthapuram - A study on the architecture of traditional buildings in Thiruvanthapuram was undertaken by the INAE Engineering Heritage (Civil) group. This has been published as a book entitled "Thiruvanthapuram -Monograph of Heritage Buildings". The idea behind the documentation is to give the reader an insight into the heritage buildings most of which were constructed on basic principles while harmoniously blending with nature. The book covers the general influences, which have made an impact on the architectural character of Kerala and gives a brief description of the history of Thiruvanthapuram city and the planning of the core of the city and its development. It also covers various features of the ancient and colonial architecture.

c) Monograph on "Domes and Vaults of South India" - The study group on Indian Engineering Heritage (Civil) discovered the wealth of Domes and Vaults construction in Thanjavur area and decided that a detailed study of Domes and Vaults of South India should be undertaken. Consequent to this study, a monograph has been published. This monograph gives the reader an insight into the techniques used by the artisans in the distinct Hoysala architecture and in the transition to more expressive architectural forms.

THE INDIAN SCIENCE CONGRESS ASSOCIATION (ISCA), KOLKATA

A. Organization Particulars

1.	Name of the Institute	: The Indian Science Congress Association
2.	Established in the year	: 1914
3.	Broad Grouping of among AIs of DST	: Autonomous Body (registered under Act XXI of 1860.)
4.	Total Number of Employees	: 31

B. Report on Activities during 2011-2012

1. Areas of focus

The Indian Science Congress Association was established in 1914 with the following objects:

(a) To advance and promote the cause of Science in India;

(b) To hold an Annual Congress at a suitable place in India;

(c) To publish such proceedings, journals, transactions and other publications as may be considered desirable;

(d) To secure and manage funds and endowments for the promotion of Science including the rights of disposing of, or selling all or any portion of the properties of the Association;

(e) To do perform any or all other acts, matters and things as are conducive to, or incidental to, or necessary for, the above objects.

2. Major Accomplishments (2011-12) :

01. Holding of 99th Indian Science Congress Session at SRM University, Chennai
02. Publications including ISCA's bi-monthly journal Everyman's Science
03. Augmentation of ISCA Chapter Activities
04. Subscription of Journal for ISCA Library
05. Organising Seminars, Symposia, Discussions, Workshop etc.
06. Young Scientists' Programme
07. Science Awareness Programme for Popularisation of Science
08. Advancement and Promotion of Science and Technology through National/ International Symposia, Follow-up of Recommendation(s) Involving Young Scientists
09. International Collaboration on Exchange Programme
10. Microfilming of ISCA Old Publications
11. Software Development in different departments
12. Construction of additional floor including renovationa/alteration in existing buildings
13. Infrastructure Development

3. Important Highlights of 5 Major Programmes (2011-12)

The 99th Indian Science Congress will be held at Bhubaneswar under the auspices of the KIIT University (from January 03 to 07, 2012. The 99th Session of the Science Congress will be inaugurated by the Prime Minister of India, on January 03, 2012. The Focal Theme of the Congress is "Science and Technology for Inclusive Innovation –Role of Woman"

The Indian Science Congress Association (ISCA) has instituted several Awards to honour and encourage scientists in India – mainly through special endowments received from individuals and groups and also from its own funds.

The Association envisaged constructive work for the popularisation and advancement of science by organising seminars, symposia, discussions, popular lectures, quiz contest, etc. thought out the year under twenty five ISCA Chapters. The Association also observed the science day, environment day, doctor's day, engineer's day, technology day, and also organize joint collaborative programme with other organizations at its Headquarters.

4. Major and Unique National Facilities Created (2011-12) : Not Applicable

5. Important collaborations (national and global) established (2011-12)

At National Level ISCA through its chapters is holding science popularization activities with various Institutes / Universities. The Indian Science Congress Association also has exchange programme with British Association of Science, Sri Lanka Association of Advancement of Science, Ameican Association of Advance of Science, Chinese Academy of Science, etc.

THE NATIONAL ACADEMY OF SCIENCES (NASI), ALLAHABAD

A. Organization Particulars

1.	Name of the Institute	: **THE NATIONAL ACADEMY OF SCIENCES, INDIA**
2.	Established in the year	: **1930**
3.	Number of scientists/faculty	: **25 NASI-SENIOR SCIENTISTS** (on an Hon. Of Rs 30,000/month to each for five years); and **05 NASI-Chair Professors** (on an Hon. Of Rs 80,000/month, for five years).
4.	Total number of regular employees	: **17 only** (total sanctioned posts are 18)

B. Report on Activities during 2011-12

1. Areas of Focus : **Promotion & Popularisation of Science & Technology; to aid & advise in Policy Making**

2. Major Accomplishments : **The major accomplishments were the following-**

An Establishment of a Magnificent Ganga-gallery

The river Ganga occupies an unique position in the cultural ethos of India. Legend says that the river has descended from Heaven to the earth as a result of the long and arduous prayers of King Bhagirath for the salvation of his deceased ancestors. From times immemorial, the Ganga has been India's river of faith, devotion and worship. But the holy river Ganga's existence is under threat, due to enormously increasing load of pollution year by year. Therefore, the Council of the Academy decided to adopt ways to make the people aware for the conservation and restoration of the holy river Ganga by establishing a Ganga Gallery with well defined objectives in order to highlight the religious, cultural, socio-economic and scientific aspects of the holy river. The gallery was inaugurated by **Hon'ble Sri Pawan Kumar Bansal**, Science & Tech. Minister, Govt. of India on April 15, 2011. The highlights are given on the web page of NASI (**www.nasi.org.in**).

Publications

- Apart from regular publications, the Academy published a vast data on the **Nematode Infestations** (in two parts), a voluminous work and treasure for the researchers of India & abroad.
- The **reviews** published in the Proceedings and Science Letters of the Academy covered the most discussed areas of research from **Nanotechnology to Biotechnology; and Material Science to Transformational Technologies.**
- A book on **Malaria (in Hindi**) of about **600 pages** is also ready for publication : A first of its kind in India.

Science Communication Activities

- The highlights of activities were **Children Science Meet, Summer & Winter Schools, Vacation Training Programmes, Workshops, Seminars, National Technology Day, National Science Day and World Environment Day** etc. The Academy also encouraged the teachers for out of the class science activities by recognizing their talent and giving away awards to them.
- Not only that, a **first of its kind activity** was started by the Academy for the young researchers, when a series of **workshops on Scientific Paper Writing** was organized by the Academy to train them for expressing their views and research findings in an appropriate manner.

Science Education Programmes in joint collaboration of other National Science Academies

The NASI together with other two Science Academies - Indian National Science Academy, New Delhi and Indian Academy of Sciences, Bangalore is jointly sponsoring the Summer Research Fellowship under the joint Science Education Panel to provide opportunities to bright under-and post-graduate students and teachers to usefully spend their summer/winter vacations, at a research

laboratory for a period of two months. It is worth mentioning that a large number of Fellows of NASI have opted to mentor students and teachers under this programme.

Annual Session/Symposia/Seminars & Scientific Discussions

During the Annual Session, every year a Symposium is also organized on some recent topic of interest, directly related to science & society. The year **2010** was the **International Year of Biodiversity;** and this year (**i.e. 2011**) has been declared by the UNO as **the International Year of Forests**. In view of this, the Academy decided to organize several programmes. In the year 2010 a National Symposium on **"Climate Change"** was organized with Prof. M.S. Swaminathan as its Chief Guest and Prof. (Mrs.) Manju Sharma as the Convener. The major topics of this symposium were decided in a meeting headed by Prof. M.G.K. Menon to give an emphasis on the adverse impact of the climate change on the planet earth in general, and the biodiversity, in particular. The recommendations of this symposium have been sent to concerned governmental and non-governmental departments; and are also on the website of NASI. Therefore, in consonance with the plan, this year, the Academy organized a National Symposium on **"Sustainable Management of Biodiversity using Science & Technology" on Nov. 24-26, 2011 at Trivandrum**; with an aim to propagate the message and take concrete steps for conserving the biodiversity for Sustainable Development.

Fellowship / Membership

The ICMR, New Delhi, posing full faith in the scientific capability of the Fellows of the Academy, has instituted the **ICMR Fellowship in the area of Public Health Research** to be given to a distinguished Fellow of this Academy. This is the first such joint endeavor of the Academy and ICMR.

Singhania Library

Library services were enriched through digitization of the library, subscribing more books and by providing facilities of storage, reading room, microfilming, citation index etc. Internet facility for educational purpose is also being provided to the students free-of-cost. **This year the library has been connected to National Knowledge Network (NKN).**

Recognition and Awards

Following Fellowships and Awards were given during the year:

- Award in the field of Biodiversity to Professor J S Singh, BHU, Varanasi
- NASI-Reliance Industries Platinum Jubilee Awards (2011) for the Application Oriented Innovations covering both Physical and Biological Sciences.
- NASI-Young Scientist Platinum Jubilee Awards (2011) in the fields of Biological/Physical/ Chemical Sciences.
- NASI-Senior Scientist Platinum Jubilee Fellowships (2012)- Announced.
- NASI – Swarna Jayanti Puruskars (2011) for Best Paper Presentation in the Annual Session
- NASI Scopus Awards (2010)
- NASI – Science and Maths Teacher Awards (2011) by NASI HQ and some of its Chapters in their respective region

Local Chapters

The 15 Chapters of the Academy have undertaken **a hundreds of activities** for the furtherance of the Academy's objectives. Detailed reports of the Chapters have included in the Annual Session's Report (published in Nov.2011; a copy of which is being sent separately) of the Academy.

3. Important Highlights of 5 Major Programmes: **The highlights are –**

a) The Council of the Academy decided to adopt ways to make the people aware for the conservation and restoration of the holy river Ganga by **establishing a Ganga Gallery** with well defined objectives in order to highlight the religious, cultural, socio-economic and scientific aspects of the holy river. The gallery was inaugurated by **Hon'ble Sri Pawan Kumar Bansal**, Science & Tech. Minister, Govt. of India on April 15, 2011

b) The **reviews** published in the Proceedings and Science Letters of the Academy covered the most discussed areas of research from **Nanotechnology to Biotechnology; and Material Science to Transformational Technologies.**

A book on **Malaria (in Hindi**) of about **600 pages** is also ready for publication, a first of its kind in India

c) ***Science Communication Activities :*** The highlights of activities were **Children Science Meet, Summer & Winter Schools, Vacation Training Programmes, Workshops, Seminars, National Technology Day, National Science Day and World Environment Day** etc. The Academy also encouraged the teachers for out of the class science activities by recognizing their talent and giving away awards to them. Not only that, a **first of its kind activity** was started by the Academy for the young researchers, when a series of **workshops on Scientific Paper Writing** was organized by the Academy to train them for expressing their views and research findings in an appropriate manner.

d) The Academy organized a National Symposium on **"Sustainable Management of Biodiversity using Science & Technology" on Nov. 24-26, 2011 at Trivandrum**; with an aim to propagate the message and take concrete steps for conserving the biodiversity for Sustainable Development. The programme was attended by Hon'ble Prof M G K Menon, Prof K Kasturirangan, Prof M S Swaminathan, Prof Manju Sharma, Prof H Y Mohan Ram; and about 600 distinguished scientists, teachers and students.

e) Apart from conferring Fellowship/Membership of the Academy, Several awards were also given in recognition of the significant scientific contributions of the young and senior scientists, such as –

NASI-Reliance Industries Platinum Jubilee Awards (2011) for the Application Oriented Innovations covering both Physical and Biological Sciences.

NASI-Young Scientist Platinum Jubilee Awards (2011) in the fields of Biological/Physical/ Chemical Sciences.

NASI-Senior Scientist Platinum Jubilee Fellowships (2012).

NASI – Swarna Jayanti Puruskars (2011) for Best Paper Presentation in the Annual Session; and the NASI Scopus Awards (2010)

4. Major and Unique National Facilities created : **The Ganga-gallery** (IGNOU, New Delhi has included the gallery in its syllabus/project to make the students learn the aspects of conservation of a river)

5. Important collaborations (national and global) established:

   a) **The NASI together with other two Science Academies - Indian National Science Academy, New Delhi and Indian Academy of Sciences, Bangalore** is jointly sponsoring the Summer Research Fellowship under the joint Science Education Panel to provide opportunities to bright under-and post-graduate students and teachers to usefully spend their summer/winter vacations, at a research laboratory for a period of two months. It is worth mentioning that a large number of Fellows of NASI have opted to mentor students and teachers under this programme.

   b) **Also continuing its established collaboration with the Reliance Industries** for recognizing the scientific research.

   c) **The Academy has established collaboration with the SCOPUS** for recognizing the scientific talents.

   d) **It has also established an association with the Springer** for publishing its journals.

   e) **Also organized many science communication activities in collaboration with the Indian Universities/Institutes/CSIR Laboratories/ NCSM and other prestigious institutions.**

C. Important Output Indicators for 2011-12 : *As per report of the NASI Chair Professors, NASI-Senior Scientists & NASI-Reliance Awardees, many papers were published/patents filed/ technologies transferred; and manpower trained (please see the brief report published in the Annual Session's Report of NASI-Nov.201I).*

NATIONAL INNOVATION FOUNDATION (NIF), AHMEDABAD

A. Organization Particulars

1. Name of the Institute : National Innovation Foundation
2. Established in the year : 2000
3. Number of scientists/faculty : 3
4. Total number of regular employees : 03 regular, 51 contractual

B. Report on Activities during 2011-12

1. Areas of Focus : Green Grassroots Innovations, technological ideas and Outstanding Traditional Knowledge

2. Major Accomplishments :

a) IGNITE 11 national award function to felicitate innovative children (upto class 12) was organised on Nov 11, 2011 at IIM Ahmedabad where 22 awards were given to 32 children by Dr APJ Abdul Kalam.

b) Grassroots Innovations Design Studios (GRIDS) were setup at IIT Gandhinagar on July 22, 2011 and Shristi School of Art, Design and Technology, Bangalore on Sep 28, 2011 to add value to grassroots technologies.

c) MoU with Malaysia Innovation Foundation (YIM) was signed on July 2, 2011 to share mutual experiences and develop strategies to take forward the grassroots innovations movement.

d) Technology Transfer of Cashew Sheller by Shri Subhash Jagtap facilitated on Nov 28, 2011 by NIF-GIAN

e) The first product to roll out from the Khoj Lab (joint initiative of Future Group and NIF) – a range of Nutritional cookies, developed from the traditional knowledge of the Bhil community was launched on April 27, 2011 at Big Bazars of Ahmedabad.

3. Important Highlights of Major Programmes:

a) Seventh National Biennial Competition concluded on March 31, 2011 in which about 20000 entries were received by NIF. The Eighth National Biennial Competition started on April 1, 2011 and would continue till March 31, 2013.

b) NIF organised two National Research Advisory Committee Meetings of experts under the chairmanships of Prof P L and one National Research Advisory Committee meeting of the informal experts was organised to short list grassroots technologies of the Sixth competition for possible recognition at different levels.

c) The 27th Shodh Yatra – journey on foot in search of local creativity, was organised from Silli to Hundru, Ranchi district of Jharkhand from May 28 to June 3, 2011. The 28th Shodh Yatra is scheduled from January 9, 2012 to January 14, 2012 in the Aizawl district of Mizoram.

4. Major and Unique National Facilities created : NA

5. Important collaborations (national and global) established:

On June 16, 2011, National Innovation Foundation (NIF) and Indian Council of Medical Research (ICMR) entered into a memorandum of understanding (MoU) for validation of practices received from traditional knowledge holders from throughout the country.

On July 2, 2011, the Malaysian Foundation for Innovation or Yayasan Inovasi Malayasia (YIM) signed a MOU with National Innovation Foundation of India (NIF-India) to collaborate on developing long term strategies to help the advancement of individuals at the grassroots.

C. Important Output Indicators for 2011-12

S.No.	Parameters	Output
1.	Books	1
2.	Chapters in Books	2
3.	Foreign Patents filed	1
4.	Foreign Patents granted	0
5.	Indian Patents filed	120
6.	Indian Patents granted	0
7.	Number of Technologies/Designs and other intellectual products commercialized	5
8.	Number of Technology leads awaiting transfer	10
9.	M.Tech/M.Sc./M.Phil projects guided	13

Audit Report

The material of audit observations to be included in the Annual Report for the year 2011-12 is as per the table given below:

Sl. No.	Year	No. of Paras/PA Reports on which ATNs have been submitted to PAC after vetting by Audit	Details of the Paras/PA reports on which ATNs are pending		
			No. of ATNs not sent by the Ministry even for the first time	No. of ATNs sent but returned with observations and Audit is awaiting their resubmission by the Ministry	No. of ATNs which have been finally vetted by audit but have not been submitted by the Ministry to PAC
1.	1 of 2006 – Union Govt.			**1 (3.1 to 3.9)**	
2.	PA13 of 2007 (Scientific Departments), DST		**1 (5.3.1 to 5.3.8)**		
3.	CA 3 of 2008 (SD), DST			**1 (5.1)**	
4.	CA 3 of 2008 (SD), DST			**1 (5.2)**	
5.	CA 16 of 2009 (SD), DST			**1 (5.1)**	
6.	CA 16 of 2009 (SD), DST		**1 (5.2)**		
7.	CA 16 of 2009 (SD), DST		**1 (5.3)**		
8.	CA2 of 2008 Union Govt.(Civil)-Autonomous bodies DST		**1 (1.1.2)**		
9.	1 for the year 2008-09 (Accounts of the Union Govt.), DST		**1 (2.11)**		
10.	CA 15 of 2008-09 Union Govt.(Civil)-Autonomous bodies		**1 (1.1.2)**		
11.	5 of 2004 (SD)			**1 (3.1)**	
12.	5 of 2005(SD)			**1 (5.1)**	

DEPARTMENT OF SCIENCE AND TECHNOLOGY
SUMMARY OF FINANCIAL REQUIREMENTS

Sl. No.	HEAD OF DEVELOPMENT PROJECTS / PROGRAMMES / SCHEMES	ACTUALS 2010-2011			BE 2011-2012			RE 2011-2012			BE 2012-2013		
		Plan	Non-Plan	Total	Plan	Non-Plan	Total	Plan	Non-Plan	Total	Plan	Non-Plan	Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14
		(Rs. in crores)											
1	SECRETARIAT ECONOMIC SERVICES												
1.1	SECRETARIAT, EXHIBITION & FAIRS & Pr. ACCOUNTS OFFICE	0.00	43.49	43.49	0.00	47.45	47.45	0.00	47.45	47.45	0.00	48.55	48.55
	TOTAL - SECRETARIAT ECONOMIC SERVICES	0.00	43.49	43.49	0.00	47.45	47.45	0.00	47.45	47.45	0.00	48.55	48.55
2	R&D SUPPORT												
2.1	MULTI-DISCIPLINARY RESEARCH IN SCIENCE & ENGINEERING (SERC)												
2.2	RESEARCH AND DEVELOPMENT SUPPORT (SERC)	556.83	1.81	558.64	260.00	1.50	261.50	410.25	1.50	411.75	299.00	1.50	300.50
2.3	DRUGS AND PHARMACEUTICALS RESEARCH	45.56	0.00	45.56	60.00	0.00	60.00	55.00	0.00	55.00	40.00	0.00	40.00
2.4	NATIONAL MISSION ON NANO-SCIENCE & NANO-TECHNOLOGY	97.81	0.00	97.81	90.00	0.00	90.00	89.55	0.00	89.55	85.00	0.00	85.00
	TOTAL - R&D SUPPORT	700.20	1.81	702.01	410.00	1.50	411.50	554.80	1.50	556.30	424.00	1.50	425.50
	TOTAL - R&D PROMOTION PROGRAMMES	700.20	1.81	702.01	410.00	1.50	411.50	554.80	1.50	556.30	424.00	1.50	425.50
3	TECHNOLOGY DEVELOPMENT PROGRAMME	95.18	0.00	95.18	120.00	0.00	120.00	129.79	0.00	129.79	128.00	0.00	128.00
	TOTAL - TECHNOLOGY DEVELOPMENT PROGRAMME	95.18	0.00	95.18	120.00	0.00	120.00	129.79	0.00	129.79	128.00	0.00	128.00
4	TECHNOLOGY PROJECTS IN MISSION MODE												
4.1	TECHNOLOGY FOR BAMBOO PRODUCTS	22.01	0.00	22.01	20.00	0.00	20.00	20.00	0.00	20.00	0.00	0.00	0.00
	TOTAL - TECHNOLOGY PROJECTS IN MISSION MODE	22.01	0.00	22.01	20.00	0.00	20.00	20.00	0.00	20.00	0.00	0.00	0.00
5	S&T PROGRAMMES FOR SOCIO-ECONOMIC DEVELOPMENT												
5.1	SCIENCE AND SOCIETY PROGRAMME	8.00	0.00	8.00	9.00	0.00	9.00	9.00	0.00	9.00	10.00	0.00	10.00
5.2	WOMEN COMPONENT PLAN	39.69	0.00	39.69	40.00	0.00	40.00	43.00	0.00	43.00	0.00	0.00	0.00
5.3	SCIENCE AND TECHNOLOGY ENTREPRENEURSHIP DEVELOPMENT												
	AND EMPLOYMENT GENERATION	39.56	0.00	39.56	40.00	0.00	40.00	44.00	0.00	44.00	41.00	0.00	41.00
5.4	SCIENCE AND TECHNOLOGY COMMUNICATION AND POPULARISATION	19.79	0.00	19.79	21.00	0.00	21.00	21.00	0.00	21.00	20.00	0.00	20.00
	TOTAL - S&T PROGRAMMES FOR SOCIO ECONOMIC DEVELOPMENT	107.04	0.00	107.04	110.00	0.00	110.00	117.00	0.00	117.00	71.00	0.00	71.00
6	SPECIAL COMPONENT PLAN FOR SCHEDULED CASTES												
6.1	S&T COMMUNICATION AND POPULARISATION	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.50	0.00	2.50
6.2	S&T ENTREPRENEURHSIP DEVELOPMENT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.50	0.00	2.50

6.3	SPECIAL COMPONENT PLAN FOR THE DEVELOPMENT OF SCHEDULED CASTES	3.00	0.00	3.00	3.00	0.00	3.00	3.00	0.00	3.00	4.00	0.00	4.00
6.4	AUTONOMOUS SCIENTIFIC INSTITUTIONS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.00	0.00	12.00
6.5	R&D SUPPORT (SERC)	0.00	0.00	0.00	15.00	0.00	15.00	0.00	0.00	0.00	8.00	0.00	8.00
6.6	TECHNOLOGY DEVELOPMENT PROGRAMME	0.00	0.00	0.00	5.00	0.00	5.00	0.77	0.00	0.77	6.00	0.00	6.00
6.7	STATE SCIENCE & TECHNOLOGY PROGRAMME	0.00	0.00	0.00	12.00	0.00	12.00	9.00	0.00	9.00	5.00	0.00	5.00
6.8	NATIONAL MISSION ON NANO-SCIENCE & NANO-TECHNOLOGY	0.00	0.00	0.00	5.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00
6.9	INSPIRE	0.00	0.00	0.00	3.75	0.00	3.75	3.75	0.00	3.75	0.00	0.00	0.00
6.10	SCIENCE & ENGINEERING RESEARCH BOARD	0.00	0.00	0.00	15.00	0.00	15.00	15.00	0.00	15.00	3.93	0.00	3.93
6.11	DISHA PROGRAMME FOR WOMEN IN SCIENCE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	1.00
6.12	ALLIANCE AND R&D MISSION	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17.00	0.00	17.00
	TOTAL - SCSP	3.00	0.00	3.00	58.75	0.00	58.75	31.52	0.00	31.52	61.93	0.00	61.93
7	SCHEDULED TRIBE SUB-PLAN												
7.1	S&T COMMUNICATION AND POPULARISATION	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.50
7.2	S&T ENTREPRENEURHSIP DEVELOPMENT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.50
7.3	TRIBAL SUB-PLAN	3.00	0.00	3.00	3.00	0.00	3.00	3.00	0.00	3.00	4.00	0.00	4.00
7.4	AUTONOMOUS SCIENTIFIC INSTITUTIONS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.00	0.00	12.00
7.5	TECHNOLOGY FOR BAMBOO PRODUCTS	0.00	0.00	0.00	5.00	0.00	5.00	5.00	0.00	5.00	0.00	0.00	0.00
7.6	R&D SUPPORT (SERC)	0.00	0.00	0.00	14.00	0.00	14.00	0.00	0.00	0.00	8.00	0.00	8.00
7.7	TECHNOLOGY DEVELOPMENT PROGRAMME	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00	0.00	6.00
7.8	STATE SCIENCE & TECHNOLOGY PROGRAMME	0.00	0.00	0.00	8.00	0.00	8.00	6.00	0.00	6.00	5.00	0.00	5.00
7.9	NATIONAL MISSION ON NANO-SCIENCE & NANO-TECHNOLOGY	0.00	0.00	0.00	10.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
7.10	INSPIRE	0.00	0.00	0.00	3.75	0.00	3.75	3.75	0.00	3.75	0.00	0.00	0.00
7.11	SCIENCE & ENGINEERING RESEARCH BOARD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.93	0.00	7.93
7.12	DISHA PROGRAMME FOR WOMEN IN SCIENCE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	1.00
7.13	ALLIANCE AND R&D MISSION	0.00	0.00	0.00	15.00	0.00	15.00	15.00	0.00	15.00	17.00	0.00	17.00
	TOTAL - TSP	3.00	0.00	3.00	58.75	0.00	58.75	32.75	0.00	32.75	61.93	0.00	61.93
8	INTERNATIONAL COOPERATION PROGRAMMES												
8.1	INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED												
	RESEARCH (IFCPAR)	9.36	0.00	9.36	10.00	0.00	10.00	9.80	0.00	9.80	10.00	0.00	10.00
8.2	SCIENCE COUNSELLORS ABROAD	1.59	5.78	7.37	0.00	8.35	8.35	0.00	6.55	6.55	0.00	7.35	7.35

8.3	INDO-US SCIENCE AND TECHNOLOGY FORUM	3.10	0.00	3.10	10.00	0.00	10.00	10.10	0.00	10.10	10.00	0.00	10.00
8.4	INDO-GERMAN SCIENCE & TECHNOLOGY CENTRE	2.50	0.00	2.50	10.00	0.00	10.00	5.00	0.00	5.00	5.00	0.00	5.00
8.5	S&T COOPERATION WITH OTHER COUNTRIES	33.03	0.00	33.03	35.00	0.00	35.00	49.10	0.00	49.10	65.00	0.00	65.00
	TOTAL - INTERNATIONAL COOPERATION PROGRAMMES	49.58	5.78	55.36	65.00	8.35	73.35	74.00	6.55	80.55	90.00	7.35	97.35
9	STATE SCIENCE AND TECHNOLOGY PROGRAMME	26.79	0.00	26.79	50.00	0.00	50.00	40.00	0.00	40.00	60.00	0.00	60.00
10	TECHNOLOGY DEVELOPMENT BOARD	0.00	5.00	5.00	0.00	25.00	25.00	0.00	5.00	5.00	0.00	25.00	25.00
	TOTAL- OTHER SCIENTIFIC RESEARCH	1006.80	12.59	1019.39	892.50	34.85	927.35	999.86	13.05	1012.91	896.86	33.85	930.71
11	SCIENTIFIC SURVEYS (MODERNISATION OF MAPPING ORGANIZATIONS (SoI & NATMO)												
11.01	SURVEY OF INDIA	12.25	261.18	273.43	21.00	283.31	304.31	24.00	275.61	299.61	34.20	297.38	331.58
11.02	NATIONAL ATLAS AND THEMATIC MAPPING ORGANISATION	1.55	11.62	13.17	4.00	13.03	17.03	3.94	12.03	15.97	5.80	13.48	19.28
	TOTAL - SCIENTIFIC SURVEYS	13.80	272.80	286.60	25.00	296.34	321.34	27.94	287.64	315.58	40.00	310.86	350.86
12	AUTONOMOUS SCIENTIFIC INSTITUTIONS	570.00	19.00	589.00	698.00	15.00	713.00	643.00	15.00	658.00	676.00	12.60	688.60
	TOTAL - SCIENTIFIC INSTITUTIONS	570.00	19.00	589.00	698.00	15.00	713.00	643.00	15.00	658.00	676.00	12.60	688.60
13	SYNERGY PROJECTS (O/o the PRINCIPAL SCIENTIFIC ADVISER) (including CHAIN)	13.57	0.00	13.57	15.00	0.00	15.00	15.00	0.00	15.00	18.00	0.00	18.00
	TOTAL	13.57	0.00	13.57	15.00	0.00	15.00	15.00	0.00	15.00	18.00	0.00	18.00
14	INFORMATION TECHNOLOGY	1.25	0.00	1.25	2.00	0.00	2.00	2.00	0.00	2.00	5.00	0.00	5.00
15	NATIONAL TRAINING PROGRAMME FOR SCIENTISTS & TECHNOLOGISTS	5.00	0.00	5.00	5.00	0.00	5.00	5.00	0.00	5.00	0.00	0.00	0.00
	TOTAL	6.25	0.00	6.25	7.00	0.00	7.00	7.00	0.00	7.00	5.00	0.00	5.00
	NEW SCHEMES (Eleventh Five Year Plan)												
16	SCIENCE & ENGINEERING RESEARCH BOARD	0.00	0.00	0.00	270.00	0.00	270.00	170.00	0.00	170.00	388.14	0.00	388.14
17	SCHOLARSHIPS FOR SCIENCE IN HIGHER EDUCATION (OVERSIGHT COMMITTEE RECOMMENDATION)	39.91	0.00	39.91	60.00	0.00	60.00	75.00	0.00	75.00	0.00	0.00	0.00
18	WATER TECHNOLOGY INITIATIVE	14.35	0.00	14.35	40.00	0.00	40.00	30.00	0.00	30.00	0.00	0.00	0.00
19	INNOVATIONS IN SCIENCE PURSUIT FOR INSPIRED RESEARCH (INSPIRE)	230.38	0.00	230.38	292.50	0.00	292.50	247.50	0.00	247.50	0.00	0.00	0.00
20	INNOVATION CLUSTERS	7.00	0.00	7.00	7.00	0.00	7.00	12.00	0.00	12.00	0.00	0.00	0.00
21	SECURITY TECHNOLOGY INITIATIVE	6.05	0.00	6.05	7.00	0.00	7.00	4.70	0.00	4.70	0.00	0.00	0.00
22	MEGA FACILITIES FOR BASIC RESEARCH	24.78	0.00	24.78	35.00	0.00	35.00	20.00	0.00	20.00	30.00	0.00	30.00
	TOTAL	322.47	0.00	322.47	711.50	0.00	711.50	559.20	0.00	559.20	418.14	0.00	418.14
	NEW SCHEMES (Twelfth Five Year Plan)												
23	POLICY RESEARCH CELL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00	10.00
24	DISHA PROGRAMME FOR WOMEN IN SCIENCE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.00	0.00	47.00
25	ALLIANCE AND R&D MISSION	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	366.00	0.00	366.00
	TOTAL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	423.00	0.00	423.00
	GRAND TOTAL	1932.89	347.88	2280.77	2349.00	393.64	2742.64	2252.00	363.14	2615.14	2477.00	405.86	2882.86