Outcome Review of CSIR Schemes

Comprehensive review of CSIR-New Millennium Indian Technology Leadership Initiative (NMITLI) Programme, R&D Management Support (RDMS) and Intellectual Property & Technology Management (IPTM)

A Report by Dr. V.K. Saraswat Committee

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Structure of Report

Executive Summary

A review committee was constituted under the chairmanship of Dr. V.K. Saraswat, Member S&T, NITI Aayog for outcome review of CSIR Scheme, namely (i) CSIR-New Millennium Indian Technology Leadership Initiative (NMITLI) Programme, (ii) R&D Management Support (RDMS); and (iii) Intellectual Property & Technology Management (IPTM), pursuant to DSIR OM no. DSIR/Misc/2016-IFD dated 31st October 2016 at the instance of Ministry of Finance (Deptt. of Expenditure) directives on Appraisal and Approval of Public Funded Schemes and Projects vide OM No. 24(35)/PF-II/2012 dated 5th August 2016. The committee has reviewed the schemes. Based on the presentations on the schemes, followed by in depth discussion and recommendations of the Committee, the report has been developed.

CSIR-New Millennium Indian Technology Leadership Initiative (NMITLI) Programme: The NMITLI Programme was initiated in 2001 at pilot level which was approved by Cabinet Committee on Economic Affairs (CCEA) in 2003 for implementation as an umbrella scheme. NMITLI seeks to catalyse innovation centered scientific and technological developments as a vehicle to attain for Indian industry a global leadership position, in selected niche areas in a true 'Team India' spirit, by synergising the best competencies of publicly funded R&D institutions, industry and academia.

Over the years, NMITLI has emerged as a unique programme. It has enabled conceptualization, development and operationalization of several projects, which were managed under the programme very effectively to achieve the identified objectives. The projects were under two broad categories namely: (a) Nationally Evolved Projects (NEP) evolved through National consultations; and (b) Industry Originated Projects (IOP), which were based on ideas / concepts received from industry against the national level calls every year and were generally aimed at creating technological / product niches. The selection process of NMITLI projects has been very stringent which involved scrutiny at a number of levels i.e. at the levels of: Screening Committee; Area Expert Committee; Domain Experts Committee; and High Powered Committee and the final approval by DG, CSIR. The project selection rate was about 4%.

A two-tier tight monitoring system was introduced by NMITLI to ensure realization of the project deliverables. At the first level was Steering Committee comprising of PIs, meeting once in 3 months and at the second level an external independent Monitoring Committee comprising of recognized peers, meeting once in six months.

CSIR had undertaken 79 projects for implementation. These were in the area of Drugs and Pharmaceuticals (16 projects), Information and Communication Technology (8 projects), Energy (11 projects), Materials (10 projects), Agriculture (9 projects), Bioinformatics (4 projects) and Biotechnology (13 projects), Chemistry (8 projects). Out of which 68 projects have been completed and 11 are ongoing. These

projects included about 418 partners (318 Public and 100 Private). So far, about Rs. 696 crore have been released which included Rs. 398 crore as grant to Academic and R&D institutions and Rs. 298 crore as loan to industry.

The NMITLI programme has made significant contributions. The first and foremost achievement of NMITLI has been in bringing a paradigm shift in the way R&D is pursued in the country. It successfully networked R&D institutions, Universities and Industry and created a model for working in a synergistic mode, to achieve the objectives of well-developed outcome driven projects. The NMITLI has been able to make significant impact on "Innovation Ecosystem". The efforts were appreciated by the stakeholders. NMITLI became a role model for Government Departments. Based on NMITLI Model, many schemes have been launched by various Departments/ Ministries of Government of India.

So far, about 202 patents have been filed and 659 papers have been published. About 31 technologies/products have been developed. Several technologies/products have been commercialized. The major achievements include products/technologies like MicroPCR, JD Vaccine, Novel molecular diagnostics for eye diseases Cleaner Leather Processing, Fiber Supercontinuum Light Source, Broadband Confocal Microscope, 3 kWe PEMFC System, Solutions for Security and Operations based on UV sensor technologies, IVSS System, Four-door four-seater battery operated electric car (e2o Plus), Electrical Three Wheeler - Soleckshaw Lite, nonClonableID technology for medical product authentication, novel DPP IV Inhibitors for the treatment of Diabetes, novel biotech therapeutic molecule – Lysostaphin, Dental implants, Novel Therapy for Management of Sepsis, Ashwagandha, Functional genomics in Tea, Functional Genomics in Mentha, Process for 1, 2-PDO, process for synthesis of Dimethyl carbonate (DMC) from methanol and urea etc.

The committee appreciated the efforts and achievements of NMITLI in particular for leveraging synergy of National Innovation System (NIS) through creation of desired networks of industry, national laboratories / R&D institutions and academia, for developing well positioned technology and products, through focussed and well positioned projects. The Committee noted with satisfaction that several technologies/ products developed have been commercialized. The Committee recommended that:

- NMITLI should fund project(s) in totality beginning from proof of concept/ lead stage to commercialization. The stage gate methodology could be applied to review the projects once funded;
- The screening and selection process of NMITLI projects is too long and cumbersome. The process needs to be made simpler by adopting shorter two-step selection process; and
- NMITLI should create mechanism for reviewing the commercialization plan of the technology/products being developed under the given project(s) and hand hold industry through a peer group, in case so required by the industry.

Considering the significant achievements made in terms of technologies/ products development and commercialization realised under the NMITLI programme, Committee recommended continuation of the scheme/ programme beyond 12th Five Year Plan period.

Intellectual Property & Technology Management (IPTM): CSIR has been a trend setter in Intellectual Property (IP) generation and securing in the country. In CSIR, IP management is done through an integrated approach which included drafting, filing, prosecution and maintenance of all types of IP (patent, trademark, copyright etc.). The IP policy in place and practiced over the years has aimed *"to maximise the benefits to CSIR from its intellectual capital by stimulating higher levels of innovation through a judicious system of rewards, ensuring timely and effective legal protection for its IP and leveraging and forging strategic alliances for enhancing the value of its IP".*

The Committee noted that the IPTM scheme was continued from earlier plans to 12th Five Year Plan with activities like filing, capturing, prosecution and maintaining of IP for CSIR's R&D output(s); formation, valuation of IP portfolio; and surveillance for infringement & enforcement of IPR. It was recognized that CSIR maintains a significant IP portfolio in diverse technology domains.

The achievements of IPTM scheme have been noteworthy. During 11th and 12TH Five Year Plans, CSIR was granted about 2902 foreign patents and 1387 Indian patents, and about 2340 Indian and more than 1390 foreign patent applications were under consideration. CSIR filed about 3410 foreign patent applications and 2230 Indian patent applications. CSIR created IP portfolios in the areas of drugs and pharmaceuticals, food products & processes and herbals products and processes, leather, optical fiber, bio-informatics, biotechnology, nanotechnology and polymers. CSIR has been placed strategically on the world map by capturing about 57**%** share of total US patents granted to Indians excluding foreign assignee during 11th and 12th Five Year Plans. CSIR has strengthened its capacity in the field of IP management during the period 2007-2017 in the areas of techno-legal drafting, licensing, pricing and other aspects of IP management, patent search and analysis and IP awareness. CSIR has made efforts for valorization of its IP by forming alliances with licensing firms abroad.

The Committee appreciated that the patenting activity has led to recognitions not only to CSIR but to the country at large. The patenting activity forms one of the parameter for the ranking as per the Global Innovation Index. CSIR featured in the Thomson Reuters top 50 Indian Innovator Companies and Research Organizations for the year 2015, who lead the country's innovation output. As per Nature Index-2016, CSIR ranked 75th among the top 200 institutions of the world. CSIR has been ranked 9th in the world amongst the 1207 government institutions, with an overall global ranking of 75 in the world, covering 5250 institutions. In the Asiatic region, it ranks at 14 overall out of 1431 entities, and at no 3 among 284 Government-funded research bodies, with only Chinese Academy of Sciences and Japan Science and Technology Agency ahead of the Council.

CSIR is the only Indian Organization among the Top 100 global institutions. A total of 252 Indian organizations are covered in the evaluation.

The patenting efforts of CSIR have been recognized through various awards. These awards are given for filing & grant of IP and excellence in innovation. The awards conferred upon CSIR include: "Intellectual Property Award" by Indian Patent Office for securing highest number of patents in the year 2009; "Thomson Reuter Innovation Award-2010" for securing highest number of patents during the year 2008-2009; "National Intellectual Property Award-2013" of Indian Patent Office for securing highest number of patents during five years period ; and "India Innovation Award 2013" from Thomson Reuters in the Hi-Tech Academic in Government category for the year 2013-14. The Committee recommended following in respect of IPTM:

- The system in place for IP management in CSIR may be shared with those Universities and R&D institutions in India who do not have such system in place;
- The filing of patents in the area of physical sciences and engineering sciences should be enhanced which are less at present in comparison to chemical sciences and biological sciences; and
- CSIR should make efforts to create a national facility/outreach center for providing IP related services to R&D Organizations and Universities across India.

The Committee, considering the performance of CSIR's IPTM scheme, recommended it for continuation beyond 12th Five Year Plan.

R&D Management Support (RDMS): CSIR has 38 constituent laboratories spread across India and 39 outreach centres attached to these laboratories with its headquarters in Delhi. The various functional units/divisions located in CSIR HQs. provide the R&D Management Support to the national laboratories through the scheme. The HQs is the focal point of the organization. It enables, catalyses and facilitates the activities of laboratories for achieving excellence in R&D, financial self-sufficiency, global competitiveness. It helps in building the brand equity and disseminates information and helps in technology deployment and building the partnership with stakeholders. It also provides support to the laboratories for human resource development and international scientific collaboration. The CSIR HQs undertakes performance appraisal and scientific audit. It is an organic link between the laboratories, the government, the parliament, international agencies and stakeholders.

The Committee noted that the R&D Management Support System is provided by various constituents of CSIR HQs namely, erstwhile Planning and Performance Division (now represented by Research, Project Planning & Business Development Directorate and Mission Directorate), International S&T Affairs Directorate and Unit for Science Dissemination. The major activities/achievements of RDMS include:

- R&D Planning Activity: The activity included preparation of XII Five Year Plan, 158 plan projects and project management as part of the plan activity; project

review and monitoring through Task force, Research Council, Sectoral Monitoring Committees; formulation of about 138 Fast Track Translational (FTT) research projects; formulation of about 10 mission projects in the first tranche (of which 4 projects have been made operational); dealing with Department-related Parliamentary Standing Committee on Science & Technology, Comptroller & Auditor General (C&AG) of India; preparation of the outcome budget; and the management of CSIR Awards (CSIR Technology Awards, CSIR Diamond Jubilee Technology Awards and CSIR Award for S&T Interventions for Rural Development).

- International Collaboration: In order to enhance S&T capabilities, CSIR has been strengthening its cooperation with the developed world through desired international collaboration activities. Some of the activities are: international exchange fellowships; deputing expert delegations abroad and receiving delegations from abroad; study tours; deputation of CSIR scientists abroad; and participation in international projects. These activities are performed to enable CSIR's scientists to keep abreast with latest developments in frontier and upcoming areas. Under bilateral cooperation effort, 60 new collaborations were established with the partners from 36 Countries (Australia, France, Germany, Italy, Japan, Russia, UK, USA etc.) and 170 joint research projects were undertaken. About 20 Workshops / Meetings / Summer Schools organized. Under Multilateral Cooperation effort, cooperation with EU, BRICS, SAARC countries was strengthened. CSIR has been part of Global Research Alliance (GRA) and its scientists have established linkages with the member countries. CSIR is also a member of the NAM S&T-Industry Network. For Human Resource Development through training abroad, CSIR operated schemes like Raman Research Fellowship, Exchange of Scientists programme and TWAS Fellowships (awarded to foreign researchers for working in CSIR institutes).
- S&T Dissemination: Recognizing the fact that it is important to inform the people of India about the relevance of CSIR to them by way of regular dissemination of information on important technological developments, several S&T dissemination activities were performed by CSIR. These functions are executed through various means including Print Media; Electronic Media and Social Media; and Interactive platforms (Exhibitions, Science Festivals, Press Meets, Tableau etc.). CSIR showcased its achievements in various national and international expositions held across India including India Technology Pavilion, Hannover, Germany (2016); India-Rwanda Technology & Innovation Expo-2017, Rwanda; India Sourcing Fair, Kazakhstan (2015); India Innovation Summit & Expo, USA (2013); Regular participation in Indian Science Congress; Agritech India-2015, Bengaluru; Swadeshi Mela-2016, Kashi; Vibrant North East-2016, North East Calling- 2017, New Delhi; International Conference and Exhibition on Materials Engineering Technology-2014, Gujarat; Bangalore India Bio-2015; etc. Besides above-listed events CSIR has been participating in a number of other exhibitions as well. CSIR organized CSIR Technofest as the part of India International Trade Fair 2016 in a mega way. In this 14-day event, a large number of footfalls were observed including a large number of school children. Various quiz programmes

(Science-based), Popular Science Lectures, B-2-B meetings were organized during the event. CSIR organized India International Science Festival at CSIR-NPL during 07-11 December, 2016 on behalf of the Ministry of Science and Technology and the Ministry of Earth Sciences. The event was received well and created a benchmark.

The Committee discussed in detail activities related to 'Planning and Performance', 'International S&T Collaboration' and 'Science Dissemination' carried out under the R&D Management Sub-Scheme. The observations and recommendations of the committee are as below:

- Planning and Performance: A number of activities were pursued in this domain which include interaction with NITI Aayog, Department-related Parliamentary Standing Committee on Science & Technology, Ministry of Finance, Parliament and other socio-economic Ministries/Departments. It also included the appraisal and approval of projects and monitoring and evaluation of projects. A report on the CSIR activities was presented to the Parliament, Society, GB and other designated committees. The committee appreciated the efforts and methodology adopted to carry out diverse activities.
- International S&T Collaboration: CSIR laboratories need to benchmark continuously their knowledgebase including outputs and outcomes internationally. CSIR has been strengthening international cooperation with the developed and developing world. It has established successful linkages with various S&T organizations and some projects were in progress. The Committee recommended that under the globalized world, CSIR need to put more efforts for enhancing the international collaboration.
- S&T Dissemination: Connecting with the stakeholders and building the brand value through desired connect and image building exercises was very much essential for CSIR. In doing and achieving these, CSIR has carried out various activities fairly well. The committee suggested that quantum of diverse science dissemination activities be further enlarged and enhanced in terms of scale and delivery so as to reach the stakeholders and masses more and more and remain connected with them.

The Committee recommended continuation of R&D Management sub-scheme beyond 12th Five Year Plan in view of its diverse activities which were contemporary and significant results achieved, due to systematic persuasion of them, in a time bound manner.

The Committee appreciated the R&D efforts of CSIR in diverse S&T domains and the connect it has with its stakeholders. It was of the view that the desired focus now in a scaled up mode on translational research with stakeholder partnership should be continued with time bound delivery. CSIR is an integral component of the National Innovation System (NIS) and its performance matters for the positioning of the country in the technology and knowledge space globally.

I. New Millennium Indian Technology Leadership Initiative (NMITLI) Programme

1.0 Constitution of the Review Committee

An Office Memorandum No. DSIR/Misc/2016-IFD dated 31st October 2016 was issued by DSIR giving reference to Ministry of Finance (Deptt. of Expenditure) OM No. 24(35)/PF-II/2012 dated 5th August 2016 on Appraisal and Approval of Public Funded Schemes and Projects. As mentioned in the OM, all programme divisions and CSIR need to undertake an outcome review immediately with a view to decide as to which schemes are to be continued beyond 12th FYP i.e. 31st March 2017.

Accordingly, a Review Committee was constituted by Director General, CSIR to review following three schemes / programmes:

(i) New Millennium Indian Technology Leadership Initiative (NMITLI) Programme;

(ii) Intellectual Property and Technology Management Scheme (IPTM); and

(iii) R&D Management Support.

The Review Committee comprised of the following:

(i) Dr. V.K. Saraswat, Member, NITI Aayog-Chairman

(ii) Dr. Baldev Raj, NIAS-Member

(iii) Prof. N.K. Ganguly, Former DG, ICMR-Member

(iv) Dr. G.N. Qazi, Jamia Hamdard, Delhi-Member

(v) Prof. N.K. Mehra, AIIMS, New Delhi-Member

(vi) Prof. A.T. Kusre, IIT, Bombay-Member

(vii) Dr. Krishna Ella, CMD, BBIL, Hyderabad-Member

(viii) Dr. P.K. Biswas, Former Advisor, Planning Commission-Member

(ix) Dr. R.R. Hirwani, CSIR-URDIP-Member

(x) Dr. D. Yogeswara Rao, CSIR, Delhi-Member

(xi) Dr. S. Srikanth, Head-RPPBDD-Member

(xii) Dr. Sudeep Kumar, Head-Mission Directorate- Convener

Dr. Anjan Ray Participated in meeting in place of Dr. S. Srikanth as he has now assumed of the charge of Head, RPPBDD and become ex-officio member of the committee.

The Terms of Reference of the aforesaid Committee were:

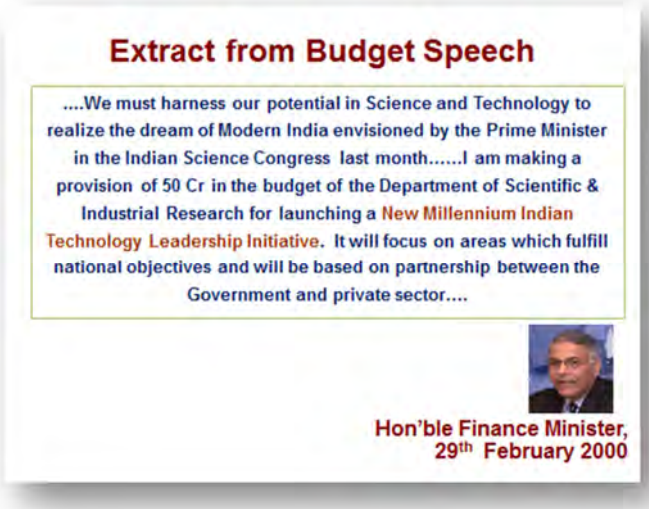
- Review the physical progress of the schemes/sub-schemes/programmes;
- Review financial progress of the schemes/sub-schemes/programmes;
- Assess and identify potential schemes/sub-schemes/programmes that can be taken up for further continuation and recommend continuation/merger of schemes/sub-schemes/programmes, or their discontinuation; and
- Submit a report to DG, CSIR with key observations and recommendations on the schemes/sub-schemes/programmes.

The committee met on August 28, 2017 at CSIR Science Centre, New Delhi and reviewed the NMITLI Programme.

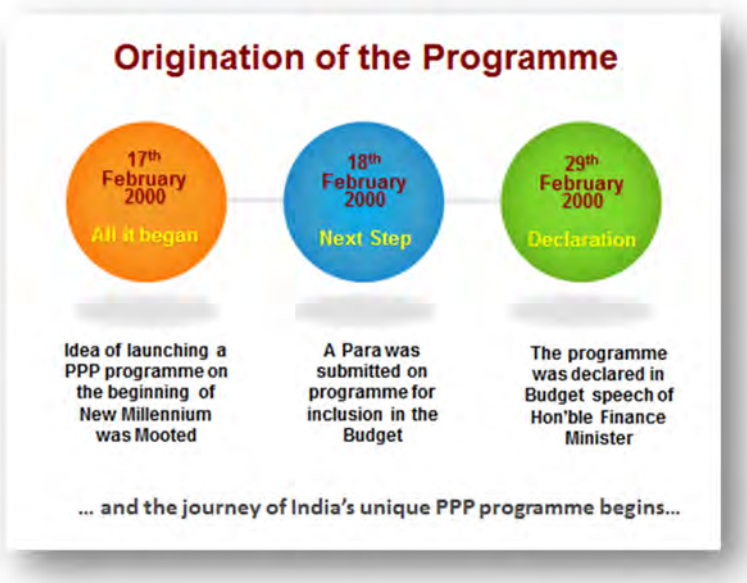
2.0 Genesis of NMITLI Scheme

The genesis of NMITLI was the address of the Hon'ble Prime Minister to the Indian Science Congress, at Pune on 3rd January 2000, wherein he called upon the scientific community to ***make the 21st Century India's Century – Ikkeesvin shatabdi Bharat Ke Shatabdi.*** Thereafter, the Hon'ble Minister for Science & Technology had enlarged upon the theme by exhorting the scientific community (on 21st February, 2000) to **take up the challenge to create Indian Science that will lead and not follow.**

The Hon'ble Finance Minister followed it up with a determined action. In his Budget - 2000 address to Parliament, he said that: "*We must harness our potential in Science and Technology to realize the dream of modern India envisioned by the Prime Minister in his address to the Indian Science Congress last month……I am making a provision of Rs. 50 crore in the budget of the Department of Scientific and*



Industrial Research for launching a ***New Millennium Indian Technology Leadership Initiative****. It will focus on areas which fulfil national objectives and will be based on partnership between the Government and private sector".* Developing globally competitive technology is often risky, costly and needs long drawn out effort and perseverance. It involves mounting of a minimum threshold size of R&D and technology development, generally envisaging trans and multi-disciplinary inputs that are difficult and often uneconomic for any single industry or a firm to assemble in-house. At the same time, Indian S&T had attained excellence in selected areas. The need then was for synergising and dovetailing the dispersed national competencies symbiotically and cost effectively. The Scheme was thus the first bold initiative of the government to enable industry to capture global leadership position, in selected areas, based on technology as the strategic resource.



The New Millennium Indian Technology Leadership Initiative (NMITLI) has thus been conceived as a vehicle, for select Indian industry players, to attain a global leadership position, in niche areas, based on technology advantage, by forging true 'Team India' partnership with publicly funded R&D institutions & academia. It is based on the premise of consciously and deliberately identifying, selecting and supporting potential winners.

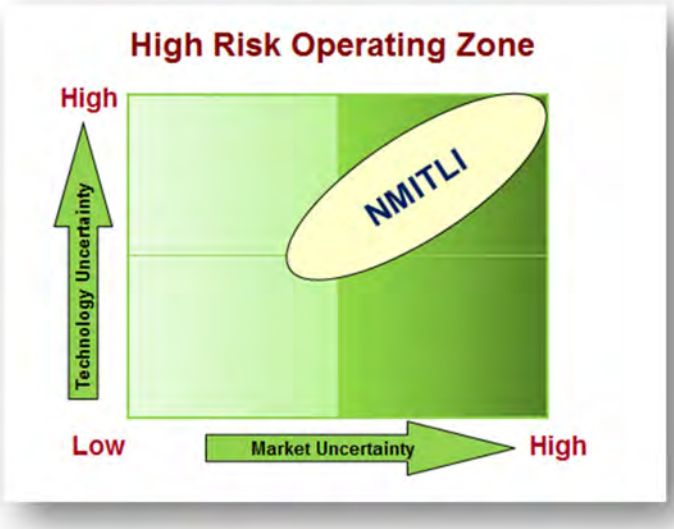
The NMITLI Programme was approved by Cabinet Committee on Economic Affairs (CCEA) in 2003. There are two broad categories of projects supported under the scheme viz. (a) evolved through National consultations; and (b) industry originated projects (that aspire for global leadership).

2.1 Objective

NMITLI seeks to catalyse innovation centred scientific and technological developments as a vehicle to attain for Indian industry a global leadership position, in selected niche areas in a true 'Team India' spirit, by synergising the best competencies of publicly funded R&D institutions, academia and private industry.

2.2 Distinctive Features of the Programme

The strategy adopted for NMITLI is to obtain an inverse risk-investment profile i.e. low investment - high-risk technology areas (with global leadership potential) with investments increasing as developments take place and the projects move up on the innovation curve with reduction in risks.



Therefore, the programme has been positioned differently with certain distinctive features. These features have been evolved based on large scale national consultation and due diligence. Some of these are briefly highlighted below:

A proactive programme - Instead of funding a project based on requests/applications, the programme identifies the areas for development based on

national consultation and invites best partners from institutions, academia and private sector to play a role in the development;

Types of Projects: Both 'push' and 'pull' type of projects are evolved under NMITLI, which are appropriately named as (i) Nationally Evolved Projects (NEP) and (ii) Industry Originated Projects (IOP);

PPP mode - Almost all projects are built in a public-private partnership mode;

Emphasis on identifying and building the projects - Greater emphasis is laid on identifying the niche areas and building the projects with the help of best brains in the country. A specially constituted project wise expert group builds the project by interacting with a large number of researchers and stake holders with focus on technology development;

S&T inputs - High quality technical inputs are provided at both project development as well as at implementation stage;

Monitoring & review system - A two-tier tight monitoring system is introduced to ensure realization of the objectives and deliverables. At the first level is an internal Steering Committee comprising PIs (meets once in 3 months) and at the second level an external independent Monitoring Committee comprising recognized peers (meets at least once in six months). The later committee is entrusted with the responsibilities to recommend: (i) foreclosure or modification of the project or sub component; (ii) inclusion of additional institutional / industrial partners wherever necessary; and (iii) revising the funding support to any / or all implementing partners;

IP mapping - The programme provides for continuous mapping of the IP scenario for each project and in licensing of IP with a view to building of a portfolio and achieving the leadership position;

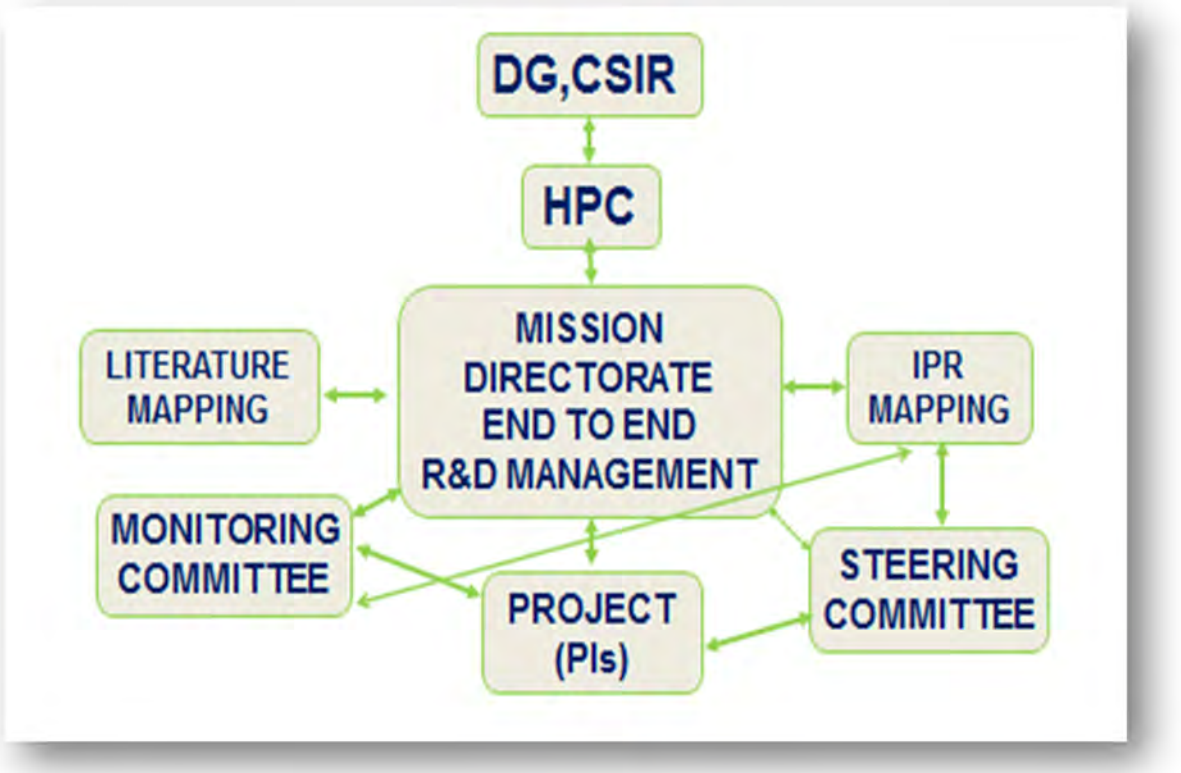
Foreclosure of projects - the programme also provides for foreclosure of the non-performing or non-achievable project components; and

Financial support – An innovative feature of the programme is that it provides financial support to all players in the project. The support is in the form of grant-in-aid to the institutional partners in public domain and as a soft loan (@3% interest) to the industrial partners.

3.0 Focused activities of NMITLI

Management Structure

A dynamic and vibrant management system has been put in place to manage the Programme and projects. At the hub of the management structure is the Mission Directorate, which manages the entire programme. It interacts with PIs and the Monitoring Committee on one hand and the High Powered Committee and DG, CSIR on the other.



Project Types

There are two broad categories of projects supported under NMITLI viz. (i) nationally evolved projects; and (ii) industry originated projects.

Nationally Evolved Projects (NEP):

The Nationally Evolved Projects follow a step-wise procedure. It begins with wide-ranging consultation to elicit ideas. The short listing of the ideas is done by a "Screening Committee" followed by selection of broad areas by the domain Expert

Groups. The projectization of the areas is then carried out by "domain champions". The best players in the field are then approached and invited to participate in the project. Once the project is finalized it is reviewed and considered by the High Powered Committee (HPC). The HPC recommended projects are then considered for support by DG, CSIR.

Industry Originated Projects (IOP):

For this category of projects the process begins by soliciting of proposals through press advertisement and letters from DG, CSIR. The screening of the conceptual proposals thus received is carried out by a "committee" followed by assessment and rating of short listed ideas by the domain experts. The development of top rated two ideas in each domain is undertaken with the assistance of NMITLI designated experts. The project thus finalized are considered and reviewed by the HPC and the recommendations of HPC are considered by DG, CSIR in order to decide on the projects to be supported in a given period.

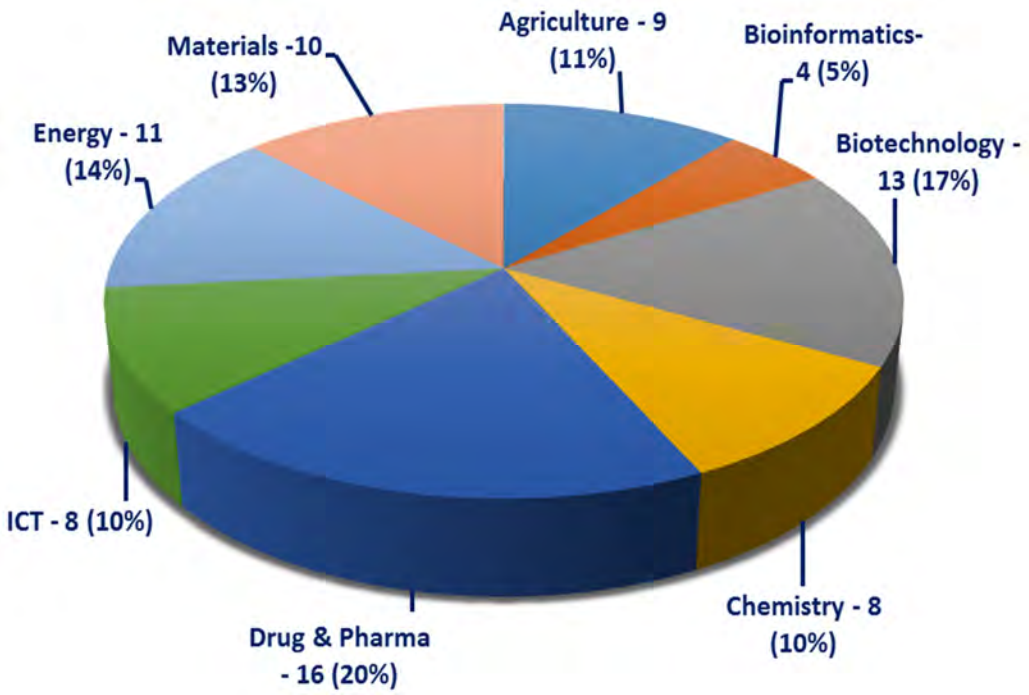
The companies registered in India and having more than 50% of shareholding by Indians/non-resident Indians are eligible for support under this category. However, at any given time not more than two projects of any individual company are supported.

Financial Support:

The financial support to all the projects under NMITLI Scheme is in the form of grant-in-aid to the institutional partners in public domain and as soft loan (@ 3% interest) to the industrial partners.

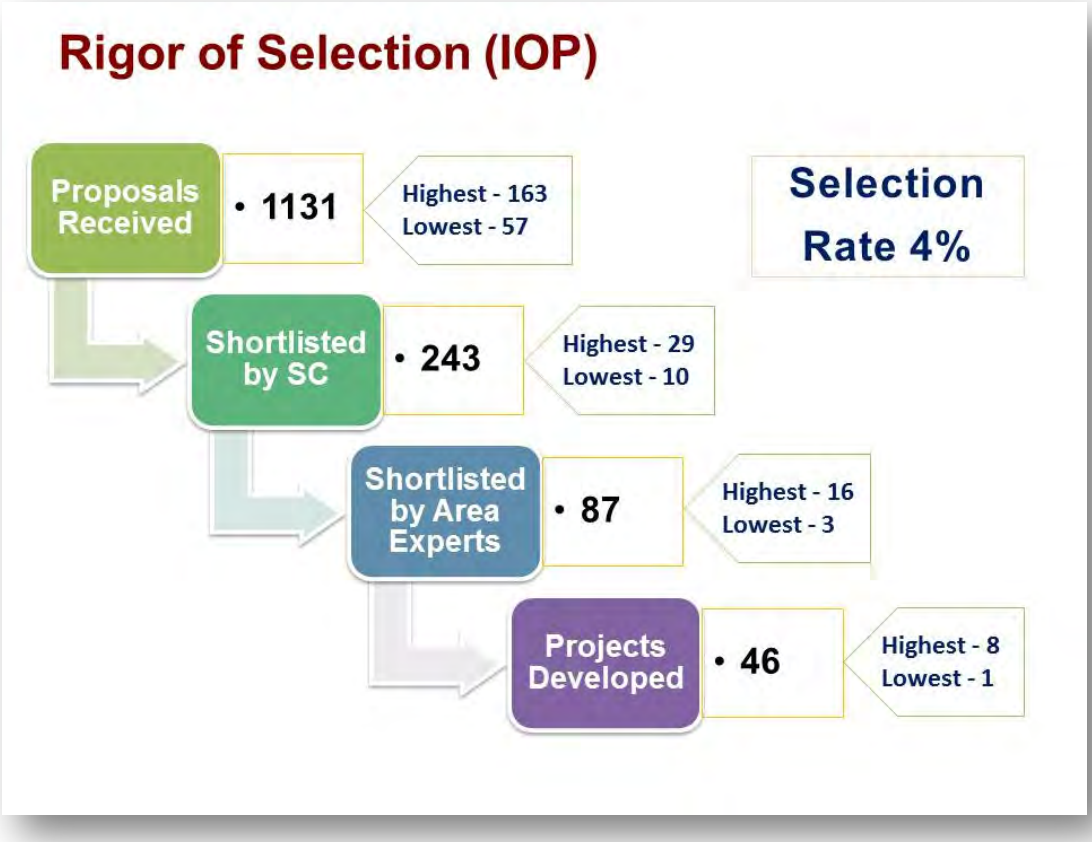
Spread of Projects:

CSIR has undertaken 79 projects for implementation so far. These are in the area of Drugs and Pharmaceuticals, Information and Communication Technology, Energy, Materials, Agriculture and Plant Biotechnology, Biotechnology, Chemistry etc. Spread of 79 projects over these areas are given below:

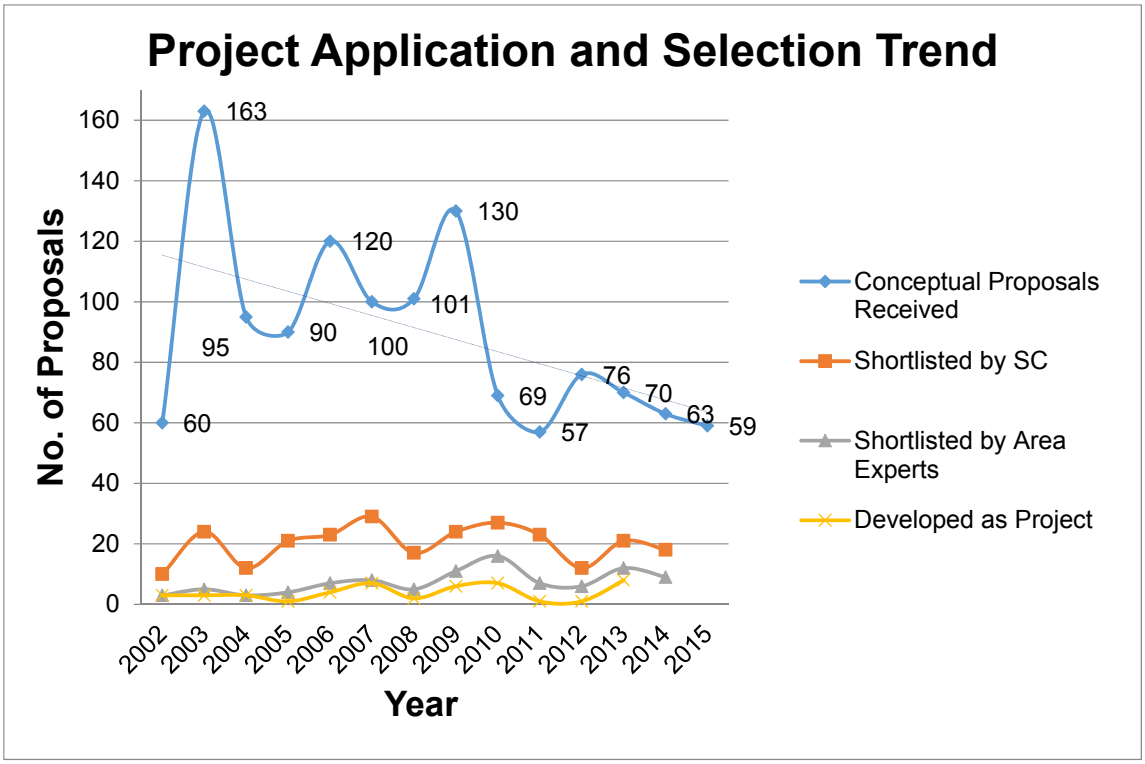


Rigour of Selection (IOP):

Selection process for Industry Originated Projects is very stringent. Experience indicates that less than 5% of the projects get qualified for development under NMITLI.



Project Application and Selection Trend



Rigour of Selection (NEP)

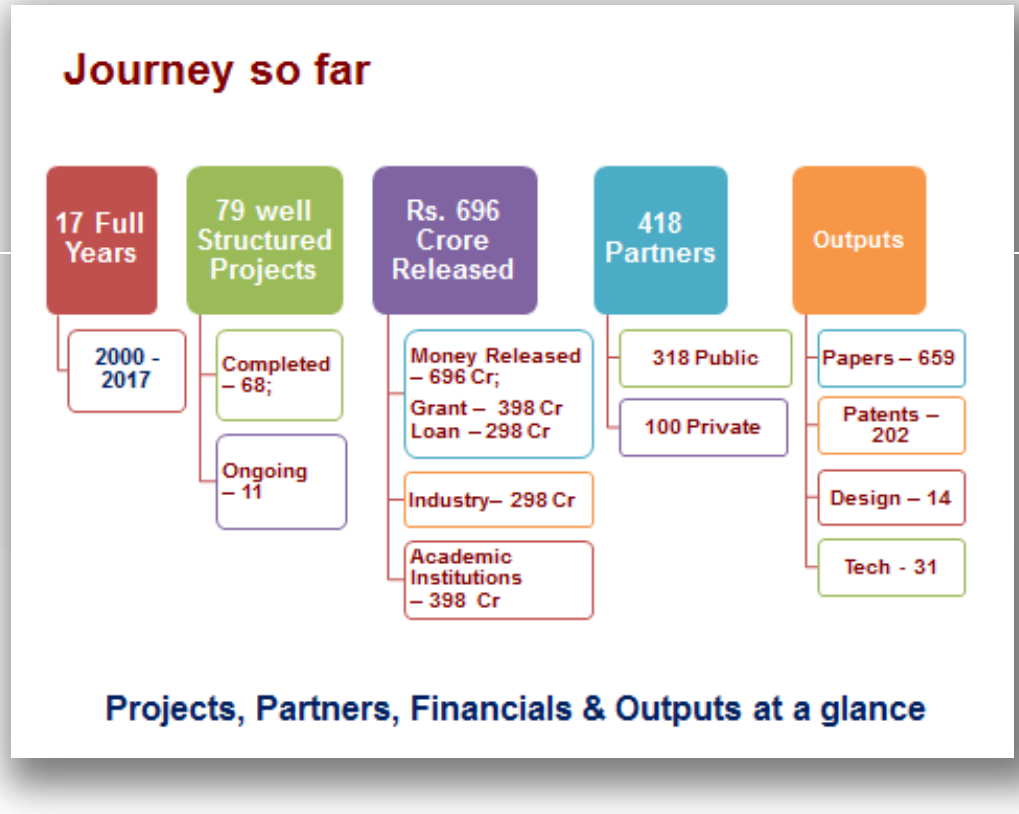
Under NEP category 85 brainstorming meetings were held and 33 projects were developed.

Monitoring of NMITLI Projects:

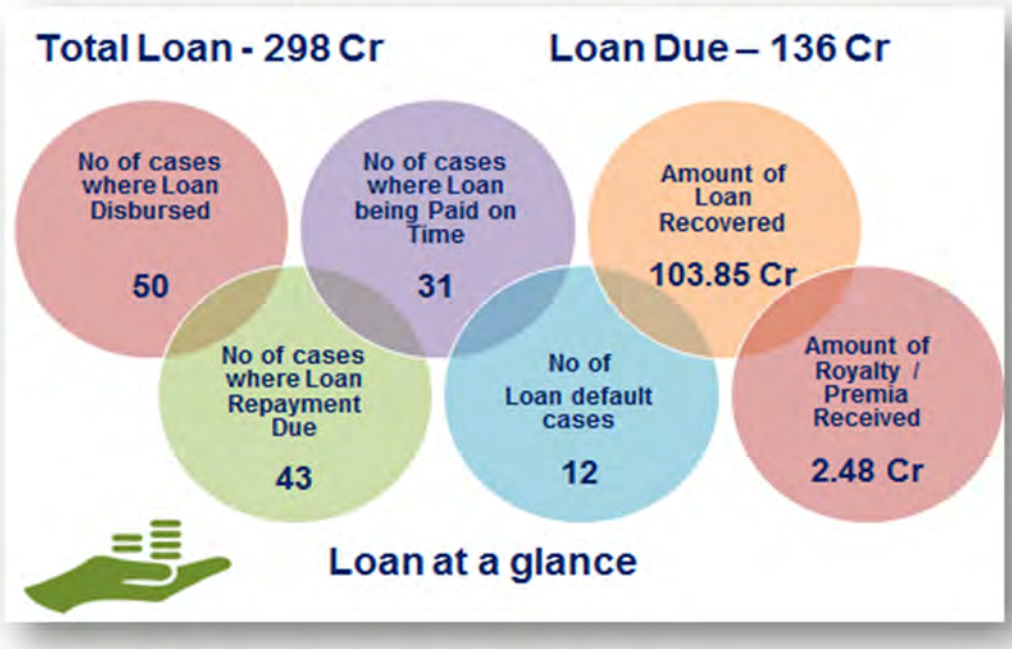
For closely monitoring and reviewing the projects, a two tier system is adopted which ensures realization of the objectives and deliverables. At the first level, there is an internal Steering Committee comprising Principal Investigators (PIs), which meets once in 3 months, monitors and sets its own periodic targets to be achieved. At the second level, an external independent Monitoring Committee comprising recognized peers reviews the project once in six months and guides the project towards its final objectives. Besides reviewing the progress of the project in conformance with the objectives, the later committee is entrusted with the responsibilities to recommend: (i) foreclosure or modification of the project or sub component; (ii) inclusion of additional institutional / industrial partners wherever necessary; and (iii) revising the funding support to any / or all implementing partners.

Tabular Brief: Summary of Project

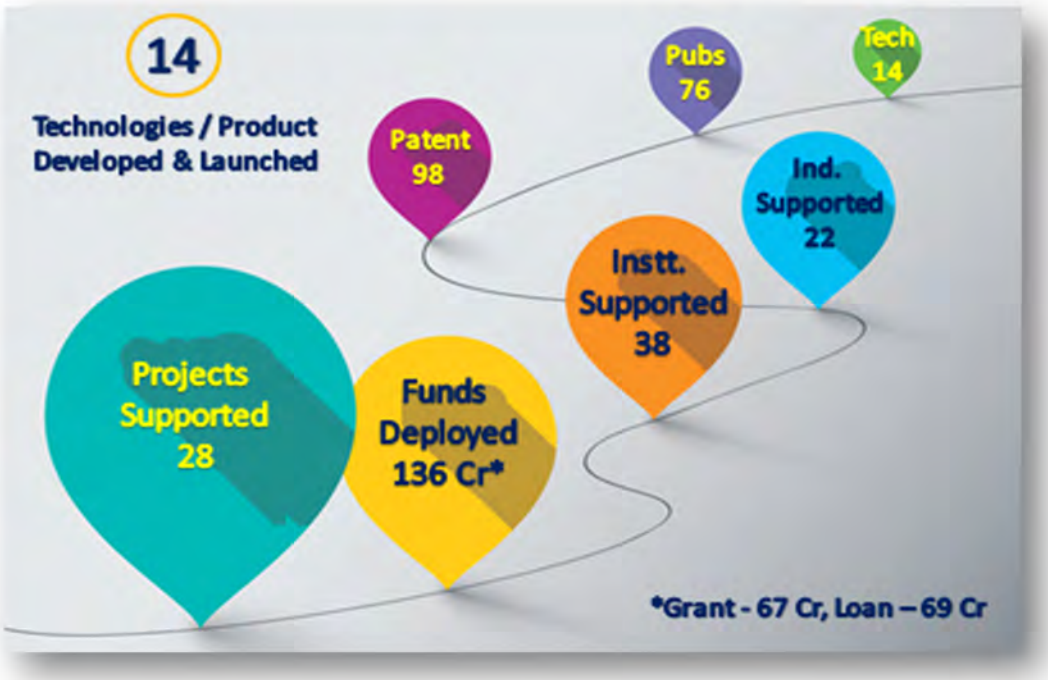
Performance including Financial Performance of NMITLI



Loan Repayment under Scheme

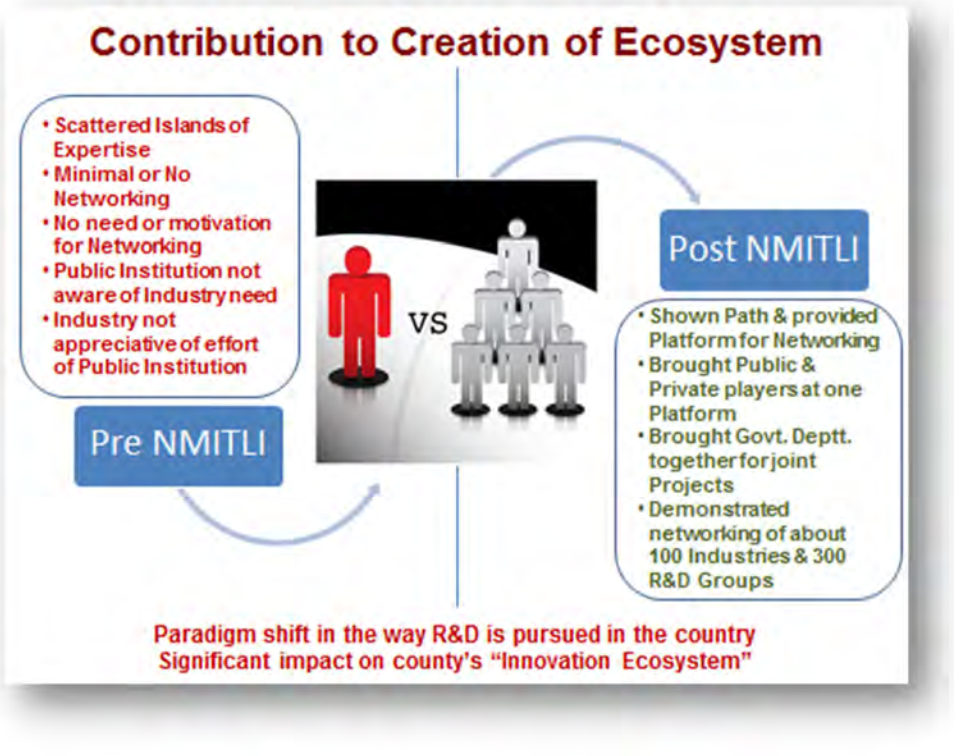


NMITLI Outputs in Preceding 5 Years



4.0 NMITLI as a catalyst for National R&D Ecosystem

The NMITLI has been able to make significant impact on our county's "Innovation Ecosystem". It is being appreciated by the stakeholders. NMITLI has become a role model for governments departments. Based on NMITLI Model, following schemes have been launched by various departments/ministries of Government of India:



DBT - Small Business Innovation Research Initiative (SBIRI):

The Small Business Innovation Research Initiative (SBIRI) scheme of the Department of Biotechnology, Ministry of Science & Technology was launched in 2005 to boost Public-Private- Partnership (PPP) efforts in the country. SBIRI was the first of its kind, early stage, innovation focused PPP initiative in the area of Biotechnology. Launching of SBIRI has worked as an enabling platform for the target organizations to realize their potential in terms of product and process development and taking them to the market. It has facilitated innovation, risk taking by small and medium companies and bringing together the private industry, public institutions and the

government under one roof to promote the research and innovation in the Indian Biotech Sector.

DBT - Biotechnology Ignition Grant (BIG):

Biotechnology Ignition Grant (BIG) is available to scientist entrepreneurs from research institutes, academia and start-ups. The Applicant must be either an Incubatee or have a registered company with a functional R&D laboratory to be eligible for this grant. The scheme is designed to stimulate commercialization of research discoveries by providing very early stage grants to help bridge the gap between discovery and invention.

DST - Drugs and Pharmaceuticals Research Programme (DPRP):

Recognising the profound influence of R&D on the prospects and opportunities for the growth of the Indian Drug Industry, Department of Science and Technology (DST), Government of India mounted the programme on drug development during 1994-95 for promoting collaborative R&D in drugs and pharmaceuticals sector with the following specific objectives:

- To synergise the strengths of publicly funded R&D institutions and Indian Pharmaceutical Industry;
- 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; and
- To enhance the nation's self-reliance in drugs and pharmaceuticals especially in areas critical to national health requirements.

During January 2004, Government of India established Drug Development Promotion Board (DDPB) under the administrative control of DST for supporting R&D projects jointly proposed by industry and academic institutions/ laboratories and to extend soft loan for R&D to drug industry.

DBT - Biotechnology Industry Partnership Programme (BIPP):

Biotechnology Industry Partnership Programme (BIPP) is a government partnership with Industries for support on a cost sharing basis for path-breaking research in

frontier futuristic technology areas having major economic potential and making the Indian industry globally competitive. It is focused on IP creation with ownership retained by Indian industry and wherever relevant, by collaborating scientists.

BIPP supports the development of appropriate technologies in the context of recognized national priorities in the area of agriculture, health, bio-energy, green manufacturing, when the scale of the problem has serious consequences for social and economic development. BIPP is an Advanced Technology Scheme only for high risk, transformational technology/ process development. It is for high risk futuristic technologies and mainly for viability gap funding. The uniqueness of this scheme is that it is for "*Break through research*" which enables product and process development and is patentable, with IP ownership rights resting with industry.

Ministry of Steel - Research & Development in Iron and Steel Sector:

This scheme aims to augment R&D initiatives and to step up investment for it in the steel sector. Under this scheme, upto December 2016, 91 R&D projects have been approved with a total cost of Rs. 950.65 crore with approved SDF contribution of Rs. 536.26 crore. The R&D projects include basic/ fundamental research as well as applied research i.e. to find out ways to solve problems being faced by the industry. Research results of several R&D projects have already been implemented by plants under SAIL and in Tata Steel, resulting in improvement in productivity, reduction in energy consumption and pollution etc.

MNRE - Research, Design, Development, Demonstration (RDD&D) and Manufacture of New and Renewable Energy:

In December 2006, MNRE launched a comprehensive programme on Research, Design and Development and Manufacture of New and Renewable Energy including establishment of the Research, Design and Development (RD&D) Project Appraisal Committee(RDPAC) and guidelines for the purpose of appraising and recommending projects for approval of the competent authority focusing attention on areas and activities identified and to work towards aims and purposes stated therein. Around 60 numbers of RD&D projects were recommended till July 2008.

DIT - Multiplier Grant Scheme:

Department of Electronics and Information Technology (DeitY) is implementing Multiplier Grants Scheme (MGS). MGS aims to encourage collaborative R&D

between industry and academics/ R&D institutions for development of products and packages. Under the scheme, if industry supports R&D for development of products that can be commercialized at institution level, then government will also provide financial support that is up to twice the amount provided by industry. The proposals for getting financial support under the scheme are to be submitted jointly by the industry and institutions.

TIFAC, DST - Collaborative Automotive R&D:

During January to March 2003 the Office of the Principal Scientific Adviser - PSAO organized a series of high level discussions for enhancing Academia-Industry-Interactions, which led to the formation of a Core-group on Automotive Research (Core-Group) as an academia-industry interaction forum with a mandate to create a user-friendly database of scientists and to identify frontier technologies, so as to promote development of vibrant, world-class automotive systems, sub-systems & parts industry in India. The CAR technology roadmap was published in March 2006, and is being kept updated. The vision is to enhance energy security, environmental quality, economic growth and establish a globally competitive transportation industry in India.

Ministry of Food Processing PPP Schemes:

The Scheme of Mega Food Park aims at providing a mechanism to link agricultural production to the market by bringing together farmers, processors and retailers so as to ensure maximizing value addition, minimizing wastage, increasing farmers' income and creating employment opportunities particularly in rural sector. The Mega Food Park Scheme is based on "Cluster" approach and envisages a well-defined agree/ horticultural-processing zone containing state-of-the art processing facilities with support infrastructure and well-established supply chain. There are several other schemes being implemented by the ministry.

TIFAC-SIDBI Revolving Fund:

Salient features of the scheme are:

- Provide financial assistance to MSMEs towards development, up scaling, demonstration and commercialization of innovative technology based projects.

- The assistance is given in the form of early stage "debt" funding on softer terms for development, demonstration and commercialization of new innovations in emerging technological areas, un-proven technologies, new products, process, etc. which have not been successfully commercialized so far.
- Maximum assistance is generally not more than `100 lakh per project.
- Interest rate would be as approved by the Project Approval Committee (PAC) (not be more than 5% p.a.).
- All the proposals for assistance under the Scheme shall undergo technical evaluation by TIFAC and financial viability by SIDBI. The assistance is approved by a Project Approval Committee (PAC) consisting of officials of SIDBI and TIFAC.

DST - National Initiative for Developing and Harnessing Innovations (NIDHI):

National Initiative for Developing and Harnessing Innovations (NIDHI) is an umbrella programme conceived and developed by the Innovation & Entrepreneurship division, Department of Science & Technology, Government of India, for nurturing ideas and innovations (knowledge-based and technology-driven) into successful start-ups. The programme would work in line with the national priorities and goals and its focus would be to build an innovation driven entrepreneurial ecosystem with an objective of socioeconomic development through wealth and job creation.

NIDHI aims to nurture start-ups through scouting, supporting and scaling of innovations. The key stakeholders of NIDHI includes various departments and ministries of the central government, state governments, academic and R & D institutions, mentors, financial institutions, angel investors, venture capitalists and private sectors. NIDHI is developed keeping in line the new national aspirations and on the basis of DST's experience of three decades, in promoting innovative start-ups.

5.0 Concept of Networking and Public Private Partnership in R&D through NMITLI

The first and foremost achievement of NMITLI has been in bringing a paradigm shift in the way R&D is pursued in the country. Before the advent of NMITLI, publicly funded R&D institutions and universities were pursuing research in an isolated way. There were islands of expertise scattered around the country without any need and motivation to connect to each other. NMITLI has been able to show path, provide a platform and inculcate the need for the doyens of science and technology to come together and work for a joint goal in a time bound manner. NMITLI has been able to bring in up to 18 public institutions in a single project to shed their internal inhibitions and work jointly.

Further, the research and development in public institutions and private industry were alien to each other. The only possible interaction was at the time of technology transfer from former to later. Scientists in public institutions were not aware of the need of private industry, the level of refinement of technology which can be easily assimilated and up scaled by industry and other last mile problems associated with the technology. Similarly, the industry was not appreciative of the efforts of scientists in public institutions, their limitations and lack of exposure to industrial rigor. NMITLI is credited to bring these two domains of R&D at one platform to understand the requirements and constraints of each other, collaborate to alleviate them and foretell and discuss the nuances of technology/product development.

NMITLI has been able to network about 100 industry partners and about 300 R&D groups from different institutions. Further, for the first time NMITLI has been able to bring together different departments of Government of India to launch a joint project. If this initiative is adopted further, it can bring different expertise and different funding agencies together for a common cause.

6.0 Review of Technology/Product Portfolio

MicroPCR:

A battery operated hand held MicroPCR for diagnosis of various diseases has been developed under NMITLI. The diseases which can be diagnosed are: Salmonella, Tuberculosis, Malaria, Dengue, Chikungunya, Hepatitis B and H1N1. This is a global product which has been patented in over 130 countries. The device currently costs a tenth of a conventional real-time PCR and a fifth of existing NAAT tests in the market and these can further come down with scale and early adoption by governmental programs. The product is available in Indian and global market. ICMR has deployed 100 numbers of device at various health centres in the country.

Committee appreciated the product and suggested ICMR/Health Ministry to deploy more number of device in the country.

JD Vaccine

Drugs Controller General of India (DCGI) has approved and State Drug Authority, Karnataka has issued drug manufacturing license on June 2, 2014 for manufacture of vaccine against Johne's disease. Two formulations of vaccine i.e. JD Oil and JD Gel have been developed under the CSIR-NMITLI Scheme. Vaccine is manufactured and marketed by industrial partner of the project-M/s Biovet Private Limited, Bengaluru. Johne's disease (JD) is progressive granulomatous enteritis of ruminants

characterized by untreatable, profuse, chronic diarrhoea, weight loss, and emaciation. JD may be the major cause of reduced productivity in Indian animals, which number over 200 million. JD is endemic in the ruminant population of India and has also been reported from human beings. The developed vaccine will lead to increased milk and meat production and improved health of cow, buffalo, sheep and goat. Vaccine was launched by Hon'ble Minister of Science & Technology on CSIR Foundation Day-September 26, 2015. This is the third vaccine in the world after Mycopar, US and Gudiar, Australia.

Committee lauded the efforts of CSIR and project team for development of JD Vaccine. It recommended CSIR to approach ICAR and Ministry of Agriculture so that the benefit of vaccine reaches to farmers.

Novel molecular diagnostics for eye diseases:

Ocular infections are leading cause of ocular morbidity and if untreated can progress to loss of vision. Treatment of infection depends on the pathogen. And specific therapy saves people from blind ness. Most popular and well accepted method is microbial culture and smears. However, culturing takes long time, results are available for making treatment decisions. Beyond the very critical time after 72 hours by which time more than 60% patients lose vision. Moreover due to paucity of the sample culture is successful only in less than 10% of the cases. Considering the importance of the problem, CSIR mounted a project in which 24 signature genes of 14 pathogens were detected on DNA Chip. The test System is named as Syndrome Evaluation System or SES. This one SES will simultaneously detect in one sample and one single test all the 15 pathogens that are known to cause dangerous eye infections.

The development involved four institutes viz. CCMB, Hyderabad; Shankar Netralaya, Chennai; LV Prasad Eye Institute, Hyderabad; and AIIMS, Delhi and XCyton Diagnostics Pvt. Ltd., Bangalore.

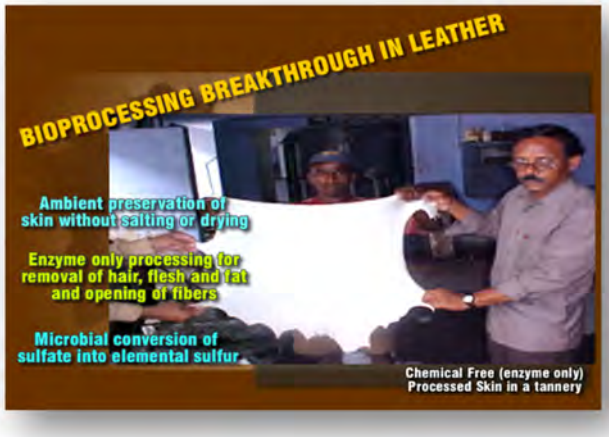
This development had altered the paradigm of management of the ophthalmic emergency called Endophthalmitis. In a study on out comes performed at Arvind Eye Hospital by XCyton it was shown that the SES had saved eyes and the overall cost benefit was immense in comparison to all conventional microbiological investigations employed in this study.

Committee expressed its happiness on the development.

Biotechnology for Leather: Towards a Cleaner Processing

The making of leather is an age-old process. World over leather is made employing technologies which involve processing of skin or hide using large amounts of industrial chemicals and a wide variety of specialty chemical formulations. A large number of the processes involve 'do-undo' operations resulting in severe environmental pollution. The world is compelled to follow this highly polluting 'Chemical Route' in the absence of any alternative. This was a great challenge before the scientific community. Under the NMITLI programme, a paradigm shift has been brought about in beam house operations in leather manufacturing through bioprocessing as opposed to the currently used chemical processes. The salient features of the developed technology are it:

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



The technology developed by CSIR is first in the world and offer substantial reduction in pollution. The cost of leather processing will be slightly higher but if we take environmental benefits in to account it would be at par with the old technology. CSIR is demonstrating the technology to DIPP and CPCB to make the process mandatory in the country.

Committee suggested CSIR to take all possible steps to commercialize the technology.

Design and fabrication of All-Fiber Supercontinuum Light Source with application demonstration on spectroscopic signature detection

The project resulted in the technological innovations, optoelectronics hardware and software developments and 2 compactly designed and packaged products viz.: Supercontinuum Source for generating white light with wide wavelengths of 400 nm – 2200 nm and Broadband Confocal Microscope in a short period of 2 years. Both these products are unique with multiple applications in fluorescence spectroscopy, coherence tomography, biomedical imaging and analysis etc., the industrial partner, Vinvish Tech. Ltd. has become 3rd company in the world and 1st company in India to come up with such high tech products by using specialty type of developed photonic crystal fibers (PCF). The company has sold 1 unit of SC source which is working perfectly at IIT, Kanpur and has received more than 20 queries from interested customers. He added that tunable filter for selecting range of wavelengths for study has also been fabricated which will become integral part of the above two products.

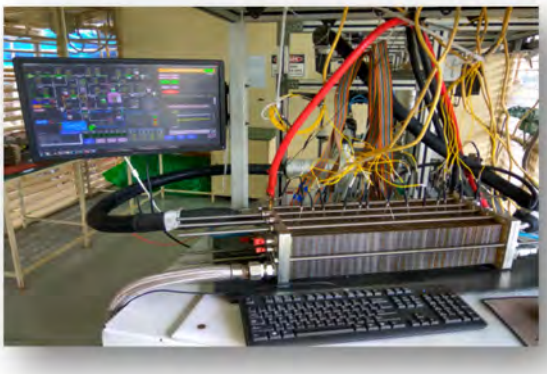
During the discussion, Dr. V.K. Saraswat, Member, NITI Aayog and Chairman, NMITLI Review Committee asked the company to make a concrete business plan with timelines for commercializing the developed products.

Launch of Broadband Confocal Microscope

Demonstration and validation of a 3 kWe PEMFC System

The indigenous developments of PEMFC technology, new innovations, designing and fabrication of fuel cell testbed station and its demonstration at RIL's Patalganga location, vendor's development for fabrication of components and their rigorous testing were the major highlights. 3 CSIR labs had developed graphite composite bipolar plates, porous carbon paper based gas diffusion layers (GDL), a decal methodology for making low temperature MEAs, high temperature membranes based on phosphoric acid doped polybenzimidazole, a process for assembling high temperature MEAs, gaskets for both low- and high-temperature fuel cells and other stack accessories such as; end plates, collector plates, tie rods, tubings and fittings. A 3 kWe LT-PEMFC Prototype has been demonstrated which can later on replace DG sets at mobile towers for providing electricity through this green technology product. In addition, the deployments high temperature PEMFC (HT-PEMFC) would be integrated with Vapor Absorption Machine recovering waste energy from fuel cell to provide combined electricity and cooling. A working prototype of 2 kWe HT-PEMFC system is expected to be fabricated by end of March 2018.

Dr. Saraswat inquired about the catalyst being used for reforming and 3D printing of bipolar plates on which Dr. Lele said that it is a Pt/Ni based catalyst and 3D Printing process could be explored in future. He further wanted to know about the integrator of these technologies. Dr. Sonde said that Thermax would finally integrate the complete product. Dr. Sonde requested to the Chairman for some policy intervention on green technology development. Dr. Saraswat also suggested for cost reduction without compromising the performance. The Committee was highly appreciative of the fuel cell technology and termed it as the excellent development in the country.



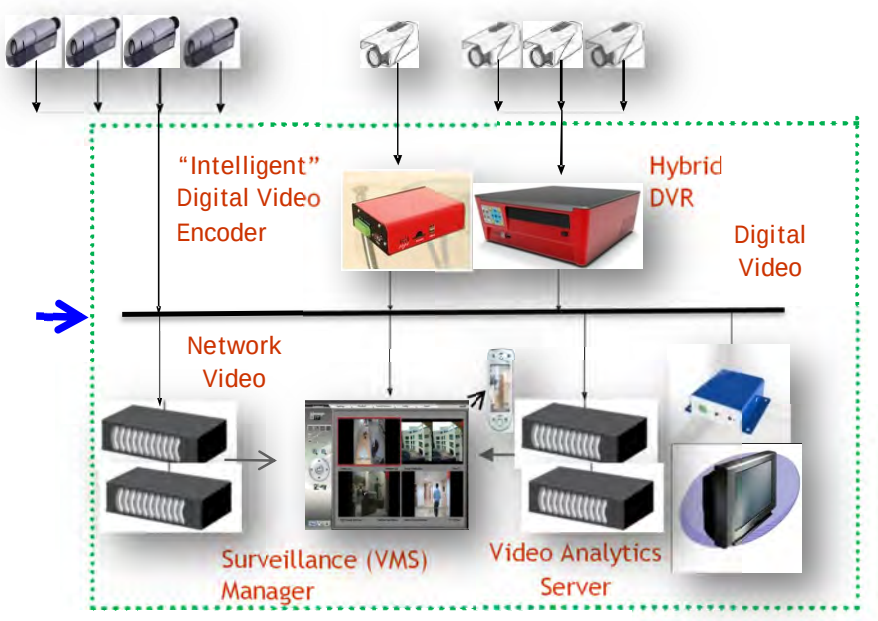
Integrated Technological solutions for Security and Operations based on UV sensor technologies

The project has resulted in the development of an indigenous Process Technology for Offset Inks, UV Curable, Screen, Stamp pad, Digital Inks & Plastic Prills and new UV sensitive materials (single and bi-fluorescent). New materials developed have already been commercialized and initial sales generated to the tune of about Rs. 45 lakhs with offset ink type products approved by M/s Security Printing & Minting Corp. (I) Ltd (wholly owned by GoI). Market trends and company details were the indicative of commercialization potential of the developed products. Various prototypes of Programmable Invisible Marker Authenticating Device (Pi-MAD) for the detection of UV tags by integrating the hardware (optics / electronics) and software were also designed and developed for providing integrated solution by detecting the fluorescence with a high signal to noise ratio.

Dr. NK Ganguly observed that this is a very important development and could be extended for detecting spurious drugs. The Committee complemented the team for the developments.

IVSS System

A complete intelligent video surveillance server (IVSS) system has been developed and commercialized under NMITLI. The IVSS system was designed around five core themes: scalable, distributed, standards based, intelligent and networked. The solution has been developed for Indian deployment scenarios. The video analytic algorithms are well-tuned for Indian conditions and behave better than foreign counterparts. A few examples are the Automatic Number Plate Recognition, granular object classification as applicable to vehicles etc. Unique low complexity and cost effective video algorithms developed that are accurate and can run real time on standard platform. The system has open architecture supporting a combination of analog, IP and wireless camera and the solution can be licensed independently on in combination to original equipment manufacturers (OEMs) and System integrators. Developed ONVIF 1.02 (Open Network Video Interface Forum) standards compliant software stack for both the camera and management server has been licensed to international customers also.



Committee appreciated the product/ solution and expressed happiness after noting that associated company has established its name as a leading provider of white labelled Video Surveillance Products designed for the Indian Market.

Four-door, four-seater battery operated electric car (e2o Plus)

World's lightest and lowest cost, 4-door, 4-seater battery operated electric car and low cost indigenous off-board fast charger have been developed under NMITLI. The car has been launched in the market under a brand name of e2o Plus in October 2016. On a full charge, e2oPlus can travel for upto 140 kms and can achieve a top speed of 85 kmph. Powered by the latest electric drive train technology, the e2oPlus can effortlessly cruise through city traffic. The tall-boy design and spacious interiors make for a compact city car that can comfortably seat four adults. The e2oPlus has been evolved keeping in mind the feedback from the potential customers and is a near perfect amalgam of the dramatic advancements in automotive technology, electronics and information technology, combined with minimal running costs. With its technologically advanced features, home charging facility, easy manoeuvrability and affordable ownership, it is expected that the e2oPlus will soon be accepted as a mainstream car. The host of innovative features include remote diagnostics through telematics, connectivity through smart phone app, new and advanced infotainment system, regenerative braking, hill hold control for easy driving in hilly terrains, REVive® for reserve charge and automated messages amongst others. Charging the e2oPlus is as simple as charging a mobile phone. The car is currently being sold in 23 cities in India. Recently, over 100 e2oPlus have been sold to Ola Cabs and were made part of first "Multimodal Electric Vehicle Project" launched in May 2017 to build an electric mass mobility ecosystem in Nagpur.

The committee noted the development and suggested Mahindra Mobility to make efforts to produce the car with 100% indigenous components/ parts.

Electrical Three Wheeler "Soleckshaw Lite"

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

The committee appreciated the product and suggested Kinetic to commercially launch the same at the earliest.

nonClonableID Technology for Medical Product Authentication

One of the key challenges facing India in the pharmaceutical space, both in domestic and export sectors, is that of counterfeit drugs with dire implications to not only the pharmaceutical companies but also government authorities and the general public. In this context, product accountability and traceability has been recognized as a critical need for providing quality medical products. The issue covers not

only detecting counterfeits or eliminating illegal duplicates but more importantly to also ensure that medicine of genuine origin is consumed by the patients.

Under the CSIR-NMITLI programme, CSIR in partnership with an industry has worked towards the challenge of demonstrating the ability of a novel nonClonableID technology to address the unmet needs in medical product authentication and patient safety. The nonClonableID technology, based on novel aspects of material science and utilizing the law of randomness, creates unique non-duplicable fingerprints. These fingerprints when processed, digitized and activated function as unique identification tags. The nonClonableID tags have been developed which can be utilized for establishing product accountability through secured traceability from the point of origin to the point of dispensation, authenticity check and establishing e-pedigree. Tangible benefits of the technology in improving patient compliance to medications have also been demonstrated.

Novel DPP IV Inhibitors for the treatment of Diabetes

The project involved development of a novel DPP IV inhibitor. It is an industry originated project (IOP), driven by Cadila Pharmaceuticals Limited, Ahmedabad. CSIR-Central Drug Research Institute (CSIR-CDRI), Lucknow and CSIR-North East Institute of Science and Technology (CSIR-NEIST), Jorhat were the institutional partners in the development.

A novel DPP IV inhibitor has been developed. The novelty of the compound is due to it being synthesized as a prodrug of Sitagliptin, which is a known drug in the market since 2007. Cadila Pharmaceuticals holds a product patent on the compound. The synthesis process too is novel for which a process patent was filed by Cadila. Drug development related studies were completed and IND filed was approved by DCGI. Presently, Phase I studies have been completed and data submitted to DCGI. Approval from DCGI for Phase II studies is pending.

On a query from Chairman regarding the pendency, it was informed that the proposal has been presented twice before the IND Committee of DCGI. The Committee has recommended long term toxicity study in non-rodent animal species.

Dr. Ganguly explained that the developed drug has only one amino acid phenylalanine, which is an essential amino acid, added to Sitagliptin. After drug administration, phenylalanine is removed in the small intestine and only Sitagliptin is detected subsequently in blood and other organs. Sitagliptin is a known drug for

diabetes. The compound has not shown any toxicity in 28 days study in large animals. Also Phase I clinical studies has established the safety of the compound in humans. Therefore, the IND Committee's recommendation for long term safety studies does not hold ground. The Committee was informed that DG, CSIR had written to DCGI for a joint meeting of the IND Committee with experts including members of the project Monitoring Committee to discuss the matter.

Chairman suggested that write a paper on suggested changes in the procedure for drug trials and methodology of approving drugs and send it to NITI Aayog for necessary action.

Development of novel biotech therapeutic molecule – Lysostaphin

Globally there is a demand for effective drug against hospital acquired infection. A major cause of the infection is *Staphylococcus aureus*, a highly virulent human pathogen. Current treatment includes Penicillinase-resistant antibiotic-methicillin (MRSA), vancomycine (VRSA) and recently introduced oxazolidinone. However, rise of antibiotic-resistant microbes has caused standard treatment for infection becoming less reliable. The magnitude of the problem and development of resistance in *S. aureus* has left the field as unmet medical need.

Lysostaphin either as a standalone product or in combination with other antibiotics as topical application has a huge potential in treatment of *S. aureus* skin and skin structure infections like wound, abscess, burns, ulcers, trauma etc. in all age groups. Recombinant Lysostaphin that is more than 99% pure and that can be produced in large quantities by *E. coli* has provided an excellent opportunity to assess its efficacy against drug resistant *S. aureus* infections.

In the project, lysostaphin gel formulation has been developed for *Staphylococcus aureus* infection. It was the first biotech molecule to clear IND. The formulation was found safe on human subjects through Phase I randomized double blind placebo controlled clinical trials conducted on 26 adult male healthy subjects in the age group of 18-50 years. The formulation was taken up for Phase IIa clinical study in patients with uncomplicated *Staphylococcus aureus* skin and skin structure infection and the study result and protocol for Phases IIb/III were submitted to DCGI for approval. DCGI approved the protocol for Phase IIb/III clinical study with the formulation. Presently, the Phase IIb/Phase III clinical trials are in progress.

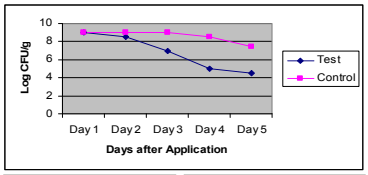
The IP on the molecule is protected through PCT. Patent has been granted in 85 countries including USA.

Fig: Efficacy Studies

Clinical Studies

Before Treatment After Treatment

Experimental Animals



The Committee noted that hospital acquired infection has gained serious proportions. It appreciated the progress achieved in the project.

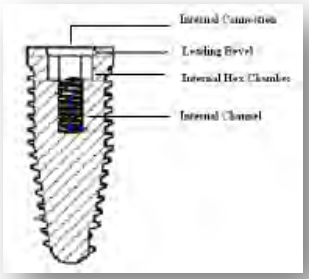
Development of Dental implants-Phase II study

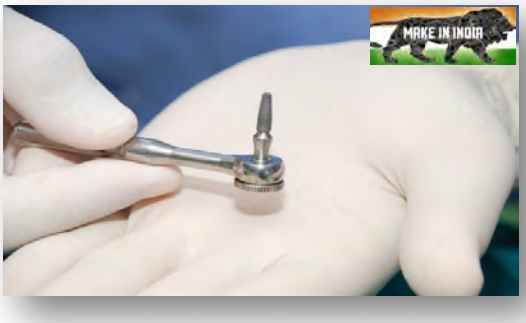
Among the few selected projects, the NMITLI project on Dental implants-Phase II study was presented by Dr Naresh Bhatnagar, PI from IIT Delhi and Dr Farrukh Faraz, MAIDS.

Highlighting the project achievement, Dr Bhatnagar said the global market of Dental implants is around 7.2%. He said despite great achievements in oral health of populations globally, problems still remain in many communities all over the world - particularly in developed and developing countries. In India the market is completely dominated by imported dental implants which have high cost and low penetrability.

Prosthetic components

Under CSIR-NMITLI a completely indigenous dental implant system was developed along with complete prosthetic and surgical kit with the collaborative efforts of IIT Delhi, MAIDS under the expert guidance of project Monitoring Committee. Describing the project, Dr Bhatnagar said an indigenous dental implant has been designed on the basis of scientific rationale and experimentally optimized to serve the treatment needs of an edentulous or partially edentulous Indian patient. The innovations include the use of same prosthetic platform for all implant diameters (3.5, 4.0,4.5,5.0), integrated platform switching and the developing a single component which serves as implant mount, implant impression transfer coping, implant impression pickup coping(with long screw) and as the final straight abutment. The design of the screw is a tapered root form with a combination of reverse buttress thread and microthreads and was validated with Finite element analysis to provide ideal stress distribution to bone. The material chosen for the Implant fixture and the prosthetic components is Ti-6Al-4 V (titanium alloy) and the surface treatment for the implant was developed with a combination of grit blasting and acid etching. In addition various other components including the surgical and prosthetic ancillaries were developed. The implants were duly tested for biocompatibility studies (as per ISO 10993) norms and engineering tests for fatigue. A trial in rabbit model was also done to prove the safety and efficacy of the implants as per CPSCEA guidelines and Good Laboratory Practices (GLP). Based on this success initial usage in human subjects was carried out in comparison with an International Implant. An initial clinical use of the implant was done at MAIDS with the registration at CTRI being - CTRI/2011/11/002149. The implants are now being manufactured, sterile packaged by IIT Delhi at the facility developed under the project at IIT Delhi premises. The implants are now undergoing phase II clinical trial at MAIDS after receiving the permission from DCGI. Efforts are also ongoing to commercialise the implants through a suitable industry. The technology for dental implants was transferred to M/s Innvolution Healthcare Pvt Ltd, Delhi on May 24, 2017.





The Committee was appreciative of the indigenous technology developed under CSIR-NMITLI and hoped that this comes to market soon for the benefit of Indian population.

Novel Therapy for Management of sepsis-Phase II study

Sepsis is the culmination of complex interactions between the infecting microorganism and the host immune system. Normally the host response prevails in containing and eliminating the pathogenic threat. The excessive and or sustained response leads to sepsis (systemic inflammatory response, SIR). Current management of sepsis includes broad spectrum antibiotics and supportive care to maintain oxygenation, systolic blood pressure (more than 65 mm of Hg), central venous pressure (8-12 mm of Hg), hematocrit (more than 30%). Steroids may be considered in presence of organ failure. Activated protein C may be of value in patients with APACHE II score > 25. The drug (activated protein C) is not approved in India.

The project thus emphasized exploring a novel multipronged therapeutic approach for management of sepsis using Mw, an immunomodulator. The Phase I study has established that its usage is not associated with any systemic side effects thereby making it an ideal safe candidate for evaluation in management of sepsis. With the success of Phase IIa study in humans using Mw along with standard treatment/care in Gram negative sepsis patients, the phase IIb study in severe sepsis cases (those admitted in ICU) was approved by NMITLI High Powered Committee of CSIR. In the current Phase II project, Mw is being evaluated for its efficacy in management of severe sepsis in patients admitted to intensive care unit of clinical centers under Phase IIb multicenter clinical trial.

The treatment result on 102 patients has shown distinct outcome in two groups of patients with significant difference in primary and secondary outcome. One of the groups of patient was administered 0.3 ml of Mw along with antibiotics as per standard care while the other group of patient was administered 0.3 ml of placebo along with antibiotics as per standard care. The primary outcome (mortality) and secondary outcome (Stay on ventilator, ICU length of stay and hospital stay) were determined. A stark difference was seen in two groups of patients. The trial being double blind, the nature of group cannot be ascertained now. However objectively, seeing the result the study would be a decisive one. The fact that such difference was observed in 102 patients, it can be expected that by meeting the target of 150 patients, a clinical impact of Mw can be predicted in future.

The Committee appreciated the outcome of study and hope that CSIR-NMITLI project may be able to solve the unmet need of the world in future.

NMITLI Project on Ashwagandha

Contrasting qualitative and quantitative differences in phytochemical constituents of Ashwagandha plants collected from nature is expected to lead to variations in the observed pharmacological response to commercial formulations of Ashwagandha. It was felt that establishment of association between chemotypes and pharmacological activities will give a globally acceptable basis to validate the health related activities of the Indian formulations. This was essential so as to place Ashwagandha on a global platform *vis a vis* Chinese Ginseng.

Under CSIR-NMITLI project, the multifarious achievements in Ashwagandha research viz. developing and propagation of best medicinal varieties and their related agro-technologies; genomics research for validating the pharmacological activity of varieties, an antistroke lead and an immunomodulator lead in hand; a comprehensive Withanome database created by partner CSIR laboratories was obtained.

NMITLI 118 and NMITLI 101, the two best varieties were released through the hands MOS &T and were successfully deployed in farmers' field.

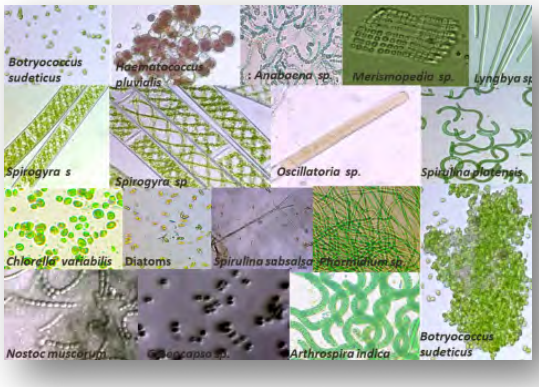
NMITLI-118: Chemotype selection, recurrent selfing cycles

NMITLI-101: Chemotype selection, recurrent selfing cycles

Biofuel from Marine Microalgae

The challenge for biofuel production from microalgae is to develop a process for producing a low value product at high scales. In line with global efforts to develop

intensive, large scale microalgal cultivation technology and exploiting India's advantageous geographic positioning, the project was first such initiative in the country. It sought to develop a viable and scalable process for biofuel production from marine microalgae isolated from Indian coast. It envisaged screening of the marine algal biodiversity along select areas of the Indian coastal regions, their characterization and development of environmentally and economically viable production technologies for biodiesel from microalgae.



A chlorella strain was identified having total lipid content of 22.5% out of which non-polar lipid was 10-12%. A specific growth rate of 0.09 g/day was achieved at scale of 1.1 tpa dry biomass in 500 m^2 with productivity of 32.4g/m^2/day. In first such development in the country and among few worldwide, road worthiness of B20 and B100 biodiesel from marine microalgal source was established through test drive of a regular diesel vehicle under full load condition. Cost of biodiesel using the above process was calculated to be approximately Rs125/litre, making it the most cost effective development globally at that point of time.

Pic: Flagging off Vehicle running on B100 Microalgal Biodiesel

Microalgal Biodiesel: Calorific value: 9429 kcal/kg (Fossil diesel: 10124 kcal/kg)
Mileage: 11-12 km/litre under full load / AC running condition

The Committee noted that biofuel from microalgae has not been found to be a viable option. It suggested that the project be not supported further. The Committee was informed that the project has since been completed and the leads have not been taken up further.

Functional genomics in tea

The project was initiated by CSIR-IHBT in collaboration with United Planters' Association of South India (UPASI), Coimbatore and Tea Research Association's Tea Experimental Station, Jorhat as an R&D effort towards value addition to Indian tea using tools of functional genomics for higher value traits. In first such report worldwide, tea database profiling catechin content was developed. A kit for catechin estimation was also developed. Further, catechin biosynthetic pathway genes were cloned and characterized.

The Committee was informed that CSIR-IHBT also developed a green process for extraction & purification of catechins utilizing tender & coarse tea shoots not suitable for making premium quality teas. The purification is a single step process with 65-70% yield of catechin and amino acids as byproduct. The process was upscaled to 40kg leaves/batch. Process patent has been granted in USA & China. The technology has been transferred to M/s. Baijnath Pharmaceuticals Pvt. Ltd., Paprola in 2014 and INDCOSERVE, Coonoor in June 2017

The importance of catechin as antioxidant was explained by Dr Ganguly. The Committee appreciated the project outcome.

Functional Genomics in Mentha

The project involved using tools of functional genomics in Mentha for higher production of secondary metabolites of use to Indian industry in line with efforts to help Indian industry sustain global leadership in Mentha. It was driven by CSIR-CIMAP, Lucknow. The terpenoid pathway was elucidated and Expressed Sequence Tags (ESTs) for quality improvement in Mentha were identified. Three new Mentha varieties were developed through molecular breeding and released to farmers for cultivation. Among them, one is a *Mentha arvensis* (menthol mint) variety named Kushal, which is a late transplanting variety with oil yield of 235kg/ha and menthol content of 177kg/hectare. Two *Mentha piperita* (peppermint) varieties were also developed. These are CIM-Indus and CIM-Madhuras. CIM Indus has high Menthofuran content between 23-27% (normal: 0-6%), Pulegone 10-16.8%, Oil yield of 70kg/ hectare. CIM-Madhuras is sweet smelling variety with oil yield of 100kg/ hectare in two harvests. Kushal & CIM-Indus have been patented in USA.

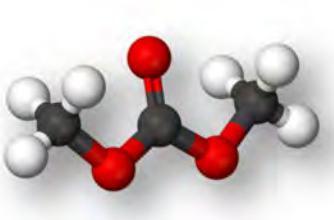
The Committee was appreciative of the project outcome.

Process for 1, 2-PDO:

Under 'Scale up of CSIR-NCL process for selective hydrogenolysis of glycerol to 1,2-propanediol' project, the partners have developed technology package for conversion of glycerol to 1, 2 PDO. Bio-glycerol conversion of > 85% and 1,2-PDO selectivity of > 93% through CSIR-NCL proprietary catalyst which is highly stable has been achieved. The downstream processing has also been carried out and the flow sheet has been firmed up by the industry partner (Praj) using ASPEN PLUS simulator. A technology package with engineering designs has been developed. An

industry has approached CSIR to commercialize the technology. The terms and conditions of technology transfer are being decided by a Committee.

Synthesis of Dimethyl carbonate (DMC) from methanol and urea:



$H_3C\text{-}O\text{-}CO\text{-}O\text{-}CH_3$

DMC-A Green Chemical

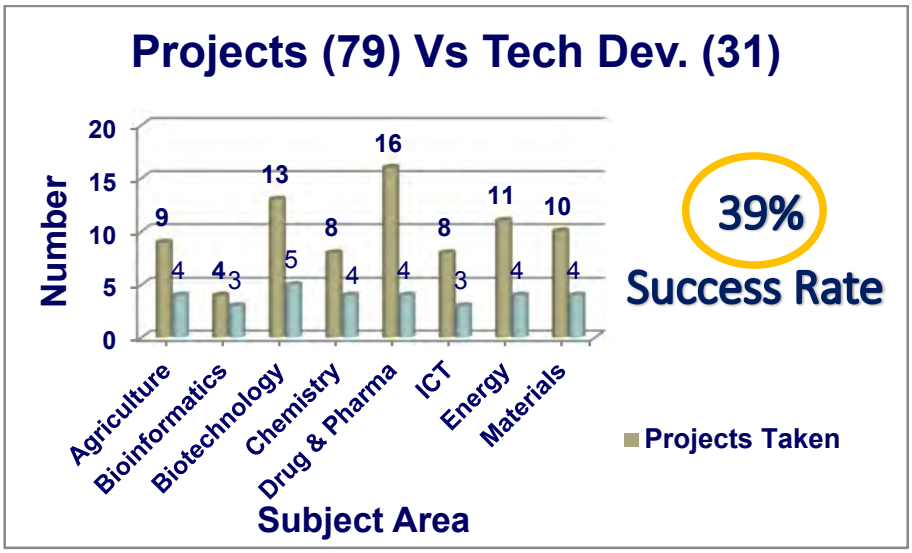
Under the project 'Development of non-hazardous process for the synthesis of Dimethyl carbonate (DMC) from methanol and urea' technology package has been developed for synthesis of DMC from methanol and urea. The developments include: Development of a series of Catalysts (100+), which have been tested for identified activity and the potential use; Development of a two-step process for DMC (1st Step-Conversion of Urea to Methyl Carbamate; and 2nd Step - Catalytic Conversion of Methyl Carbamate to DMC) with 76% selectivity to DMC as per target objective; Creation of Process Flow Sheets and establishment of Lab scale set-up with separation system as basis for developing Bench scale setup; Carried out simulation studies throughout the process of development of reactor configuration / reactive distillation strategies; Establishment of regeneration protocol of used catalyst; and Establishment of the Bench scale set-up (0.045 Kg/hr) as basis for developing pilot scale setup. Industrial partner of the project has approached CSIR for technology transfer and commercialization.

Bench Scale setup

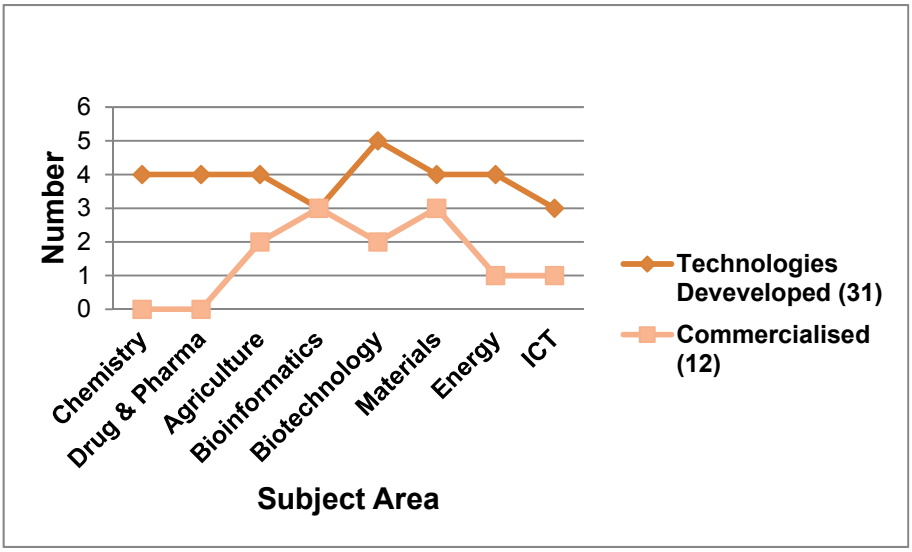
7.0 Analysis of NMITLI

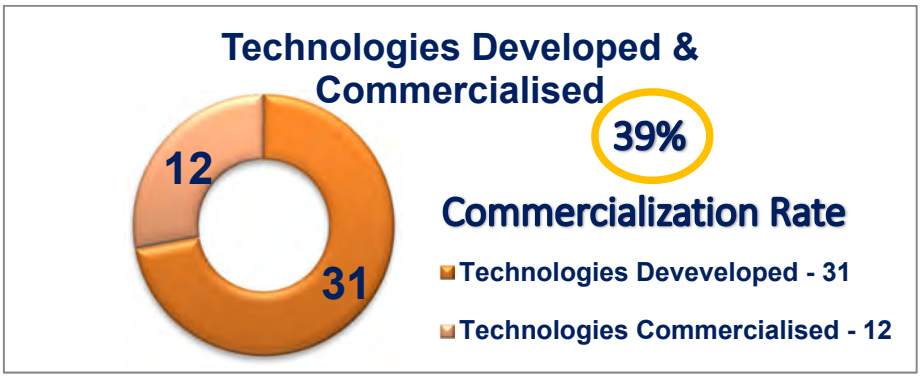
The main purpose of the analysis of NMITLI Programme is to understand the success of the scheme when measured on different indices. It is firmly established that NMITLI is a game changing programme which have galvanised the National Innovation Ecosystem in the country. The committee delved deeper to find out the success rate of projects, number of technologies / products developed vis a vis total project undertaken, performance with respect to patents and papers and financial analysis of the Programme. Some of the indices of analysis are shown below:

Project Success Rate:

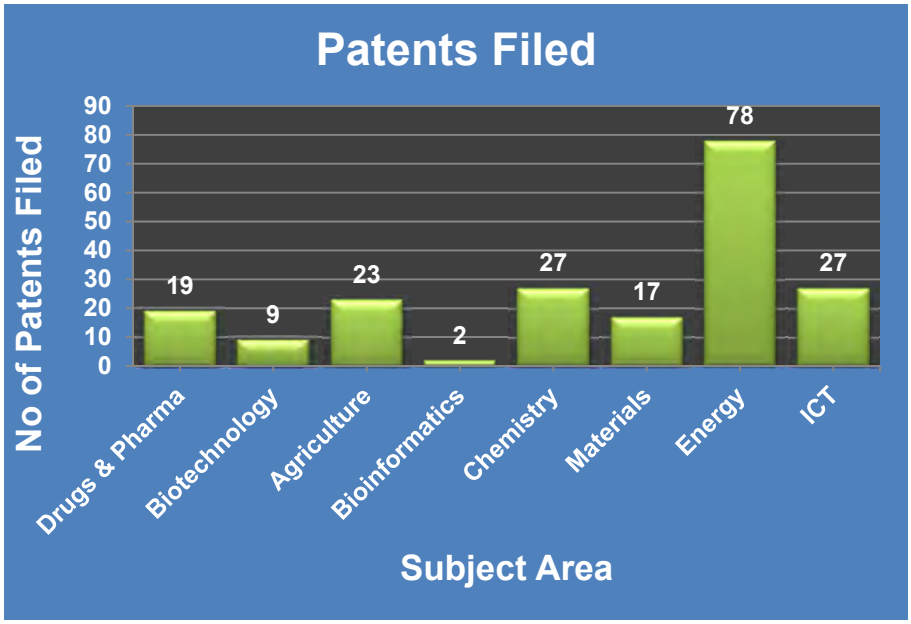


Technologies Developed & Commercialised:



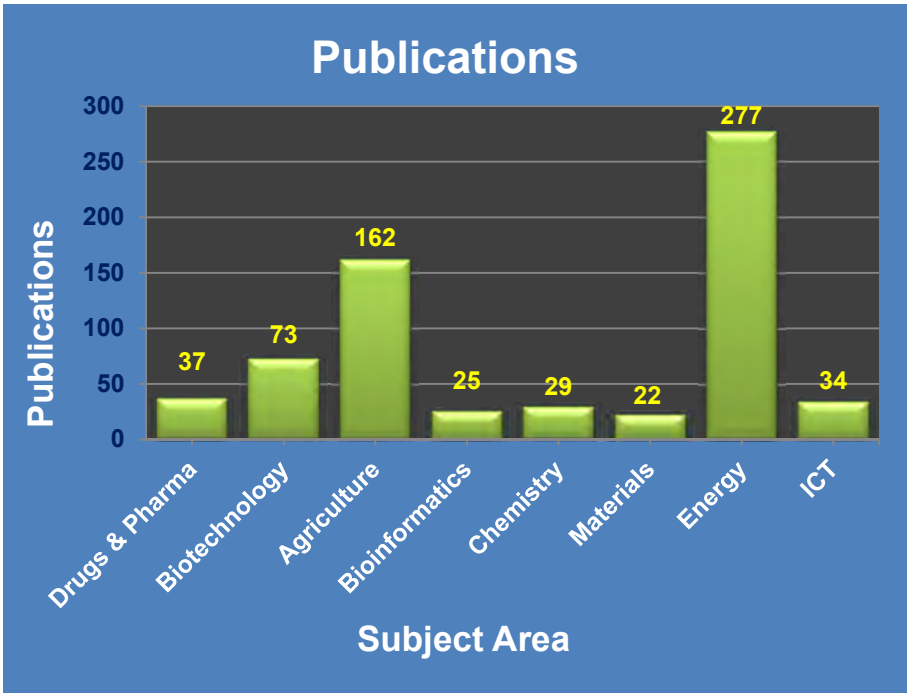


Patents Portfolio:



NMITLI Patents Footprints across Globe:

Publications:



Expanding the Science and technology horizons:

NMITLI is an innovation-driven scheme which strives to expand its research and development horizon by foraying into hitherto unknown territory to the nation. There are some areas on which projects have been developed where Indian expertise was very weak. Although, the approach has inherent risks of high failure, NMITLI pursued these areas. Some of the examples of such projects are given below:

Fuel Cell

As a result of the growing gap between the energy requirements and energy availability, the world is no longer in a position to depend only on the conventional energy generating technologies. Worldwide hike in the crude oil price and the increasing concerns about the gasoline supply to cater energy requirements have necessitated intensive R&D activities to pursue new energy generating technologies. A growing interest for "clean energy" with "zero emission" norms has given an edge towards the development of hydrogen based systems. Based on this, CSIR under NMITLI program decided the goals of the fuel cell program: (a) to develop knowhow for the components in a PEMFC stack, (b) to bring technology readiness into the country through development of a vendor base; and (c) to create a platform

for research, development and innovation in the area of PEMFCs. Accordingly, it has designed and developed many prototypes of 500W, 1.0 kW, 1.5 kW, 2.0 kW and 3.0 kWe PEMFC systems. It also did a comprehensive testing and benchmarking process of a 3.0 kW system on a test bed in collaboration with M/s Reliance Industries Ltd., Mumbai who will be a major player in 4G telecommunications. It is expected to enable the development of a cost effective PEMFC system for the targeted application for the first time in the country. CSIR is continuing its efforts in this green technology area by developing even vendors for critical components of the Fuel Cell Technology in the country.

Sugarcane Bio-refinery

NMITLI for the first time proposed the concept of "Sugarcane Bio-refinery" and pursued with time bound projects. The main objective of the concept was to derive the industrial products from renewable resources. India is the second largest producer of sugarcane, about 300 million metric ton, which in turn generates nearly 90 million metric ton of bagasse. A large quantity of bagasse is currently used as fuel. Conceptually, these raw materials could be used for a variety of products, besides sugar.

NMITLI had initiated focused project for establishing feasibility for fractionating the components of sugarcane bagasse, i.e., cellulose, hemicellulose, and lignins in highly pure form. An elegant process with good recoveries of the products was developed and demonstrated at a pilot scale. This process is generic in nature and can be adopted for other cellulosic raw materials. Cellulose so generated can then be converted into cellulose esters, which are useful as biodegradable polymers. Lignin is converted into liginin sulphonate, which finds application as cement binder. Cellulose and hemicellulose can also be converted into sugars (enzymatically) and then fermented to derive biofuel (Ethanol). Ethanol then can become a raw material for a variety of industrial chemicals. The technology for fractionation of sugarcane bagasse was licensed to Godavari Sugar Mills which is still in the process of setting up a plant.

Similarly, a process for producing highly pure lactic acid from sugarcane juice, with an impurity profile that matches polymer grade lactic acid has been developed. The sugarcane Bio-refinery concept is shown in the picture below.

The ultimate long-term objective is to substitute petroleum products as a base for many industrial goods with renewable biomass. Few more projects have been

launched to convert cellulose and hemi-cellulose into sugars and ethanol and ethanol to value added chemicals.

Antibody against NAMPT: eNAMPT

The therapeutic advantages of antibodies over conventional small molecule drugs are many. Originally, the high target binding specificity led to the notion of using antibodies as "magic bullets" for curing diseases (ascribed to Paul Ehrlich). Even after initial failures, and the current triumph (26 in market, ~120 in pipeline), the high target specificity remains a driving motivation for choosing to make therapeutic mAbs, as opposed to small molecules, for near minimization of non-target effects. Another feature that makes antibodies attractive drug candidates is their organization into distinct structural and functional domains. As a result, antibodies are easily tunable. In other words, they can be engineered in several different ways depending upon specific needs. Thus, by engineering specific domains, it is possible to alter the affinity, the avidity, the effector functions, the bio-distribution, the half-life, and the immunogenicity of antibodies. In addition, domains from different antibodies can be swapped and/or they can be linked to other molecules to create molecules with new properties. Each of these engineering options plays a very important role in transforming antibodies into real drug candidates.

To establish the antibody as biotherapeutic platform, NMITLI has undertaken this project. Industrial partner of the project has developed world's largest naïve human phage display libraries ($2079*10^{11}$cfu) compared to Berkeley ($2.5*10^{11}$ cfu) and a fast panning process. The platform can be used to generate antibody against any antigen within 30-40 days. The project has expanded reach of Indian Scientist in this new area of R&D.

Sepsis

Sepsis is the culmination of complex interactions between the infecting microorganism and the host immune system. Normally the host response prevails in containing and eliminating the pathogenic threat. The excessive and or sustained response leads to sepsis (systemic inflammatory response, SIR). Current management of sepsis includes broad spectrum antibiotics and supportive care to maintain oxygenation, systolic blood pressure (more than 65 mm of Hg), central venous pressure (8-12 mm of Hg), hematocrit (more than 30%). Steroids may be considered in presence of organ failure. Activated protein C may be of value in

patients with APACHE II score > 25. The drug (activated protein C) is not approved in India.

All-cause mortality is usually the primary endpoint chosen for phase 3 pivotal trials in sepsis and acute heart failure, but no treatments to date have effectively reduced the high mortality associated with either of these conditions. Effective therapies are needed to better manage sepsis patients. Therapeutic goals include not only improving survival but also reducing morbidity, preventing organ failure, and shortening convalescence. Substantial attention has been directed at reducing mortality in sepsis, but all recent multinational trials have failed to improve survival. By the year 2009, sepsis pipeline has dwindled to a mere two candidates in phase III. TAK-242 from Takeda and Eritrean from Eisai, both are TLR4 signal transduction inhibitors/antagonists. However, reports in later 2010 revealed that these candidates also did not showed significant effect. Other pipeline products have not been able to go beyond phase II trials. Thus treatment for sepsis remained as an unmet medical need and efforts are underway world over for suitable remedial measures.

The science in using the suspension of heat killed Mycobacterium w in treatment of sepsis due to its immunomodulatory effect has been exploited to develop an adjuvant drug for the management of sepsis due to Gram negative bacteria. In the Phase I study that was completed under NMITLI, extensive studies in mice model were conducted. The results revealed that treatment with Mw (a lead product of Cadila, *Mycobacterium w*) along with co-therapy with standard drugs improved the overall survival by 30 to 40 %. The evaluation of serum cytokine indicated effect on TNF- alfa suppression. The human studies under Phase IIa clinical trial was conducted at PGI, Chandigarh showed encouraging results with improvement in different organ functions mainly lung, liver, kidney and fever. The approach of using Mw in management of sepsis has been successful in Phase IIa trial. The multicentre Phase IIb trial currently ongoing under NMITLI project is further increasing the hope as statistically significant outcome (p=0.029) is being observed in double blind studies.

New technology base created:

NMITLI strives to select an area, develop knowledgebase and synergize and put enough intellectual and resource capital to cross the threshold of intellectual barriers to develop technologies and products. Many projects have been implemented where Indian knowledgebase was non-existent and NMITLI has been able to make a dent. Some of the examples of such projects are given below:

Confocal Microscope

Interaction of the ultra-short pulse with a nonlinear Photonic Crystal Fibers (PCF) leads to spectral broadening. Coupling an ultra-fast laser pulse directly out of an oscillator into a few meters of PCF produces (non-linear micro-structured optical fiber) more than an octave broad supercontinuum. By varying the design parameters, the PCF can be fabricated to have zero dispersion at a given wavelength, thus enabling soliton formation and dispersive wave generation in a specific length of PCF resulting generation of supercontinuum light. Widest spectra are obtained when the pump pulses are launched close to the zero- dispersion of the non-linear PCF. Enough experiments are required to design, develop and manufacture suitable PCF and to optimize the length. The intense engineering has led to the development of a product "Broadband Confocal Microscope" through close collaboration between a R&D institute and a private industry. Such a high tech product with refractive technology is unique in the world. This public private partnership under the CSIR-NMITLI is enabling achieving global leadership in the market rather than just indigenization in the area of cutting edge laser products. Such an effort also goes well with **"Make in India"** Initiative in the country.

Leather

The making of leather is an age-old process. World over, currently employed technologies in leather manufacture involve processing of a biological material i.e. skin or hide using large amounts of industrial bulk chemicals and a wide variety of specialty chemical formulations. A large number of the processes involve 'do-undo' operations with both avoidable economic and environmental loss. The basic rationale and shortcomings involved in the present chemical processing of skin or hide into leather are loss of recoverable leather area, sub-optimal utilization of inputs, environmental constraints (Total dissolved solid and solid waste), loss of (skin) bio substances due to chemical contamination and pH alterations.

CSIR considering aforesaid aspects supported a project entitled "Biotechnology for leather: Towards cleaner processing" in two phases. The phase-I project was for a period of 3 years involving institutional partners. The project focused on three components a) significant reduction of Total Dissolved Solids in treated tannery waste waters by replacing common salt through salt-less and ambient preservation of hide/skin, b) significant reduction of amount of solid (biological) wastes by replacing currently employed lime and sulfide for the removal of hair and flesh as

well as in opening of fibers through enzymatic processes and c) conversion of sulfate in the tannery waste streams to sulfur through the biotechnology route.

Phase-I Project achieved significant progress and generated several leads on the b) part the technology above. A shift from Chemical to Bio-processing in the beam house operations of tanneries seemed feasible. **For the first time, the project opened up a possibility for technologically achieving 2100 mg/liter TDS and 100 kg/Tones solid waste norms.**

Phase-II of the project was taken up for 4 years to develop and provide integrated technology packages for bio-processing of leather complete with revalidation and performance evaluation under an expanded knowledge network involving also user industries. An opportunity for India gaining leadership in leather processing technologies by replacement of chemicals in beam house operations in tanneries became evident from the results gained under the project. The technology will be commercialized with support from DIPP and CPCB.

eSkin

Human skin is a relatively simple tissue consisting of predominantly three major cell types namely Keratinocytes, Melanocytes and Fibroblasts. These three cells physically and functionally interact to form the structure of the skin and maintain the barrier and other skin functions. These cells coming from different lineages have diverse functions, keratinocytes form the bulk of the cells and they form the impervious barrier called the stratum corneum. Melanocytes, on the other hand synthesize melanin granules and transfer them to keratinocytes. Presence of melanin in keratinocytes provides protection against the harmful UV rays, which would otherwise cause DNA damage. Fibroblasts in the dermis synthesize collagen that gives the skin its strength and resilience. Since topical application of molecules/cosmetics is restricted to epidermis and dermis, the model for skin needs to account for relatively fewer cell types and their interactions. Currently the models used to evaluate effects on skin range from cultured cells to 3D organotypic cultures. Whilst the cultured cells are too simplistic to recapitulate the events happening in the skin, organotypic cultures are difficult to establish and maintain. Small animals as an alternative has ceased to be useful because of inherent differences in the skin like the absence of cutaneous pigmentation and animal ethics considerations. Further animal models for cosmetics have been banned in US and Europe and India. Therefore, there was an urgent need to develop alternate systems which could model homeostatic perturbations in skin and predict the outcome in a reliable

manner. *In-silico* approaches combining experimental data from along with available molecular information on the skin provides an excellent approach to address this issue. These models can also be used by Dermatology Industry which has a huge market as regulations for bringing new products into the market will become increasingly difficult. A Bangalore-based company, Cell works has developed a prototype-based on literature data. But the point is to note that no data is available for Indian skin. Cosmetic industry is very much interested in this data since India has a huge market and both L'Oreal & Unilever need such systems.

Under CSIR-NMITLI, a different domain area of research and product development was undertaken through the project "System based computational model of skin". The area was largely unexplored and scattered research was available within Indian Research institutes. Through the NMITLI project a computational solution named eskin was developed which has ruled out the use of animal model for predicting the behaviour of chemicals on human skin. "eSkIN", a first- of- its- kind computational platform converts large scale high-throughput omics data into biomedical knowledge. It empowers skin researchers to predict the effects of their compounds on human skin in a cost and time- efficient manner with reduced animal testing.

Dental Implants

The loss of a tooth or multiple teeth in an individual has been necessitating care over many decades. Missing teeth lead to a reduction in the overall health of an individual and quality of life, as the important functions of mastication and speech are affected. The percentage of totally edentulous population in the country ranges from 19 % in the age-group of 60-74 years as per W.H.O. to more than 30 % in the age group of 75 years and above.

The goal of modern dentistry is the identification of such clinical needs associated with missing or deficient teeth and/or maxillofacial tissues and rehabilitation and maintenance of the oral function, comfort, appearance and health of patients using biocompatible substitutes. These biocompatible substitutes are called dental prosthesis and apart from the conventional methods like complete dentures (for edentulism), removable partial dentures (Removable Dental Prosthesis) and bridges (Fixed dental prosthesis taking support from remaining teeth), dental implants have emerged out as the best treatment modality in the lost tooth rehabilitation.

Dental implants act as an anchor for single crowns, multi-tooth bridges, and even entire dental prostheses. Compared with conventional methods, which involve

grinding down healthy adjacent teeth to support a prosthetic bridge, implants offer significant advantages, because they avoid damaging healthy neighboring teeth, have a proven record of clinical success, documented by numerous scientific studies and have been shown to improve patients' quality of life and well-being. Currently, screw type root-form dental implants made of Titanium based alloys/commercially pure Titanium with a special surface are most popular. These are surgically placed in the jaw bone and along with other components involved in the procedure like abutments which are joined to the implants, are used to support the dental prosthesis. This procedure conventionally takes about 3- 6 months in total however newer concepts have introduced faster treatment time in certain clinical conditions.

The global dental implants and prosthetics market is estimated to grow at 7.2%, to reach USD 12.32 Billion by 2021. In India currently about 1,50,000 implants are used annually (industry estimates) and the market is growing in double digits. The Indian market is completely flooded by expensive imported implants and till date no indigenous dental implants are manufactured in the country. There have been sporadic attempts in the past from different indigenous bodies but none have been commercially successful.

The research and development of indigenous dental implants started way back when the scattered research groups working in different areas of implant were brought together in a common platform of NMITLI. The engineers and the doctors (dentist) were brought together to undertake collaborative research in development of the technology. The research and development starting with the conceptual designing, fabrication and manufacturing till the testing in animal and then in human was carried out under NMITLI project. Further the capacity development in terms of manufacturing, cleaning and sterile packaging was developed. The indigenous technology for dental implants system has been now transferred to M/s Innvolution Healthcare Pvt Ltd by CSIR.

New Technology Capacity Created:

NMITLI envisages to bring innovation through technological means such as new technology capacity creation in the country knowing fully well that not all technology projects will be successful. The approach is to enable partners to develop new technology capacity through substantial funding aiming to develop state of the art in the field with the guidance of NMITLI experts having multiple expertise. The approach enabled it to identify the technology-driven pressure to change and adjust the structural and institutional architectures to develop knowledgebase, technologies

and products or at least platforms for future technologies. Some of the examples of this approach are:

Intelligent video surveillance server (IVSS) system

Video surveillance market has been growing exponentially on account of growing concerns for security worldwide. Seeing this opportunity, M/s Mind Tree Limited decided to enter into the domain of surveillance and security products and approached NMITLI for the purpose. A project aimed to develop low cost intelligent video surveillance server (IVSS) system tuned for the Indian deployment scenario has been supported by NMITLI. A complete intelligent video surveillance server (IVSS) system has been developed and commercialized under NMITLI. The IVSS system was designed around five core themes: scalable, distributed, standards based, intelligent and networked. The solution has been developed for Indian deployment scenarios. The video analytic algorithms are well-tuned for Indian conditions and behave better than foreign counterparts. A few examples are the Automatic Number Plate Recognition, granular object classification as applicable to vehicles etc. Unique low complexity and cost effective video algorithms developed that are accurate and can run real time on standard platform. Developed ONVIF 1.02 (Open Network Video Interface Forum) standards compliant software stack for both the camera and management server has been licensed to international customers also.

M/s Mind Tree Limited has developed a strong portfolio of products and solutions for different vertical markets under the project. Mind Tree has established its name as a leading provider of white labelled Video Surveillance Products designed for the Indian Market. All leading Security System Integrators in the India including ECIL, Zicom/Schneider, HCL, Godrej, SPANCO and several other smaller integrators have partnered with Mind Tree for at least one tender each. All these tenders are complex, distributed, intelligent surveillance tenders with at least 100 cameras. Mind Tree has established presence in the ONVIF International standards forum. It has also been shortlisted as an authorized vendor by a few government departments – Department of Atomic Energy and Railways to name a few.

Four-door, four-seater battery operated electric car (e2o Plus)

A significant majority of all cars sold in India today are A and B segment small hatchback cars, which are less than 4 m in length and seat 4 adults comfortably. This segment is expected to grow considerably over the next 10 years with the expected

increase in income levels and urbanization in the country. Given India's dependence on imported oil, the cost of such growth is likely to severely strain India's trade (im)balance. Oil imports already today account for over 60% of the country's trade deficit, and this scenario is only set to worsen with increasing number of cars in the country. Mahindra Mobility (earlier Mahindra Reva) which is a pioneer in electric vehicle (EV) technology with the longest history of continues commercial production of electric vehicles has planned to develop no compromise 4-door, 4-seater battery operated electric car and off-board fast charger to expand range of its car portfolio and approached NMITLI for support. World's lightest and lowest cost, 4-door, 4-seater battery operated electric car and low cost indigenous off-board fast charger have been developed under NMITLI project. The car has been launched in the market under a brand name of e2o Plus in October 2016. On a full charge, e2oPlus can travel for upto 140 kms and can achieve a top speed of 85 kmph. Powered by the latest electric drive train technology, the e2oPlus can effortlessly cruise through city traffic. The tall-boy design and spacious interiors make for a compact city car that can comfortably seat four adults. With its technologically advanced features, home charging facility, easy manoeuvrability and affordable ownership, it is expected that the e2oPlus will soon be accepted as a mainstream car. The host of innovative features include remote diagnostics through telematics, connectivity through smart phone app, new and advanced infotainment system, regenerative braking, hill hold control for easy driving in hilly terrains, REVive® for reserve charge and automated messages amongst others. Charging the e2oPlus is as simple as charging a mobile phone. The car is currently being sold in 23 cities in India. Recently, over 100 e2oPlus have been sold to Ola Cabs and were made part of first "Multimodal Electric Vehicle Project" launched in May 2017 to build an electric mass mobility ecosystem in Nagpur.

Electrical Three Wheeler "Soleckshaw Lite"

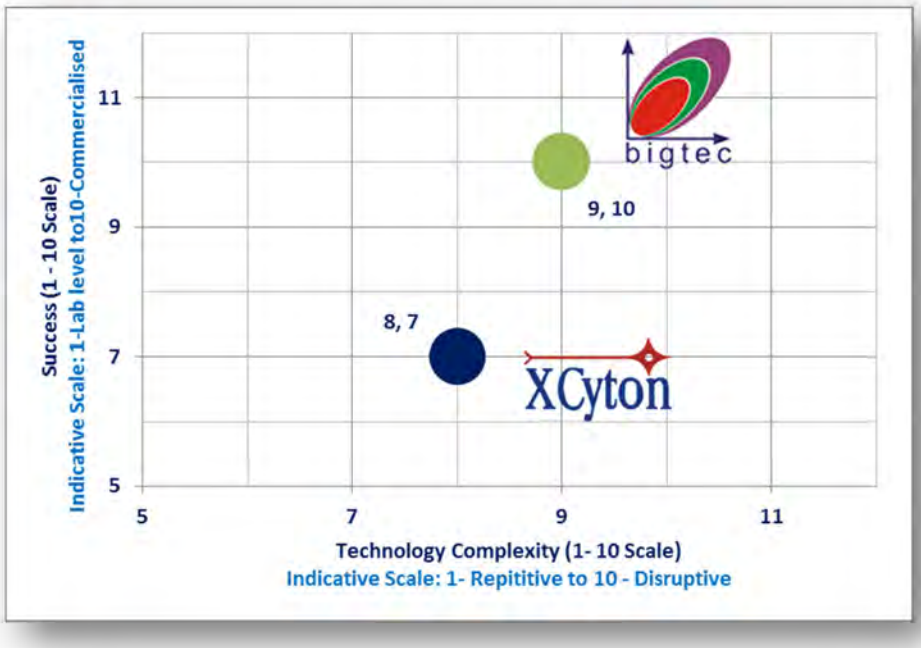
It has been established through market research that auto rickshaw runs about 100 kms a day, that too, in the most crowded parts of the city, and results in huge pollution impact on the cities. The cost per kilometre of hiring an auto rickshaw has increased to about Rs. 8-10 per km due to rising prizes of petrol, diesel and CNG. In many cities, meters are not used and thus, the customer and rickshaw driver has to haggle over the fare to be paid which varies from Rs. 60 to Rs. 150 for traveling only 5-10 kms. Keeping in mind the rising fuel prices, dwindling resources of fossils fuels and the threat of global warming, it was envisaged to develop Electric Three Wheeler 'Soleckshaw Lite' which will have more than sufficient range to cater to such intra-city usage characteristics, thus would offer an affordable, environmentally

friendly city commuting option with a low running cost for auto rickshaw owner as well as users.

In a project supported under CSIR-NMITLI, Kinetic Engineering has developed electric three wheeler 'Soleckshaw Lite'. It is designed primarily to meet the need of short to medium distance transport within cities. It is designed for a top speed of about 40-45 kmph and a driving range of about 100 kms per charge. It would carry the driver and three passengers comfortably. Successful deployment of 'Soleckshaw Lite' for short to medium distance transport will bring India a leadership position in the electric three wheeler segment. After rigorous testing and trials at ARAI, Pune, Central Motor Vehicle Rule (CMVR) certification for 'Soleckshaw Lite' has been obtained. 'Soleckshaw Lite' is the country's first electric auto rickshaw which has obtained CMVR certification under L5M category with a speed of over 40 km/hr. 'Soleckshaw Lite' technology has been developed as a platform technology and can also be for developing other application such as vehicle for intra-campus movement of people and goods, for large campuses of hospitals, industry and universities, a load carrier for carrying small to medium loads within an urban area for replacing the existing diesel/ CNG operated vehicles.

Start-up Success:

Many start-ups approached NMITLI for funding. NMITLI supported few of them. Few succeeded and few failed. Although, a good product idea and a strong technical team are not a guarantee of a successful start-ups. There are many reasons for success and failure of a start-up, NMITLI tried to support them under 'Risky Project Category'. Some examples of success are given below:



Development of an integrated micro PCR system with In-situ Identification

Bigtec Private Limited was set up in year 2000 and struggling to establish itself. It approached NMITLI with a concept of miniaturized version of PCR. CSIR supported the project and through experts advise guided the company to develop MicroPCR. Rational of CSIR support was that there was no point of care diagnostic assay which gives the test result in short time with affordable price. Thus, this project was positioned to create diagnostic tests for various diseases using Gold Standard-PCR method, which can be made available in even rural settings where power is a problem. Further, results can be transmitted to distantly located expert for advice.

Bigtec Labs, Bangalore with CSIR-NMITLI support, developed a microPCR device - Truelab Uno™ for real-time PCR based nucleic acid detection of pathogens. Two patents have been filed in around 130 countries and granted in over 70 countries. The device consists of a portable unit housing a PDA (Portable Data Assistant) running a software application, the PCR chip, optical detection system and electronic Circuits controlling all aspects of the unit. They developed microPCR chips for detection of Tuberculosis, Malaria, Dengue, Chikungunya, Hepatitis B and H1N1, ailments that contribute significantly to the disease burden in India. They have opened a joint venture and selling the products in India and abroad. ICMR is using them at various locations in the country.

With timely support from CSIR and handholding, Bigtec labs have developed capabilities in design, fabrication and testing of Micro Electromechanical Systems (MEMS) and handheld electronics, genomics and proteomics, biology and chemistry. Bigtec labs' development of microfluidic devices to detect pathogens on-chip is an instance of the interplay of diverse disciplines to realize a product addressing a key need in healthcare. This lab-on-chip technology is targeted at developing systems capable of sample preparation, mixing, complex bio-chemical reactions, sample screening and detection on a single chip platform. Thus, CSIR has helped a start up to success.

Novel molecular diagnostics for eye diseases and low vision enhancement devices

XCyton Diagnostic Limited was registered in 1993 and was looking for product portfolio in the area of diagnostics. It was invited to become an observing partner in one of the Nationally Evolved Project (NEP). Based on the knowledge gained and its interest, it was involved in the development of DNA Macrochips for detection of eye diseases. 24 signature genes of 14 pathogens were detected on DNA Chip. The test

System is named as Syndrome Evaluation System or SES. XCyton's Syndrome Evaluation System (SES) allows for the simultaneous identification of multiple organisms inclusive of Bacteria, Viruses, Fungi and Parasites, in a specific test from a single sample. This process provides the clinician with a rapid, definitive assessment of a patient who is presenting a set of symptoms common to multiple pathogens. The company is now offering wide range of services based on SES Platform.

The company is now established and looking to be global leader in Innovative Diagnostic Product development. With the ambition to highlight India on the world map of Medical diagnostics, XCyton is the catalyst for accurate and time management Diagnostics. XCyton ventured into the conception and invention of Molecular Diagnostic products for improved diagnosis of Critical Care Infections, and developed the unparalleled Syndrome Evaluation System, the world's first Critical Care Therapeutic Decision Support System.

8.0 Recommendations of the Review Committee

- The committee appreciates the efforts and achievements of New Millennium Indian Technology Leadership Initiative (NMITLI) in particular for leveraging synergy of National Innovation System (NIS) through creation of desired networks of industry, national laboratories / R&D institutions and academia, for developing well positioned technology and products, through focussed and well positioned projects. Several of the technologies/ products developed have been commercialized.

- The Committee recommends that:

  - NMITLI should fund project(s) in totality beginning from proof of concept/ lead stage to commercialization. The stage gate methodology could be applied to review the projects once funded;

  - The screening and selection process of NMITLI projects is too long and cumbersome. The process needs to be made simpler by adopting shorter two-step selection process; and

  - NMITLI should create mechanism for reviewing the commercialization plan of the technology/products being developed under the given

project(s) and hand hold industry through a peer group, in case so required by the industry.

- Considering the significant achievements realised under the NMITLI, Committee recommends continuation of the scheme/ programme beyond 12th Five-Year Plan period.

* * *

II. Intellectual Property & Technology Management (IPTM) Scheme

Preamble

CSIR has been a pace setter in IP protection in the country. On India joining the WTO in 1995, there were apprehensions in diverse sections of the society of India meeting the challenges ahead, especially in regard to the changed scenario in intellectual property domain. CSIR considered it an obligation to reassure and prepare the nation to face the emerging scenario resolutely and with confidence. Thus, early in 1996, CSIR suo moto initiated action with the USPTO, for the re-examination and revocation of the US patent granted on 'turmeric as a wound healing agent' The outcome was the successful revocation of the US Patent in 1998. The success demonstrated CSIR's and Indian capabilities to understand the complex techno-legal-issues of IPR both defensively and aggressively and reassured the Indian public and policy makers of India's capacity and capability to meet the challenges of globalization and WTO.

However, with the changes in IPR imminent due to TRIPs, a deliberate and massive programme of education and skills acquisition on diverse aspects of IPR, innovation and technology management was mounted at the commencement of the Ninth Five Year Plan (NFYP) Period under a new plan scheme 'Intellectual Property and Technology Management' (IPTM). In view of the fluidity of the situation prevailing with respect to IPR and TRIPs nationally, it was considered prudent to assess the feasibility of CSIR learning and mastering the IP game through a pilot/trial phase.

Post-1995, India has met its entire Trade Related Intellectual Property Rights (TRIPs) obligations in various stages starting from providing mailbox applications in 1999 with retrospective effect from 1st January 1995 followed by second amendment in the Patents Act which was passed by the Parliament of India in 2002 and came into force on 20th May 2003. This amendment for the first time made our Patents Act more or less at par with the developed countries in providing a 20 year patent term, 18 months publication and also safeguarding national interest by remodeling compulsory license provisions and by introducing Bolar provisions. The third amendment in the Patents Act came into force from 1st January 2005 providing product patenting in pharmaceuticals, food and chemicals, rationalizing and reducing timelines for processing of patent applications and doing away with

Exclusive Marketing Rights (EMRs). The act also provides necessary safeguards through introduction of Section 3(d) which does not permit 'ever greening' of patented invention.

India's National Intellectual Property Rights (IPR) Policy has been released recently in 2016. The Policy which is in compliance with WTO's (World Trade Organization) agreement on TRIPS (Trade Related aspects of IPRs), aims to sustain entrepreneurship and boost the government's 'Make in India' scheme. This Policy which will be reviewed every five years in consultation with stakeholders, aims to push IPRs as a marketable financial asset, promote innovation and entrepreneurship, while protecting public interest. One of the major highlight is to review of existing IP laws and to update and improve them. The IPR policy also favors financial support for a limited period on sale and export of products based on IPRs generated from public-funded research.

CSIR not only aims at working towards successful implementation of the IPR policy but also intends to obtain maximum benefit from such policy.

IPTM Scheme

In the Tenth Five Year Plan (TFYP), CSIR emerged on the international IP scene as an entity to be reckoned with and poised to play the IP game internationally with confidence and maturity. The scheme was continued to 12th FYP with activities like filing, capturing, prosecution and maintaining of IPR for CSIR R&D outputs; Formation, valuation and valorization of patent and IP portfolios; Surveillance for infringement and enforcement of IPR; Human Resource; Modernization of computing, communication and related facilities. The objectives were:

- To capture, secure, enhance and realize the value from the Intellectual Property of CSIR.
- To file around 150-200 patent applications per year in India.
- To file around 150-200 patent applications per year abroad.
- To police the CSIR IP for infringement and enforcement of IPR.
- To impart training to young women scientists/interns in IP management.

In the 11th FYP CSIR has maintained position in the field of IP. The scheme was continued to 12th FYP for the following activities and objectives.

During the period of 10th FYP & 11th FYP, CSIR has developed a sizeable portfolio covering wide spectrum of scientific disciplines. However, there have been challenges in realizing value from this portfolio. CSIR experimented with various models. One such model relates to assigning of IP rights for licensing high value IP to multinationals and foreign entities in view of existing monopolies in certain fields to requirement of huge risk investments in developing new molecules into drugs. Another model aimed at helping out Indian industry through limited exclusivity, exclusivity or non-exclusive licensing to add to country's industrial output. Such attempts have helped in creating a market share in import dominated domain in chemicals and drugs and pharmaceuticals thus bringing down the huge cost of imports through competition and by replacing / creating a market share through leveraging CSIR's IP portfolio. In many such cases, value realization is small but impact to the economy is huge both in financial terms and societal benefits. Similarly, a need has been felt to provide affordable technological solutions at near zero cost or at very notional cost to individuals and industry providing goods and services.

Thus, efforts made during Post 2006 period in this direction have led to the evolution of a new CSIR IP Management Policy which would govern the measurement and utilization of CSIR's IP portfolio in terms of its impact on the society.

CSIR IP policy:

"To maximise the benefits to CSIR from its intellectual capital by stimulating higher levels of innovation through a judicious system of rewards, ensuring timely and effective legal protection for its IP and leveraging and forging strategic alliances for enhancing the value of its IP".

Accordingly, CSIR's new IP Policy during XII Plan aimed at:

a. CSIR used prior art search analysis for project formulation, monitoring and IP protection.
b. CSIR focused on protection of commercially and strategically important inventions nationally and internationally.
c. High value IP patented nationally and internationally to be licensed exclusively at internationally competitive cost to those firms who could make huge risk investments over a long period of time. Even in such cases, especially in the health sector, interest of Indian and poor populations to be

safeguarded through the introduction of appropriate clauses concerning public health concerns in the licensing agreements.

d. In case of IP material to the economic benefits of the nation with huge impact in terms of savings on imports, employment generation and economic advantages to the nation, CSIR co-partnered with industry towards development cost and may even have stakes through equity participation.

e. In case of IP which helps in raising the living standards of the poor and can be easily practiced by them, CSIR aimed at providing technological solutions whether patented or developed as know-how at near zero-cost or at fractional cost to individuals and industry.

CSIR would, however, zealously guard acknowledgement of its contributions by the users.

CSIR has 75 years of leadership in IP protection. IPU is the Centralized facility catering to the need of IP related matters of all CSIR labs and is one of its kind.

Work flow of IP Management in CSIR

In CSIR IP is management is done through an integrated approach. The work flow in CSIR can be categorised in to three categories:

1. Pre-development of IP at lab level is done by URDIP which includes:

    - Prior art search
    - Project Evaluation
    - Freedom to operate
    - Competitive intelligence and Mapping

This pre-development activity helps our CSIR in Planning of R&D, removing duplicity of work. Help in landscaping of the technological area. This helps in finding gaps on the research area and accordingly helps in planning of research.

2. IP Protection and Maintenance is done by IPU which includes:

- Drafting, filing, prosecution and maintenance of all kind of intellectual Property of CSIR like patent, trademark, Copy right etc.
- IPU also provides its inputs on IP related issues to the agreements signed across CSIR.
- IP commercialization and Business Development is primarily done at lab level.

Objectives of the IPTM Scheme

The scheme has been continued from 11th FYP to 12th FYP with the following objectives:

- To file, prosecute and maintain the inventions generated by CSIR labs nationally and internationally.
- To file around 150-200 patent applications per year in India.
- To file around 200-250 patent applications per year abroad.
- To obtain grant of around 200 patents in India.
- To obtain grant of around 250 patents abroad.
- To police the CSIR IP for infringement and enforcement of IPR.
- To file around 25-30 other IPs every year.
- To impart training to young women scientists/interns in IP Protection.

Activities of IPU

1. To secure and maintain IPR for CSIR R&D outputs

CSIR is the premier publically funded R&D organization in India and provides solution to technological needs of the India. CSIR generates Intellectual Property as a part of R&D outputs. CSIR secures intellectual property rights for its R&D outputs not only in India but also internationally. CSIR, not only secures patents but also secures other forms of IPR like TM, copyrights, design, plant varieties and trademark. To capture, file, prosecute and maintain the IPR of CSIR R & D output in

India and abroad is the major activity of IPTM carried out by Innovation Protection Unit-CSIR (IPU-CSIR).

Each lab of the CSIR has the IP cell and has an IP coordinator. IP cell acts as an interface between the Scientist at the laboratory and the central operations called Innovation Protection Unit. The early capture of an IP is done pro-actively in a two-tier mode. Each laboratory has got a publication and patent committee, which scrutinizes all the research publications and identifies intellectual property which could be protected by patents and other forms of IP. There is a close interaction between IPU and the lab. Several communications take place towards finalization of the proposal and to the grant of the patent.

Indian filing

With regard to Indian filing, prosecution and maintenance and other related matters like opposition, infringement the activities done in-house by IPU are:

Searching, drafting, filing, prosecuting and maintaining Indian applications. Over the years, IPU has developed expertise in handling Indian patent drafting, filing, prosecution and maintenance in-house. Whereas, Opposition, infringement are rare instances which requires high level of legal expertise and therefore needs to be outsourced to empaneled law firm. CSIR is the only organization in India, which files and gets grants to its own patents in India.

Foreign filing

With regard to foreign filing, prosecution and maintenance and other related matters like opposition, infringement, CSIR engages the services of the local empaneled attorneys.

2. Formation, valuation & valorization of patents & IP Portfolio

Formation, valuation, valorization of IP Portfolio (group pf patents) has been given greater emphasis and they require the major inputs from the IPU. Firstly, all presently owned IP are analyzed and checked if they can become the part of any IP portfolio. The valuation of patents has been done patent wise and portfolio wise.

3. To police (surveillance) the CSIR IP for infringement and enforcement of IPR

IPU in association with CSIR-Unit for Research and Development of Information Products (CSIR-URDIP) keeps surveillance about infringement of intellectual property of CSIR. This activity helps the CSIR to know the company/industries that were knowingly/unknowingly using our IP without CSIR consent. CSIR expects to earn good revenue.

4. To develop Human Resource in Intellectual Property Rights

a. Training of CSIR interns/TIFAC –KIRAN IPR interns

To commensurate with the **National Intellectual Property Right Policy, 2016** and also aligning with skill development initiative of the Government of India, IPU-CSIR provides hands on training in various areas of IPR to CSIR interns and TIFAC –KIRAN IPR interns and made them job ready.

b. In-house capacity building through IPR awareness in CSIR labs/institutes

IPU-CSIR has created awareness about economic, social and cultural benefits of IPRs and stimulated IPR protection and awareness on IPR infringements in various CSIR labs/institutes.

c. Conducting workshops and seminars

IPU, CSIR organizes seminar, workshops and conferences for the IP awareness alone and jointly with HRDC, Ghaziabad, URDIP and with other Organizations. The target audience/stakeholder are the scientists from CSIR, R&D professionals from Govt. of India/Public Sector/private sector or IPR Practitioners.

Highlights of achievements of IPTM scheme during 11th and 12TH FYP

(i) CSIR secured a sizable portfolio of about 2902 granted foreign patents and 1387 granted Indian patents, apart from about 2345 Indian and more than 1393 foreign patent applications are in-process.

(ii) CSIR has filed 3413 foreign patent applications and 2228 Indian patent applications

(iii) CSIR developed key portfolios in the areas of Bio-informatics products, leather, optical fiber, drugs and pharmaceuticals, biotechnology, nanotechnology, polymers, food products & processes and herbals products and processes.

(iv) CSIR has been placed strategically on the world map by capturing about **57%** share of total US patents granted to Indians excluding foreign assignee during 11th and 12th FYP.

(v) CSIR has strengthened its capacity in the field of IP management during the period 2007-2017 in the areas of techno-legal drafting, licensing, pricing and other aspects of IP management, information and documentation, patent search and analysis and IP awareness.

(vi) During the year 2002, CSIR initiated the scheme 'CSIR Diamond Jubilee Invention Award for school children' creating interest and awareness about IP amongst school children and to inculcate creativity. The scheme has been continued during the year 2007 to 2017. 14 students were awarded in CSIR Innovation Award for school children (CIASC-2016). The scheme has gathered appreciation in different forums.

(vii) CSIR made sincere efforts for valorization of its IP by forming alliances with licensing firms abroad.

Targets achieved during 11th and 12th FYP

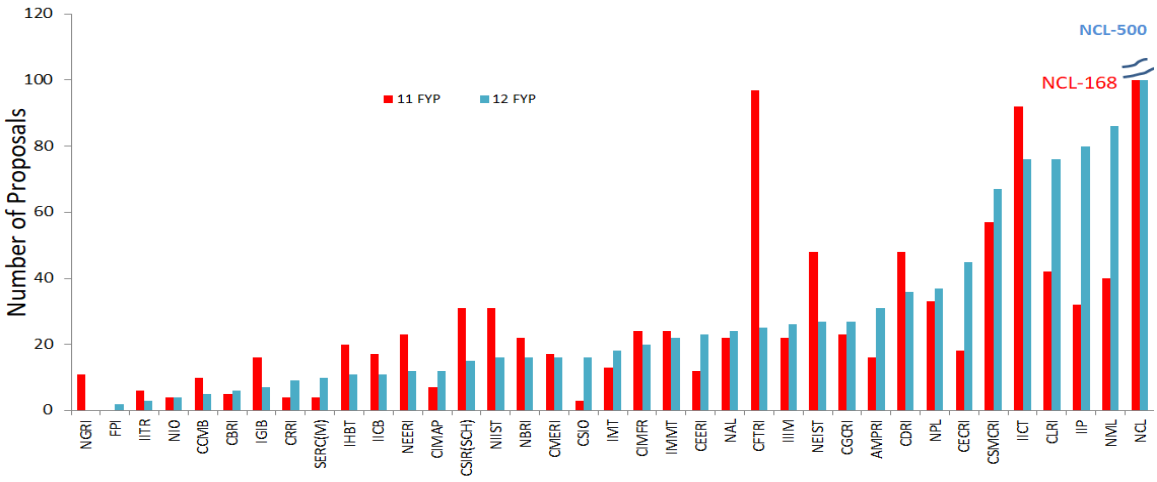
Physical performance of IPU can be assessed directly through the filing of Indian and foreign patents.

Table 1 shows the target set and targets achieved for filing of patents in India and abroad. It can be seen that, IPU had fully achieved the set targets.

Other forms of IP were also filed by the IPU. The other IP includes design, trademark, and copyrights.

Table 1: Performance (Target set & achieved) of scheme

YEAR	FILING (INDIA)		GRANTED (INDIA)		FILING (ABROAD)		GRANTED (ABROAD)		OTHER IP	
	TS	TA	TS	TA	TS	TA	TS	TA	TS	TA
2007-08	150-200	207	250	401	150-200	270	300	345	40-50	15
2008-09	150-200	183	250	701	150-200	414	300	344	40-50	41
2009-10	150-200	162	250	145	150-200	181	250	329	40-50	52
2010-11	150-200	180	250	260	150-200	242	250	264	40-50	76
2011-12	150-200	191	250	98	150-200	430	250	307	40-50	76
2013-14	150-200	265	250	92	150-200	403	300	344	40-50	30
2014-15	150-200	310	250	65	150-200	454	300	337	40-50	37
2015-16	150-200	324	250	115	150-200	453	300	319	40-50	31
2016-17	150-200	225	250	100	150-200	312	300	251	40-50	21



TS-Target set, TA-Target achieved

Figure 1: Patent proposal received in 11th and 12th FYP

Figure 1 shows the patent proposals received from various labs of CSIR in 11th Plan and 12th Plan. Some of the labs like IGIB, IHBT, NEERI, NIIST, CFTRI has reduced its number of filing in 12th Plan. Whereas, labs like NPL, CECRI, CSMCRI, CLRI, IIP, NML and NCL had enhanced its filing in 12th Plan.

The Table 2 shows the CSIR patent portfolio in major countries. It can be observed that CSIR has more number of patents in India than in any other country. It can also be observed that, CSIR holds good number of product patents. Number of process patents that CSIR has is more than the product patents. CSIR files its patents mainly in India, US, UK, Germany, Japan, China, France, Australia and Canada. European and PCT application are the regional application.

Table 2: CSIR Patent portfolio in Major countries

Country	Product	Product and process	Process	Total
India	822	1008	1875	3723
US	297	366	465	1137
UK	85	82	109	279
Germany	79	75	115	272
Japan	62	80	110	253
China	58	27	111	226
Europe	32	126	67	226
France	64	61	87	215
PCT*	15	125	56	196
Australia	40	45	83	170
Canada	29	37	64	132
Total	1583	2032	3142	6829

The Table 3 indicates the lab-wise data of the patent applications filed and granted in India.

Table 3: Lab wise patent applications filed & patents granted in India (2011-2017)

LAB/ YEAR	Filed in India						Granted in India					
	2011 -12	2012 -13	2013 -14	2014 -15	2015 -16	2016 -17	2011 -12	2012 -13	2013 -14	2014 -15	2015 -16	2016 -17
AMPRI	0	3	3	0	11	7	1	2	3	1	0	0
CBRI	0	0	0	2	1	3	0	0	0	0	0	2
CCMB	2	0	1	0	3	0	2	0	0	0	0	0
CDRI	9	6	9	10	10	1	1	6	5	1	5	7
CECRI	4	0	4	8	12	10	4	1	2	3	4	2
CEERI	5	2	4	6	9	3	0	0	0	1	0	0
CFTRI	4	3	3	8	2	5	26	12	13	7	9	7
CGCRI	4	6	6	5	6	7	4	3	1	5	7	4
CIMAP	3	0	1	2	1	4	2	1	1	0	0	1

CIMFR	2	0	3	2	7	4	2	3	6	3	10	6
CLRI	9	6	13	29	17	10	5	5	6	4	10	1
CMERI	1	0	2	0	11	4	0	1	2	0	4	1
CRRI	0	2	1	3	3	1	0	0	0	0	0	0
CSIO	1	1	1	4	5	3	0	0	4	1	0	1
CSIR (SCH)	1	3	1	4	1	2	2	2	1	2	2	5
CSMCRI	9	17	10	10	18	13	3	6	1	3	6	8
DJA	0	1	1	0	0	0	0	1	0	0	0	0
FPI	0	0	1	0	1	0	0	0	0	0	0	0
IGIB	2	2	0	1	0	1	2	0	2	1	1	1
IHBT	5	3	1	3	2	0	1	1	2	0	3	1
IICB	1	0	1	2	1	2	0	0	1	2	1	0
IICT	12	15	9	16	18	11	7	11	7	6	7	10
IIIM	1	1	7	7	4	1	0	0	0	0	1	2
IIP	8	22	11	17	20	11	3	4	5	5	3	7
IITR	0	0	1	0	1	0	0	1	0	0	0	0
IMMT	3	4	6	4	5	2	1	3	3	3	4	2
IMT	3	1	6	2	3	4	1	2	1	1	0	1
IPU-CSIR	0	0	0	0	0	0	0	0	0	0	0	0
NAL	3	4	1	9	9	3	0	3	2	1	3	0
NBRI	4	1	2	6	1	0	2	2	0	0	0	0
NCL	75	73	122	108	98	82	11	20	10	4	10	11
NEERI	4	1	1	1	4	3	0	1	2	2	0	1
NEIST	3	6	4	7	3	6	3	4	2	2	5	4
NGRI	0	0	0	0	0	0	0	0	0	0	2	0
NIIST	5	5	3	2	4	1	3	3	4	2	4	5
NIO	0	0	1	1	1	0	2	0	2	0	1	1
NMITLI	0	0	0	0	0	0	1	0	0	1	0	0
NML	3	7	16	15	24	15	4	7	2	3	7	6
NPL	4	4	8	12	5	6	5	3	2	1	6	3
SERC(G)	0	0	0	0	0	0	0	0	0	0	0	0
SERC(M)	1	0	1	4	4	0	0	0	0	0	0	0
Total	**191**	**199**	**265**	**310**	**325**	**225**	**98**	**108**	**92**	**65**	**115**	**100**

Table 4: Lab wise patent applications filed & patents granted abroad (2011-2017)

LAB/ YEAR	Filed Abroad						Granted Abroad					
	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
AMPRI	0	1	0	2	1	4	0	0	0	0	2	0
CBRI	0	0	0	0	0	0	0	0	0	0	0	0
CCMB	1	3	4	5	2	10	2	3	10	9	2	1
CDRI	14	6	27	9	32	9	12	3	16	8	16	19
CECRI	0	3	19	6	1	1	2	0	6	12	10	7
CEERI	0	1	2	0	0	0	0	0	0	0	1	1
CFTRI	0	0	0	0	0	0	27	8	9	4	2	1
CGCRI	2	3	4	5	12	0	1	0	1	0	0	2
CIMAP	5	4	2	1	3	0	8	11	6	3	3	0
CIMFR	2	5	0	0	0	0	3	4	6	5	5	1
CLRI	4	2	2	5	1	13	0	1	0	0	1	0
CMERI	0	0	0	0	0	1	1	0	1	0	0	0
CRRI	0	0	2	3	0	0	0	0	0	0	1	2
CSIO	0	0	0	0	2	1	5	2	3	0	0	0
CSIR (SCH)	5	8	4	0	2	1	12	10	21	16	3	6
CSMCRI	86	45	68	72	34	25	54	42	71	55	47	44
DJA	0	0	0	0	0	0	0	0	0	0	0	0
FPI	0	0	2	0	0	1	0	0	0	0	0	0
IGIB	2	6	8	3	5	0	27	27	1	5	5	5
IHBT	6	8	19	11	1	6	3	5	8	5	16	7
IICB	18	3	11	2	11	6	9	6	5	4	12	14
IICT	69	39	31	13	34	13	51	43	55	49	32	31
IIIM	8	9	4	15	17	17	2	0	13	5	6	2
IIP	4	10	7	17	15	10	6	14	18	9	5	7
IITR	1	0	0	1	2	0	0	0	2	0	0	0
IMMT	6	2	5	1	9	0	1	6	4	4	5	0
IMT	22	31	6	10	12	20	16	9	9	5	14	17

IPU-CSIR	0	0	0	0	0	0	0	0	0	0	0	0
NAL	3	1	2	10	7	0	0	0	1	4	0	7
NBRI	9	3	3	14	9	6	3	5	8	1	7	2
NCL	114	169	130	207	202	141	17	31	65	82	86	92
NEERI	3	3	12	1	3	1	0	1	1	1	3	2
NEIST	6	23	4	6	7	3	0	4	4	6	6	0
NGRI	0	2	0	5	0	0	5	5	8	6	2	0
NIIST	23	18	17	21	14	14	8	12	10	21	20	11
NIO	0	0	1	1	0	0	20	2	7	0	0	0
NMITLI	2	4	5	1	3	1	0	3	4	6	10	2
NML	0	0	0	1	0	0	3	0	0	0	0	0
NPL	15	2	5	8	13	3	9	17	9	12	3	5
SERC(G)	0	0	0	0	0	0	0	0	0	0	0	0
SERC(M)	0	1	1	0	1	3	0	0	0	0	0	1
Total	**430**	**415**	**407**	**456**	**455**	**310**	**307**	**274**	**382**	**337**	**325**	**289**

Commercialized Technology backed by patents

Commercialized : 547

Percentage : 7 %

Global Average : 3 to 4 %

Expenditure on IPTM

Most of the budget of the IPTM is spent on the securing of IP of CSIR. Table 5 shows the comparative data of patents filed and granted in respective financial Years. With respect to the XI plan the number of filings both in India and abroad is increased in XII plan. As CSIR has no control on the grant of the patent. (patents are granted by patent office), the grant number got reduced. Also, CSIR obtains the grant tot only those patents which have commercial potential. It can be seen that Number of cases filing abroad is increased by upto 700+ patent application abroad and 400+ patent application in Indian, whereas the expenditure did not rise significantly.

IPU rigorously does review of its portfolio at every stage, due to which it was able to file more IP, secure more IP at a less cost.

Table 5: Comparative data of patents filed and granted

Period	Expenditure, Rs crore	India		Abroad	
		Filed	Granted	Filed	Granted
IX Plan	24.83	1969	859	1628	279
X Plan	130.23	1818	1173	4036	1322
XI Plan	188.00	905	1884	1380	1600
XII Plan	204.50	1323	480	2033	1596

Table 7 shows that expenditure on patents, that has remained constant and under control despite inflation worldwide. The rise in expenditure in 2016-17 is due to some billing related issues in previous financial Years.

Table 6: Expenditure during 2007-2012 (Total Expenditure: Rs. 188.00 crore)

Year	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012
Total Expenditure (Rs. in Crores)	34.77	40.4	37.89	34.89	40.00*

Table 7: Expenditure during 2012-2017 (Total Expenditure: Rs. 204.5 crore)

Year	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017
Total Expenditure (Rs. in Crores)	35.61	37.23	37.11	40.00	54.53

Table 8 shows the number of granted patents that CSIR held at the end of each Financial Year. It shows that, CSIR during XII plan CSIR had reduced number of grant as compared to XI plan. It again shows that CSIR is more focused on having relevant patents in its portfolio. The patents gets obsolete or not relevant after the certain period of time are lapsed or abandoned.

Table 8: Patent Portfolio at the end of 9th, 10th, 11th and 12th FYP

Period	India	Foreign
IX Plan	658	342
X Plan	1413	1333
XI Plan	2350	3250
XII Plan	1387	2902

Expenditure Distribution

The **Figure 2** shows the expenditure towards filing, prosecution and maintenance of Indian patents. Approximately, 15 % of the total budget is utilized for the said activity. It can be seen that 87% of the budget is utilized for maintenance of the patents in India. The rise in percentage is due to increase in the fees by the patent office.

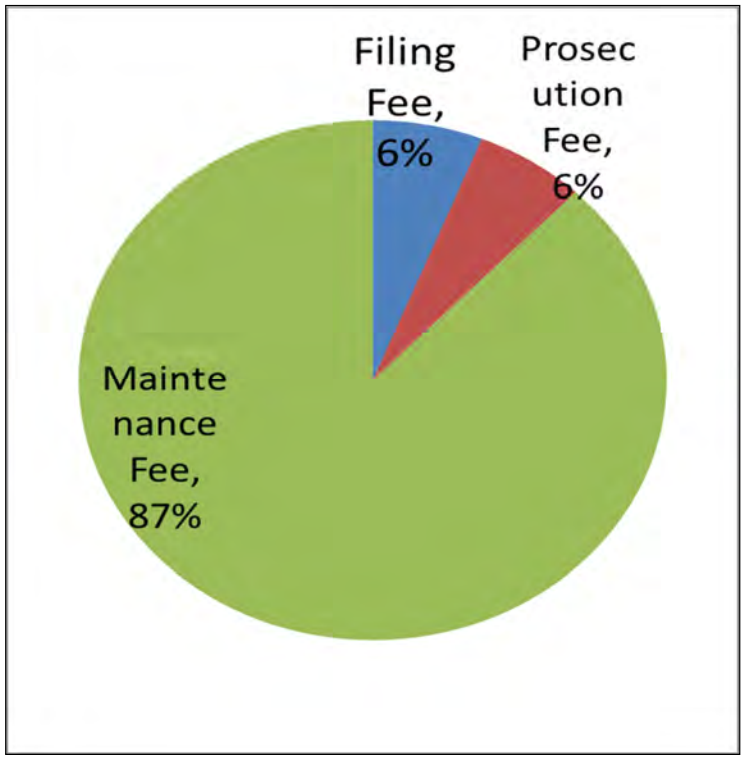


Figure 2: Indian expenditure (15 %)

The **Figure 3** shows the expenditure towards filing, prosecution and maintenance of foreign patents. Approximately, 85 % of the total budget is utilized for the said activity. Out of which 85% of the budget 39% goes in the maintenance of the patents.

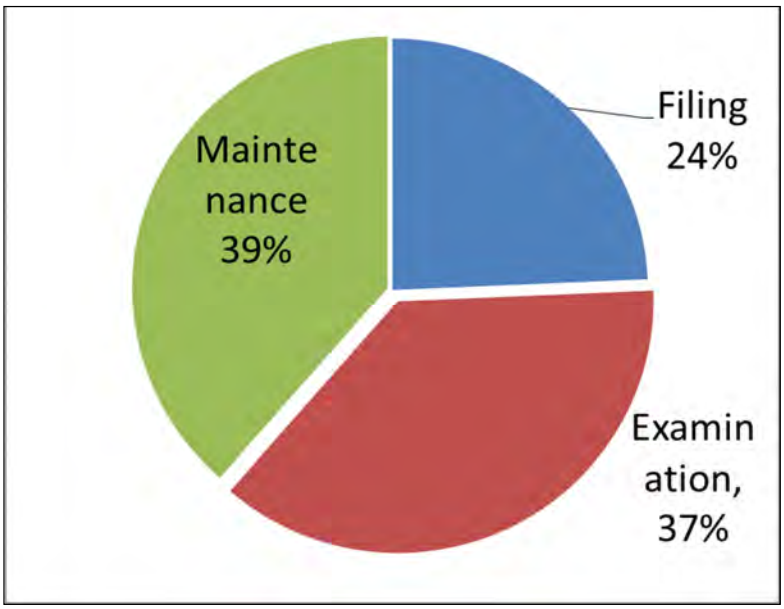


Figure 3: Foreign Expenditure (85%)

Yet another way to show the breakup of the expenditure is to show the expenditure done lab-wise. The CSIR has divided its laboratories into four cluster like Chemical Sciences, Biological Sciences, Physical Sciences, Engineering Sciences and Information Sciences. CSIR also has NIMITLI projects and CSIR Schemes from which IP is generated.

The **Table 9** shows the cluster wise expenditure in percentage for the period 2012-2017. It is seen that CSIR does around 60% of its expenditure on Chemical Science cluster labs.

Table 9: Cluster wise expenditure Percentage (2012-17)

Subject Cluster	Percent (%)
Chemical Sciences (CS) Cluster	61
Biological Sciences (BS) Cluster	29
Physical Sciences (PS) Cluster	5.3
Engineering Sciences (ES) Cluster	4.7

Labs considered under different cluster groups are:

BS Cluster: CCMB, CDRI, CFTRI, CIMAP, IGIB, IHBT, IICB, IIIM, IITR, IMTECH and NBRI
CS Cluster: CGCRI, CIMFR, CLRI, CSMCRI, IICT, IIP, NCL, NEIST and NIIST
ES Cluster: AMPRI, CBRI, CGCRI, CMERI, CFRI, CRRI, IMMT, NAL, NEERI, NML and SERC
PS Cluster: CEERI, CSIO, NGRI, NIO and NPL

Benchmarking with other R&D Organization

CSIR being the largest publicly funded R&D organization in India comprising 37 research labs/institutes, an attempt has been made to benchmark performance of CSIR in filing and securing IPR with other publicly funded organizations abroad.

The
Table 10 shows the organization wise distribution of PCT published patent applications for benchmarking. The International publicly funded organizations like CNRS-France, Max Planck-Germany, Riken-Japan, CSIRO-Australia, CSIR-South Africa & Chinese Academy were compared with CSIR, India in the following table.

Table 10: Organization wise distribution of PCT Published Patent Applications

S No	Organiza-tions	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	Total
1	CNRS, France	260	253	401	410	417	431	458	482	496	**3608**
2	CSIR, India	91	49	56	68	63	72	104	122	102	**727**
3	RIKEN, Japan	74	55	68	47	79	80	74	78	90	**645**
4	CSIRO, Australia	64	55	62	62	51	47	46	43	43	**473**
5	CSIR, South Africa	11	5	11	7	7	11	8	8	8	**76**
6	Max Planck, Germany	55	54	72	60	63	73	73	51	59	**560**
7	Chinese Academy of Sciences, China	79	77	95	114	308	452	409	453	382	**2369**

The key observations from the above table is that the total number of PCT applications published for CSIR-India during 2007 to 2016 has been 727 which is better than RIKEN Japan, CSIRO Australia and Max Planck Germany.

Accordingly, it can be seen that CSIR is among the top 50 institutions as per the Nature Index. CSIR ranks at 16th position.

See

Table 11 Research institutions listed in the following table appeared in the top 200 Nature Index in 2016, by weighted fractional count. The table includes the total number of STEM articles in the Web of science and WIPO patent families from the Derwent innovation index. Institutions are ranked by normalized WIPO patent families, which divide patent families by STEM articles.

Table 11: WIPO patent families- Nature Index

Normalised WIPO patent rank	Institution	Web of science STEM documents 2006–2016*	WIPO patent families 2006–2016†	Normalized WIPO patent families‡
1	Atomic Energy and Alternative Energies Commission (CEA), France	63,082	3,958	0.063
3	Massachusetts Institute of Technology	77,401	2,411	0.031
9	RIKEN, Japan	33450	723	0.022
16	CSIR, India	58,772	939	0.016
28	CNRS, France	372,101	4718	0.013

Comparison of CSIR was also done with other R&D institutions in India. Figure 4 shows the SCIMAGO Institutional Ranking, SCIMAGO provides ranks to the institutions according to three basis criteria like Research, Innovation and Societal Impact. Under Research Criteria the parameters observed are Output in terms of Publications, International collaborations, Leadership output, High quality publications, Excellence, Scientific Leadership, excellence with leadership, scientific talent pool.

Under innovation criteria the parameters that are observed are Innovation knowledge, Technological impact. These parameters are monitored by numerous parameters based on patents. Under the Societal criteria the parameters observed are web size and domain inbound links. CSIR has outperformed in all its criteria with respect to other R&D organizations. CSIR holds 75th Position world-wide, whereas other organizations are ranked above 400.

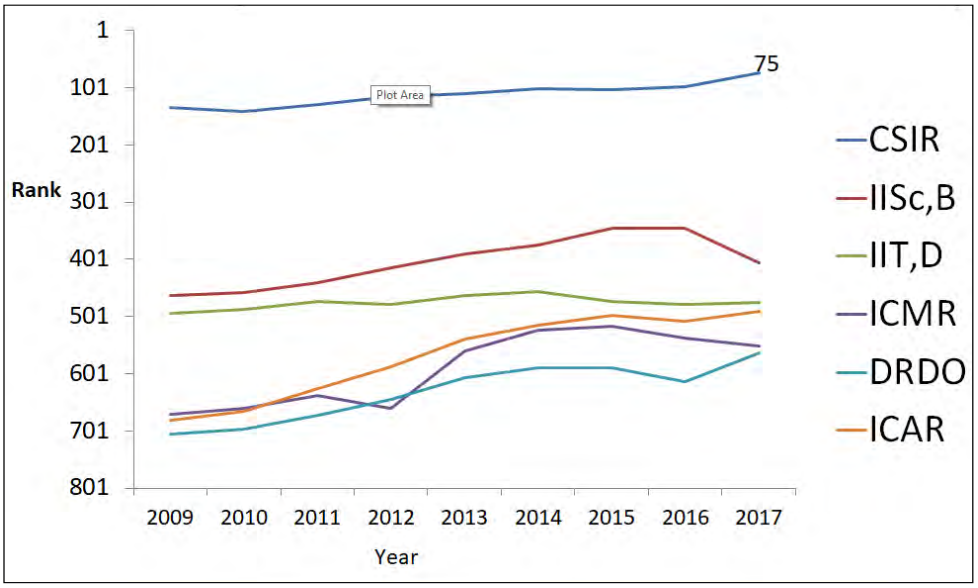
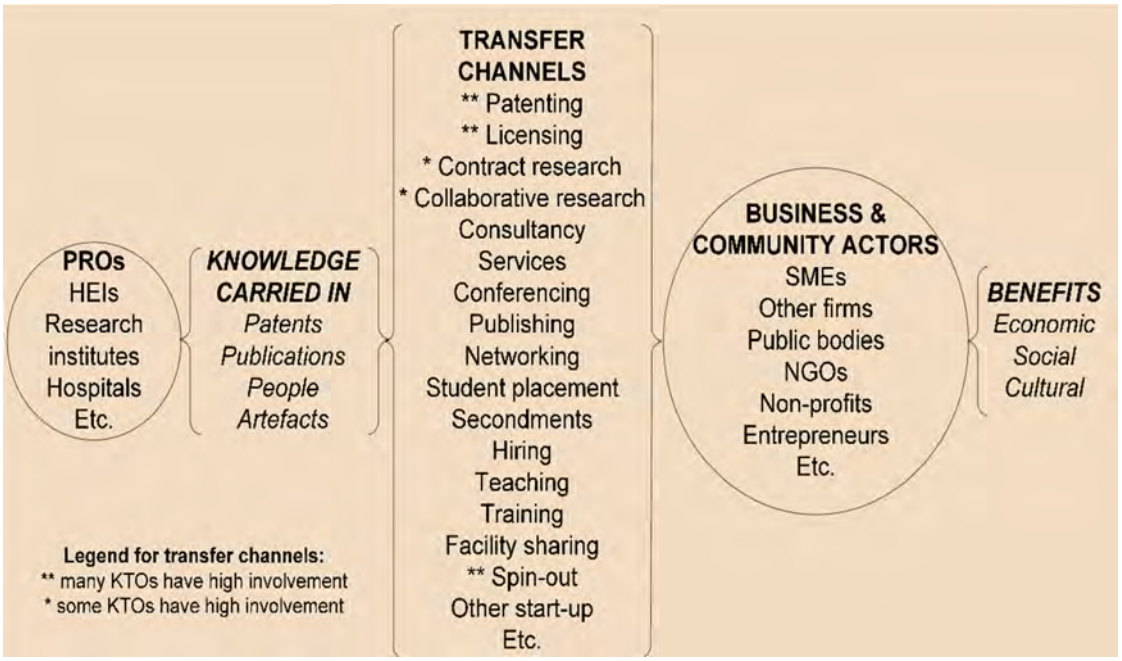


Figure 4: SCIMAGO Institutional Ranking – worldwide

Leveraging value of IP in Global Public Research organisations

Public research organizations (PRO) are generally multi focused and are largely oriented towards the societal benefit. As shown in **Figure 5** the process of Knowledge transfer in PRO situated in EP. CSIR also carries its knowledge in Patents, Publications and its employees scientific strength. The channel of Transfer of this knowledge is by way of Patenting, licensing, contract research, collaborative research, consultancy, services, conferencing, publishing, teaching, training and generation of human resource for the next generation.



Source: Metrics for the commercialisation of knowledge produced by public research organisations-European commission-2009

Figure 5: Knowledge transfer in PRO's in EP

As per the European Commission "**Knowledge Transfer Study 2010-2012 Final Report**", total license income only accounted for 0.9% of research expenditures by universities, 3.0% of research expenditures by other research organizations, and 1.2% of all research expenditures by PROs. Similarly in the United States, license income only accounted for 4.1% of total research expenditures.

As per the report, research agreements are a very important channel for knowledge transfer, even though they may generate little license income.

A further advantage of research agreements is that they can cause knowledge to flow in both directions, not only from PROs to firms but also from firms to PROs.

Return on Investment to CSIR

In view of the above discussion, it can be stated that license income is not the only parameter to judge the return on investment to CSIR. Patenting of the organization shows strength and the capacity of the organization to deliver the certain kind of research output.

This brings in capacity to the organization. The **Table 12** and **Figure 6** shows the income from Royalty and premia, as it can be see the sharp rise in its income form the sources of Royalty and premia.

Table 12: Royalty & Premia

2012-13	2013-14	2014-15	2015-16	2016-17
11.82	7.84	12.18	12.22	18.03

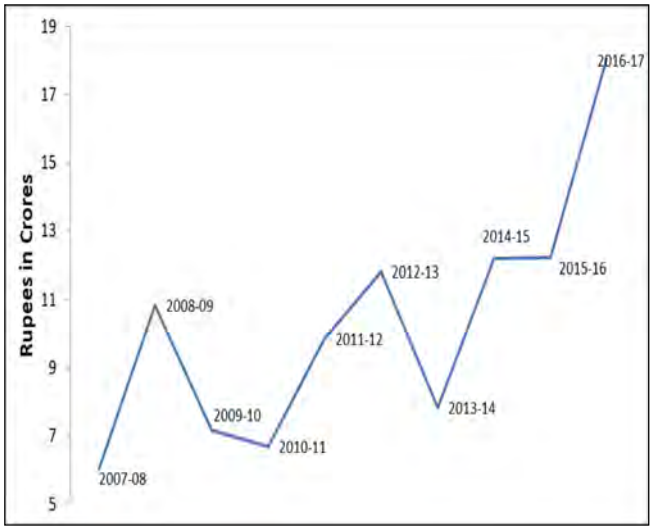


Figure 6: Royalty and Premia

The capacity to do research brings in contract research, collaborative research, and consultancy. External cash flow generated by CSIR in 11 FYP and 12 FYP are shown in rupees crores cluster-wise. Approx. 60 percent of IPTM budget goes to Chemical Sciences Cluster. It can be seen in
Table 13 that earning to CSIR has increased in Chemical Science Cluster.

Table 13: External Cash Flow (Rs in Crores)

Subject Cluster	**2007-12**	**2012-17***
Biological Sciences Cluster	431.84	501.98
Chemical Sciences Cluster	631.64	927.74
Engineering Science Cluster	639.70	937.05
Physical Science Cluster	471.69	548.11
Information Science Cluster	8.61	10.17
CSIR HQ (URDIP)	29.95	34.50
Total	**2213.42**	**2959.55**

**contains the tentative figure for FY 2016-17*

These figures includes avg. 200 Crores per year of ECF from non-government sources

As it was discussed in the previous sections, that capacity to do research and patenting also brings in other revenues to CSIR. One of such revenue is through testing and analytical services as shown in **Figure 7.**

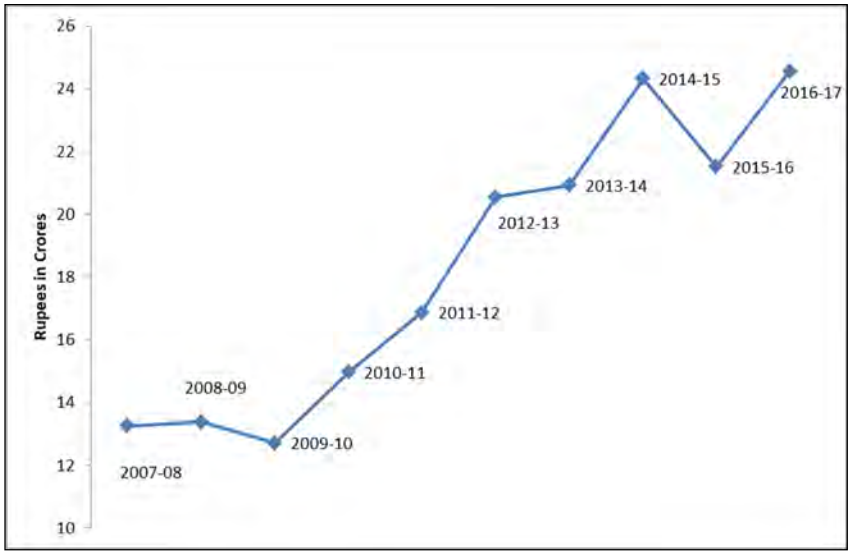


Figure 7: Testing and Analytical Charges

Recognitions to CSIR

Patenting activity has provided recognitions not only to CSIR but also the country at large. Patenting is also see as one of the parameter for the ranking as per the Global Innovation Index.

1. **Nature Index:** CSIR at 75 position among the top 200 institutions of the world (Nature 522, S34–S44 (18 June 2015) doi:10. 1038/522S34a)

2. **SCIMAGO Institutions Rankings 2017:** The overall global ranking of CSIR is improved from 117 to 75th position.

3. CSIR features in the **Thomson Reuters top 50 Indian Innovator Companies and Research Organizations for the year 2015**, who lead the country's innovation output.

Awards received by CSIR

CSIR is proud in owning the following awards, these award are given for filing, grant and excellence in innovation.

1. **"Intellectual Property Award"** has been conferred to IPU (CSIR) by Indian Patent Office for securing highest number of patents in the year 2009.

2. **"Thomson Reuter Innovation Award-2010"** has been awarded to IPU (CSIR) for securing highest number of patents during the year 2008-2009

3. IPU (CSIR) has received **"National Intellectual Property Awards-2013"** of Indian Patent Office for securing highest number of patents during five years.

4. IPU (CSIR) has received **"India Innovation Awards 2013"** from Thomson Reuters in the Hi-Tech Academic & Government category (for 2013-14)

5. CSIR – IMTECH has received **"National Intellectual Property Awards-2014"** instituted by Indian Patent Office in Health Care sector for highest number of health care patents secured by IPU and commercialised by CSIR-IMTECH.

Way forward

CSIR always improvises its system from its existing one. Under The IPTM scheme, IPU would like to undertake the following task on the priority to improve the value of its patents.

1. **Improvement of quality of patent**

    - **Focus on better drafting**
      Focusing on better drafting would help improve the quality of patent and intern would bring value to the CSIR. IPU would like to bring in resources, built robust capacity, have global best databases for the purpose of drafting.

    - **Theme specific core expertise to be created in IPU**
      CSIR would orient itself towards theme specific research thereby improving on making of IP portfolio. This portfolio would be managed by the specific core expertise which would be created in IPU.

- **Connecting with foreign IP firms**
  Connecting with foreign IP firms would help CSIR to reduce the cost on securing of IP by at least 30 %. Also, this would necessitate to bring in capacity of for filing of patents abroad by itself.

- **Rigorous criteria for selecting foreign attorneys (based on their successful track record of value generation)**
  Rigorous criteria for selecting of foreign attorney who's drafting and granting skills helped their clients in value generation. Such criteria would help CSIR to ensure quality of patents.

- **Reducing rate of premature abandonment**
  Bringing in quality consciousness among scientist would bring down premature abandonment. Proper inputs at the time of filing. Improving on drafting would help in grant of a valid patent. This would be achieved by proper IP awareness and putting in efforts while drafting of a patent of international quality.

2. **Single IP firm for Annuity payment for In-force patents**

   IPU is proceeding towards empanelment of single IP firm who provides the Annuity payment services globally. We are expecting upto 20 to 30 % saving in our payments for renewal of foreign patents. For Indian patents, IPU is itself renewing the patent without any help of external agency.

3. **Surveillance on infringement of CSIR patents in global territories**

   IPU in association with URDIP would put in place a surveillance system thereby CSIR would be aware of its IP infringement. IPU would initiate action against infringers. IPU would like to have Global IP enforcement may proceed towards litigation and claim damages on account of misuse of IP.

4. **IP awareness programmes**

   IP awareness programs had helped CSIR to be leader in IP generation and IP practices. IPU feels to provide continual support for the IP awareness across all CSIR laboratories.

Recommendations of the Review Committee

Review Committee recognized the on-going quest of CSIR to remain front runner in Intellectual Property (IP) creation, filing and securing, aimed at value creation - through development and deployment of technology and products. This value creation should be recognized by the stakeholders. The committee appreciates the performance of IPTM sub-scheme and returns, recognitions and awards that CSIR could achieve. Committee is satisfied with procedures and methodologies adopted by CSIR-Intellectual Property Unit (IPU) in filing and protecting CSIR's intellectual property.

- The committee recommends that:
  - The system in place for IP management in CSIR may be shared with those Universities and R&D institutions in India who do not have such systems in place;
  - The filing of patents in the area of physical sciences and engineering sciences should be enhanced which are less at present in comparison to chemical sciences and biological sciences; and
  - CSIR should make efforts to create a national facility/Outreach center for providing IP related services to R&D Organizations and Universities across India.
- The committee, considering the performance of CSIR's IPTM sub-scheme, recommends it for continuation beyond 12th FYP.

***

III. R&D Management Support (RDMS) Scheme

Background

CSIR has 38 constituent laboratories spread across India and 39 outreach centres attached to these laboratories with headquarters in Delhi. The various functional units/divisions located in CSIR Headquarters provide the R&D Management support to the national laboratories through the Scheme. The Headquarter is the focal point of the organization and catalyses and facilitates the laboratories by establishing, equipping and realising excellence in R&D, promoting brand equity, financial self-sufficiency, global competitiveness and disseminating organizational learning. It provides support to the laboratories for human resources development, international scientific collaboration, publicity and public relations, performance appraisal, scientific audit etc. It is the link between the laboratories, the government, the parliament and international agencies.

The R&D Management Support System has been provided by various Divisions of CSIR Headquarters namely, erstwhile Planning and Performance Division (now divided into Research Project Planning & Business Development Directorate and Mission Directorate), International S&T Affairs Directorate (ISTAD), Unit for Science Dissemination (USD).

Repositioned Objectives of the R&D Management Support Scheme

12th Five Year Plan was envisaged to be repositioned in the following lines:

- From a project monitoring role to programme facilitation and monitoring role
- From a mandate of business development to that of knowledgebase marketing and catalyzing innovation
- From a role of fostering international S&T collaborationto that of leveraging international synergies in identified areas of science, technology and innovation
- From the role of dissemination of S&T information to that of comprehensive CSIR brand

A. Planning Activities

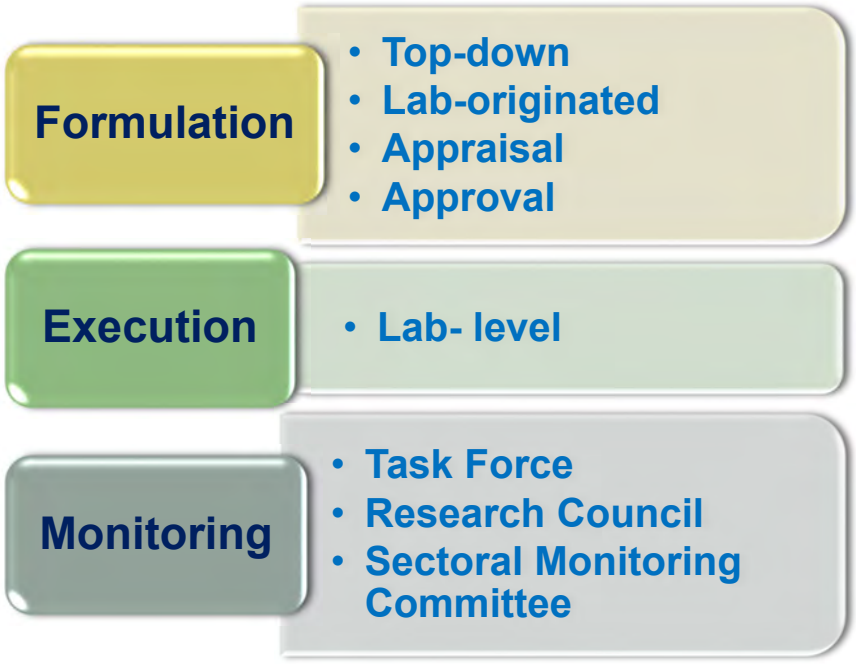
I. **XII Five Year Plan:** The then Planning Commission constituted Working Group for CSIR to formulate XII Five Plan of CSIR under the chairmanship of Secretary, DSIR and DG,CSIR with a no. of academicians, technologists and representatives of Planning Commission, Department of Space, Department of Atomic Energy, ICMR etc. The Report of the Working Group was accepted by the Planning Commission. XII Five Year Plan of CSIR was envisaged to focus upon "inclusive strategy" that could catalyse a radical but participative transformation of the CSIR system. Plan focused was centered around following three key areas:

- National Focus- that helps meet in partnership with other players of the National Innovation System, the scientific, technological and human resource development requirement of the country;
- Organizational Focus- the need of the CSIR that are instrumental in achieving the goals of the national focus; and
- Leadership Focus- that aims at achieving CSIR leadership in identified domains of science, technology and human resource development.

For ease of consolidating the efforts of CSIR constituent laboratories, concept of clusters was mooted, in which labs were grouped in five clusters viz. Biological Sciences, Chemical Sciences, Engineering Sciences, Information Sciences and Physical Sciences. All the activities were pursued through these clusters.

II. Project Management

Project Management essentially includes formulation, appraisal, approval, execution, monitoring and completion. Following pictorial representation gives the overall picture of project management.



II.1 Formulation: Project proposals are conceived either through 'top down' approach or through internal consultation and deliberations in constituent laboratories of CSIR. The concept of 'Top-down' category originates from National aspirations and/or part of larger goal. Second approach was to take up projects based on the labs' expertise.

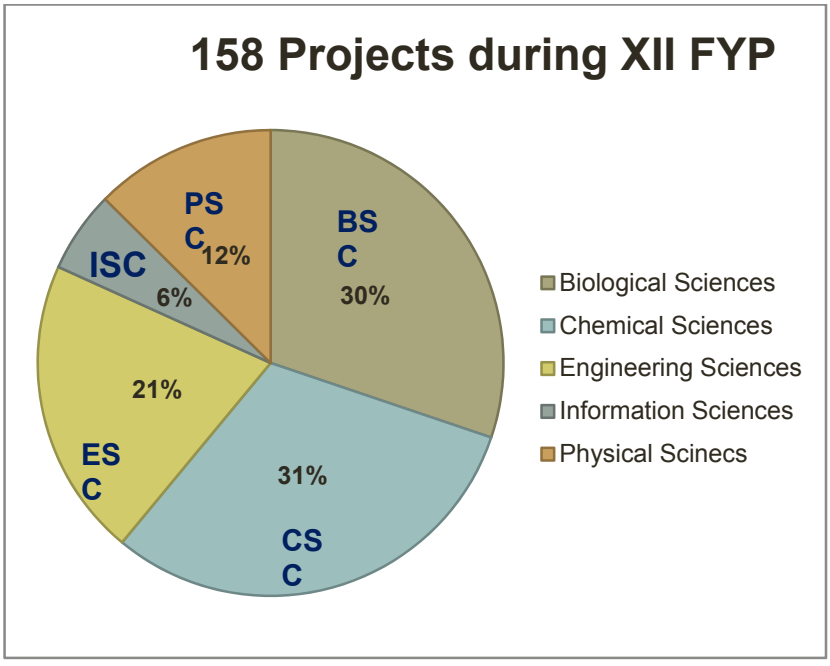
Based on this philosophy a large no. of proposals was received. These proposals were analysed in detail and converted into Standing Finance Committee (SFC) document. Following the mechanism in place (as per the guidelines issued by Ministry of Finance) appraisal and approval processes were carried out. Following table indicates the appraisal and approval mechanism, prevailing at the time of formulation of these projects (Ministry of Finance, Department of Expenditure, Plan Finance II Division OM No. 1(3)/PF.II/2001, dated 01.04.2010)

Table-1

Limit (Rs. in crore)	Appraisal Forum	Limit (Rs. in crore)	Approval Forum
< 25.00	Ministry in normal case	< 25.00	Secretary of Administrative Ministry/ Department
= 25.00 & < 100.00	Standing Finance Committee (SFC)	=25.00 & <150.00	Minister-in-charge of Ministry/ Department

= 100.00 & < 300.00	Expenditure Finance Committee (EFC) chaired by Secretary of the Administrative Ministry/ Department	=150.00 & < 300.00	Minister-in-charge of Ministry/ Department and Minister of Finance
= 300.00	Public Investment Board (PIB)/ EFC chaired by Secretary (Expenditure); projects/schemes where financial returns are quantifiable will be considered by PIB and others by EFC	= 300.00	Cabinet/ Cabinet Committee

II.2 XII five Year Plan: 158 projects were formulated, appraised and approvals obtained. There were 60 projects appraised by SFC and approved by Minister of Science & Technology, rest were less than Rs. 25.00 crore and was approved by Secretary, DSIR and DG, CSIR. Following pictorial representation provides distribution of the projects amongst various clusters:



Monitoring: There were three level of monitoring of the projects:

- Task Force level;
- Research Council level; and
- Sectoral Monitoring Committee level.

Task force was constituted for each of the project under the chairmanship of the Nodal Laboratory. It was ensured that meetings of the Task Force held regularly. Since the no. of projects was large and to save the resources and time, most of the meetings were conducted through video conferencing. Progress report were obtained on regular basis and were analysed regularly.

Research Council (RC), constituted by CSIR Hqs. for each of the laboratory, under chairmanship of an eminent Scientist/Technologist of the country, basically advises the lab for undertaking research work in cutting edge areas, however one of its role is to monitor the progress of lab as a whole and projects in particular. Accordingly, in each of the RC meetings held, progress of the projects was presented. Recommendations of RC pertaining to these projects were sent to CSIR Hqs.

Sectoral Monitoring Committees (SMC) were constituted by CSIR Hqs. for a set of projects grouped under a theme, under chairmanship of an eminent Scientist/Technologist of the country. Following is the list of SMCs constituted.

Table-2: Constitution of SMC

S. No.	Theme	Name of Chairman
1.	Adequate and Clean Energy	Dr. R K Malhotra, Former CMD & IOCL, Faridabad
2.	Sustainable Chemical Industry	Dr. T. Ramasami, Former Secretary, Department of Science & Technology
3.	Advanced Materials	Dr. Baldev Raj, Former Director, IGCAR, Kalpakkam
4.	Aerospace Engineering	Prof. Kota Harinarayana, Former Vice-Chancellor of the University of Hyderabad and the President of the Aeronautical Society of India

5.	Agri, Food & nutrition	Dr. Mangala Rai, Former Secretary, Indian Council of Agriculture
6.	Biotechnology & Biology	Prof. G. Padmanabhan, Former Director, IISc. Bengaluru
7.	Drugs Discovery & Development/Healthcare	Prof. M.K. Bhan, Former Secretary, Department of Biotechnology
8.	Earth System Sciences	Dr. Shailesh Nayak, Former Secretary, Ministry of Earth Sciences
9.	Ecology and Environment	Dr. V. Rajagopalan, Former Secretary, Ministry of Environment and Forests
10.	Electronics and Instrumentation	Shri S.K. Sharma, Former CMD, Bharat Electronics Ltd.
11.	Housing, Road construction, Structures and Safety	Dr. Anoop Kumar Mittal, CMD, National Building Construction Company
12.	Information Sciences – Data Intensive and Informatics	Dr. Rajat Moona, DG, C-DAC
13.	Mining, Metals and Minerals	Prof. K Anantha Padmanabhan, Former Director, IIT-Kanpur

CSIR Hqs. prepared all the technical details of the projects covering objectives, deliverables, positioning, stakeholder connect, technology development / deployment etc. All these details were provided to the Chairmen and members of the respective Committee.

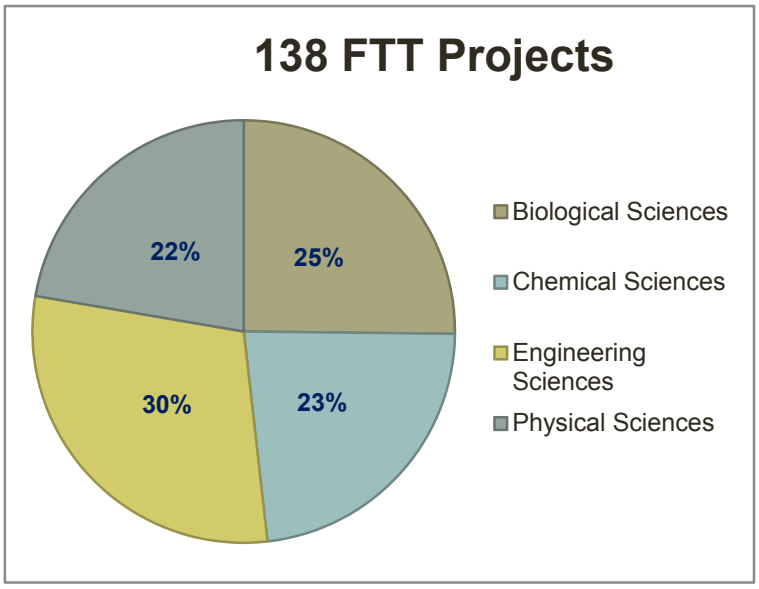
CSIR Hqs. facilitated and moderated for smooth conducting of the meetings organised at various labs. General recommendations of the Committees were praiseworthy of CSIR efforts in successful execution and completion of the projects.

II.3 Fast track Translational (FTT) Projects

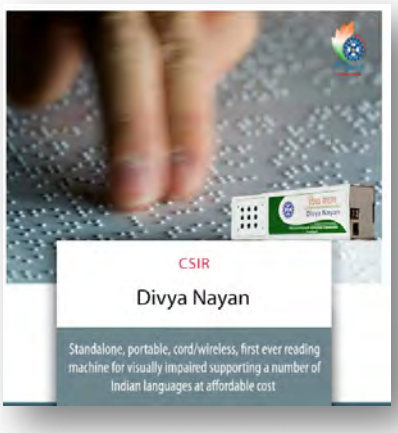
XII Five Year Plan Projects were executed through Work Package mode; each project had a number of work packages. Each work package had its own deliverables. During the course of execution of these projects it was observed that pace of development in some work package was faster than the others. Many technologies/ products and processes were acquired various level of Technology Readiness Level (TRL), however they needed some extra effort to take them to next higher level that includes technology transfer/ commercialization/ deployment etc.

A new concept, Fast Track Translation Projects (FTTs), was mooted to provide implementation of close to market, business driven projects, in any area of technology or application, without thematic restrictions. Philosophy behind these projects is to build up trans-disciplinary teams in the laboratories including scale up, down-stream processing, characterization, validation and trials to deliver innovation onto the market and/or into society nurturing cross-sector cooperation. The aim is to reduce time from idea to market, stimulate the participation of cross-section of scientists and technical personnel towards a defined goal.

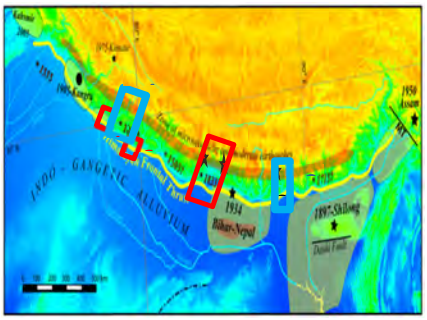
138 FTT projects, which are of short duration have been approved and are at various stage of implementation in constituent laboratories of CSIR. These projects are taken up in four clusters namely, Biological Sciences, Chemical Sciences, Engineering Sciences, and Physical Sciences. Distribution of these projects in four clusters is pictorially depicted below.



Some of the major products envisaged through these projects are:



6 log reduction of bacteria, 4 log reduction virus and 99.99 % NTU removal



Seismic Risk Assessment- of potential large Himalayan earthquakes

Solar Heat reflective Roofs for 'Energy Efficient Buildings

Hybrid green composites of different texture / surface finish

Sintered RBSN Pralay Radome

W-Recovery Rate >98%; Purity >99.9%

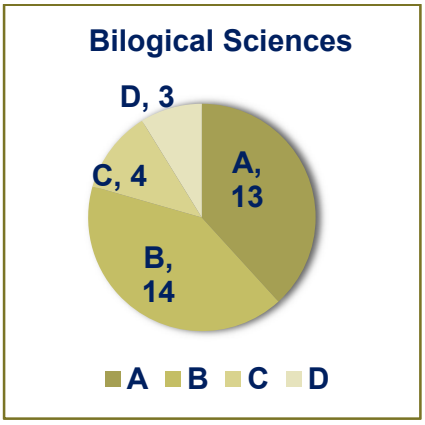
Earthquake Warning System

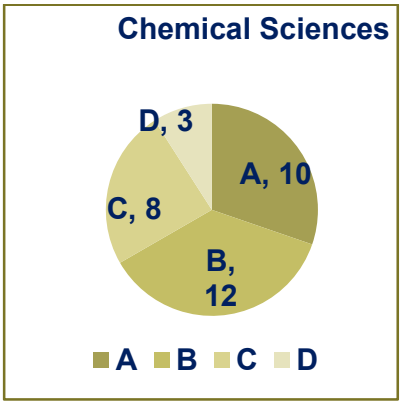
Since the projects are of short duration, usually from 18 to 24 months, rigorous monitoring was done for all the projects both at lab level and Monitoring Committee level. Quarterly Progress Report for each of the project, as per the specific format designed by CSIR Hqs was sought. Progress Reports were being continuously analysed and requisite actions were taken. In addition progress projects were monitored through specifically constituted Monitoring committees. For ease of monitoring, projects were grouped in 11 themes and accordingly Monitoring Committees were constituted. Table-3 presents themes and the Chairman of the thematic group.

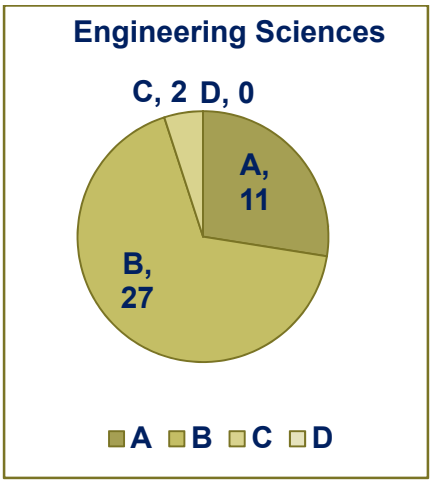
Table-3

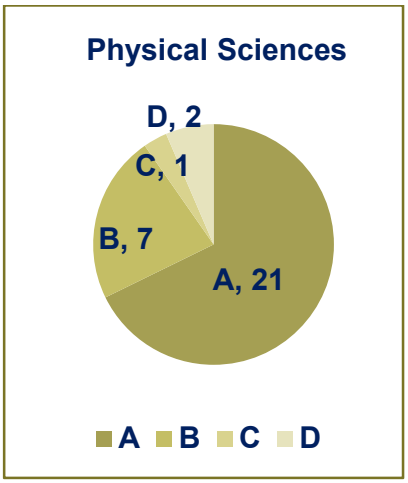
S. No.	Theme	Chairman
1.	Healthcare and Biotechnology	Prof. N.K. Ganguly, Former Secretary, Indian Council of Medical Research
2.	Agri and Food Technology	Dr. S. Ayyappan , Former Secretary, Indian Council of Agriculture Research
3.	Chemicals, Petrochemicals and Healthcare	Prof. R. Kumar, Hon. Professor, IISc
4.	Energy, Environment and Advanced Materials	Dr. Baldev Raj, Director, NIAS
5.	Aerospace Engineering	Prof. Kota Harinarayana, Former VC, University of Hyderabad
6.	Civil Infrastructure and Engineering	Prof. M.R. Madhav, Professor Emeritus, JNTU
7.	Minerals, Metals and Materials	Dr. Baldev Raj, Director, NIAS
8.	Mechanical and Environmental Engineering	Prof. R. Kumar, Hon. Professor, IISc
9.	Earth and Ocean Sciences	Dr. P. S. Goel Former Secretary, Ministry of Earth Sciences
10.	Electronics and Instrumentation	Mr. Arun Firodia Chairman, Kinetic Engineering Ltd.
11.	Electronics for Societal and Strategic Applications	Shri Surinder Singh Director, Semiconductor Laboratory

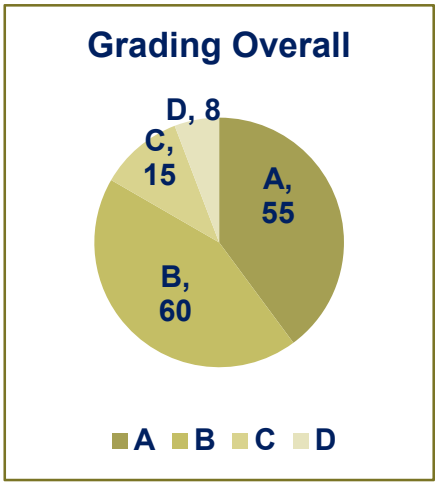
CSIR Hqs. prepared basic documents on all the 138 projects that include background, objectives, deliverables, issues to be addressed, Stakeholder connect, level of commercialization/ deployment as the case may be. These documents were provided to Chairmen and Members of the Committee before the meeting of the Monitoring Committees were organised. It helped the members to understand the projects so that monitoring could be meaningful. Committees monitored six monthly progress of the projects. These projects have shown very good progress in almost all the projects as is evident from the following pictorial representation which gives a glimpse of distribution of the grading awarded to the projects. 'A' is outstanding, 'B' is excellent, 'C' is very good' and 'D' is good.


Bilogical Sciences
D, 3
C, 4
A, 13
B, 14
A B C D


Chemical Sciences
D, 3
A, 10
C, 8
B, 12
A B C D


Engineering Sciences
C, 2
D, 0
A, 11
B, 27
A B C D


Physical Sciences
D, 2
C, 1
B, 7
A, 21
A B C D


Grading Overall
D, 8
C, 15
A, 55
B, 60
A B C D

II.4 Department-related Parliamentary Standing Committee on Science & Technology

Parliamentary Standing Committee considers Demands for Grants (Complete Government Budgetary Support, i.e. Annual Budget) of DSIR (including CSIR) each year, takes note of achievements made by CSIR, gives recommendations on various aspects. The activity covers preparation of Background Note, Replies to Questionnaire put up by the Committee, Oral evidence of Secretary before the Committee, Action Taken Report on the recommendations of the Committee, Statement by Minister of Science & technology on status of implementation of the recommendations of the Committee etc.

In addition, the Committee, from time to time, takes up a topic of public interest for discussion. Requisite Background Note, Oral evidence by the Secretary etc. is prepared and facilitated by CSIR Hqs. Some of the recent topics came up for discussion include, 'Working of Ministry of Science & Technology with special reference to 'Challenges, Critical areas and Issues', 'Detailed background material on CSIR-National Institute of Oceanography for consideration of the Committee on Estimates for examination', "Functioning of CSIR Laboratories", Status of Technological Interventions to combat adulteration of Food', 'Study Visit of the Committee to Palampur, Manali and Rohtang to study Biodiversity and effect of climate change on Rohtang' etc..

II.5 Comptroller & Auditor General (C&AG) of India

All the matters pertaining to Audit (including constituent laboratories of CSIR) are being dealt by CSIR Hqs., including Inspection Audit, Performance Audit, Compliance Audit, Factual Statement, Action Taken Report on the Audit Report presented by C&AG in the Parliament.

II.6 Outcome Budget

Following the guidelines of Ministry of Finance, every year CSIR prepare its 'Outcome Budget' which inter-alia covers outcome of activities undertaken during the previous year vis-à-vis overall funds spent by CSIR, and details of activities to be undertaken vis-à-vis Budget to be allocated by the ministry of Finance.

II.7 Awards

CSIR confers many Awards to institutions/ industries/ individuals every year that include: CSIR Technology Awards, CSIR Diamond Jubilee Technology Awards, CSIR Award for S&T Interventions in Rural Development. All the activities covering formulation and placing of advertisements in national dailies inviting proposals from every part of the country, constitution for Selection Committees, conferring the awards are being done at CSIR Hqs.

B. International S&T Collaboration

India has been doing efforts to do research and development activities at par with world leaders. It has been forging linkages with developed economies to exchange ideas and with developing economies and poor countries to help them overcome their problems. In this context, CSIR's highly qualified scientists have been playing a key role in knowledge generation of global dimensions and its exploitation. Measures are being taken to make CSIR an attractive destination for excellent R&D in the global arena.

The emergence of European Union, its further expansion with East European countries joining in, emergence of Japan, Korea, Singapore as major regional powers in basic research, new political dimensions with Israel, Taiwan etc. have opened tremendous challenges as well as great opportunities for CSIR to promote its international S&T interactions.

In order to enhance S&T capabilities, CSIR is strengthening its cooperation with the developed world through renewed international collaboration. A few such practices include international exchange fellowships; deputing expert delegations abroad; study tours; deputation of CSIR scientists abroad; and participation in large projects. This would enable CSIR's scientists to keep abreast with latest developments in frontier and upcoming areas and provide impetus to the programmes in thrust areas were proposed.

Technically-deficient developing countries offer significant opportunities for transfer of appropriate CSIR technologies, predominantly for rural sectors. It was envisaged that CSIR could also offer its vast existent trainer base, sophisticated laboratory facilities and expertise to attract trainees from these countries. Following figure gives a snapshot of the International collaborations CSIR established.

International Collaborations are being executed through: Bilateral Cooperation; Multilateral Cooperation; and Capacity Building.

I. Bilateral Cooperation

a. 60 new collaborations established with partners from 36 Countries (Australia, France, Germany, Italy, Japan, Russia, UK, USA etc.).

b. 170 joint research projects undertaken:

- 46 projects funded by CSIR under bilateral programmes with international partners; and
- 124 projects are supported by external agencies including Department of Science & Technology (DST), Department of Biotechnology (DBT), Indo-French Centre for Promotion of Advanced Research, and Indo-US S&T Forum.

c. Enhanced networking with many internationally acknowledged foreign agencies (CSIRO, Australia; BCSIR, Bangladesh; CNRS, France; CNR, Italy; BMBF, Germany; AIST, Japan, etc).

d. 20 Workshops / Meetings / Summer Schools organized.

II. Multilateral Cooperation

a. European Union: Strengthening EU-India cooperation dialogue

- CSIR is Co-Coordinator of project "Innovation-driven Initiative for Development & Integration of Indian and European Research (INNO INDIGO)" and Member of project "Support for policy cooperation in Indian and European Research and Innovation (INDIGO POLICY)";
- 6 India-EU projects implemented with co-founding by DST/DBT and EC.

b. BRICS: Resources from member countries are pooled together to have joint research projects of common interest to the member countries.

c. SAARC: CSIR is helping to develop capacity/capability in member countries. Scientists, from SAARC countries visited various laboratories of CSIR viz, CSIR-National Institute of Oceanography, SCIR-National Physical Laboratory etc. on following topics:

- Multidisciplinary Oceanographic Observations for Coastal Zone Management;
- Metrology including mass, pressure and temperature standards;
- Management and Conservation for Climate Change Impacts on Coral Reef;
- Waves in Shallow water environments (WISE); and
- Coastal & Near-shore Dynamics.

d. Global Research Alliance: Being a founder member of the Global Research Alliance (GRA), CSIR, India has been contributing CSIR's annual membership subscription of US $ 17,000 (US Dollar Seventeen Thousand only) towards the activities of the GRA. CSIR is helping its Scientists to establish linkages with the member countries of GRA.

e. Centre for S&T of Non-aligned and other Developing Countries (NAM S&T Centre): CSIR is a member of the NAM S&T-Industry Network since 1998 and has paying an annual subscription of US$ 4,000 (since 2007) to the NAM S&T Centre for this. This entitles CSIR for invitation to two CSIR nominees each year with full finances paid by the NAM S&T Centre for participation in an appropriate activity, including meetings, workshops, courses and training programmes organized by the Centre abroad.

III. Human Resource Development

a. Raman Research Fellowships:

CSIR operates the Raman Research Fellowship Scheme that enables young and bright CSIR scientists below the age of 45 years, to carry out research in the emerging and high priority areas in reputed institutions / R&D centres of excellence abroad. The entire cost of the fellowship including travel is met by CSIR. 68 CSIR scientists availed Raman Research Fellowships during 2012-17.

b. Deputation of CSIR Scientists abroad

1250 visits of CSIR Directors/Scientists were undertaken under various S&T programmes like Business Development, Bilateral, Multilateral, Conference, Fellowship, Training etc.

c. Fellowships to Foreign Researchers for research stay in CSIR institutes

CSIR-TWAS have been operating the Postdoctoral and Postgraduate (for PhD) Fellowship scheme since 1993. There are a total of 30 fellowship slots per year. Applications are invited online annually through TWAS web-portal. The selection is made by CSIR and TWAS jointly. The selected fellows are provided international travel by TWAS and the fellowship amount is provided by CSIR to meet living expenses in India. CSIR-TWAS have granted the following Postdoctoral and Postgraduate (for PhD) Fellowships to 119 foreign scholars (Algeria, Bangladesh, Cameroon, Egypt, Ethiopia, Iran, Cote D'Ivoire, Jamaica, Kenta, Malawi, Mauritius, Nepal, Nigeria, Pakistan, Rwanda, Tanzania, Togo & Tunisia) in the period 2012-2017.

IV. International Recognition

Efforts put up by CSIR w.r.t. International S&T Collaboration has resulted in more than 450 high IF research papers. Scimago Institutions Rankings of CSIR improved from 117 in 2012 to 79 in 2017. It is pertinent to note that Rating is based on 6 parameters including International Cooperation and High Quality Publications. 64 well recognized International Conferences organized by CSIR labs.

C. S&T Dissemination

Communicating science to the public is essential for following reasons:

- We need to educate and tell about science to policy makers and taxpaying public that funds are utilized for the benefit of society at large and advancement of human civilization.
- We can leverage our skills as scientists to inspire critical thinking in public and political dialog and enhance the scientific temper in the society. Scientific way of thinking will lead to better society.
- Scientists are optimally positioned to stem the flow of scientific misinformation in the media and public.
- It is our duty to explain what science is and what is not: while it is a way of thinking that upgrades our intuitions, it also comes with a deep understanding of (and tolerance for) uncertainty.
- We can communicate scientific breakthrough and about novel technologies to our stakeholders.

Focus of CSIR's endeavor is the people and nation-centric thrust to science, technology and societal pursuits. It has been felt that for maximization of the CSIR outcome, it is important that 'The People of India' be informed about the relevance of CSIR to them by way of regular dissemination of information on important technological developments amongst the groups or persons of relevance to CSIR. Furthering of the public image of CSIR entails an image building function, involving four main processes: (a) Identifying the message, (b) Knowing the audience, (c) Selecting channels of reaching them, and (d) Developing promotional material to attract and retain their attention.

These functions are being executed through following four mechanisms:

(i) Print Media (News Papers, Magazines, Brochures etc.);
(ii) Electronic Media;
(iii) Interactive Media (Exhibitions Science Festivals, Press Meets, Tableau etc.); and
(iv) Social Media (Facebook, Twitter, U-tube etc.).

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(iv) Social Media (Facebook, Twitter, U-tube etc.);

I. Print Media

Effective media relations established with the important Newspapers covering science in their respective dailies. A number of Press coverage were successfully managed. In addition regular advertisements were put up in National Dailies on various occasions such as National Science Day, Technology Day, CSIR Foundation Day etc.

Recently CSIR has put-up scientific achievements in magazines like 'Shubh Yatra' (Magazine distributed in Air India flights), and India Today.

II. Electronic Media

Achievements of CSIR, in story mode, topic-wise, Interviews with famous scientists etc were prepared in form of short video films and running through TV Channels.

III. Interactive Media

Participation in exhibitions is one of the significant interactive channels exclusively used for: creating awareness amongst CSIR stakeholders; and facilitating business development through B-2-B meetings.

CSIR showcased its achievements in various national and international expositions held across India including:

- 'India Technology Pavilion', Hannover, Germany (2016);
- 'India Rwanda Technology & Innovation Expo-2017 Rawanda;
- 'India Sourcing Fair', Kazakhstan, 2015;
- 'India Innovation Summit & Expo, Chicago, USA-2013;
- Regular participation in Indian Science Congress;
- 'Agritech India-2015, Bengaluru;
- 'Swadeshi Mela-2016, Kashi;
- 'Vibrant North East-2016',
- 'North East Calling- 2017, New Delhi;

- 'International Conference and Exhibition on Materials Engineering Technology-2014, Gujarat';
- 'Bangalore India- Bio'-2015; etc.

Besides above-listed events CSIR has been participating in number of other exhibitions also.

CSIR participated in a big way in showcasing its significant achievements. Most significant ones include: 'Participation in India International Trade Fare (2016), and India International Science Festival-2016 and CSIR Tableau in Republic Day Parade-2017.

India International Trade Fair (IITF)-2016

CSIR participated in India International Trade Fair 2016 in a mega way. In this 14-days even a large no. of footfalls was observed including school children also. Various quiz programmes (Science-based), Popular Science Lectures, B-2-B meetings were also organized. Some glimpse of the even are

Hon'ble Minister of S&T Dr. Harsh Vardhan inaugurating the event

Agriculture & floriculture Stall

Generic and Healthcare Stall

Some of the Kendriya Vidyalaya students in CSIR pavilion

KV students participating in live experiment

School Kids interacting with Scientist

Technical Session is in progress

Section of Visitors

India International Science Festival (IISF)-2016

CSIR, in association with VIBHA (Vijnana Bharati or VIBHA is a national movement dedicated to the integrated development of Bharat through the intervention of science, engineering and technology), organized India International Science Festival at CSIR-NPL during 07-11 December, 2016.

Union Home Minister inaugurating IISF 2016

Models of SARAS and CNM5

General View of a Pavilion

Students interacting with Scientist

Recommendations of the Review Committee

The Committee discussed in detail activities related to 'Planning and Performance', 'International S&T Collaboration and 'Science Dissemination' carried out under the R&D Management Sub-Scheme. The observations and recommendations of the committee are as below:

Planning and Performance: A number of activities were pursued in this domain which include interaction with NITI Aayog, Department-related Parliamentary Standing Committee on Science & Technology, Ministry of Finance, Parliament and other socio-economic Ministries/Departments. It also included the appraisal and approval of projects and monitoring and evaluation of projects. A report on the CSIR activities was presented to the Parliament, Society, GB and other designated committees. The committee appreciated the efforts and methodology adopted to carry out diverse activities.

International S&T Collaboration: CSIR laboratories need to benchmark continuously their knowledgebase including outputs and outcomes internationally. CSIR has been strengthening international cooperation with the developed and developing world. It has established successful linkages with various S&T organizations and some projects are in progress. The Committee recommends that under the globalized world, CSIR needs to put more efforts for enhancing the international collaboration activities.

S&T Dissemination: Connecting with the stakeholders and building the brand value through desired connect and image building exercises is very much essential for CSIR. In doing and achieving these, CSIR has carried out various activities fairly well. The committee suggests that quantum of diverse science dissemination activities be further enlarged and enhanced in terms of scale and delivery so as to reach the stakeholders and masses more and more and remain connected with them.

Committee recommends continuation of sub-scheme beyond 12th Five Year Plan in view of its significant achievements.