III. COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH

1. INTRODUCTION

Council of Scientific & Industrial Research, a premier autonomous R&D organization, is a multidisciplinary, multi-locational set-up, comprising of 38 laboratories and 47 regional centers has completed sixty one years of its existence. Nourished, fostered and supported by successive governments, since its inception, CSIR is now recognized internationally as an institution which is moving speedily towards achieving global excellence without diluting local relevance. In India, it symbolizes a culture that links science with society through technology and industrial manufacture.

As the nation's strongest holder of intellectual property rights, CSIR leads the way for protecting traditional knowledge strength while adding to the new IPR capital. CSIR was ranked the first amongst major PCT applicants from developing countries. CSIR has also continued to promote excellence in science and is the only S&T organization, which had nurtured and supported human tech from 16 to 65 years of age, through numerous schemes on human resource for scientific research. CSIR helped usher India into a scientific milieu, creating and nurturing talent in science, innovation and technology.

2. SIGNIFICANT DEVELOPMENTS

2.1 Creating massive knowledge networks

A key feature of CSIR's performance was the creation of major and innovative knowledge networks across and beyond CSIR laboratories. Not too long ago, most CSIR laboratories had acted as single units with several laboratory based programmes. CSIR's massive network on 'bioactive molecules', launched three years ago began the process of leveraging the benefit of networking, by bringing together 20 CSIR laboratories and

several other institutions. This philosophy was carried forward with vigour. Most of the programmes for the Tenth Plan now have been formulated with networking of resources and capabilities as the major component.

2.2 Contributing to Indian industry

CSIR continued to provide a strong support to Indian industry. The major achievements included successful commercialization of process for conversion of Naphtha to Gas and Gasoline (NTGG); catalyst for speciality polymeric materials based on zirconium tetrachloride; lacidipine process; methane sulphonic acid process; Precipitated Calcium Carbonate (PCC), etc.

Technology for the commercial manufacture of CONSAP, a vaginal contraceptive cream from Sapindas mukorosil, has been licensed to M/s Hindustan Latex Ltd. Bacopa extract (Promind) has been licensed to M/s Lumen Marketing Company and the product has been marketed by them as Memory Power and Memory Perfect. Also, double blind clinical trials for CT-1 (antihyperglycemic) are continuing. Permission has been obtained from DCG(I) to conduct clinical trials of α and β arteether (anti malarial).

CSMCRI has successfully developed Thin Film Composite (TFC) reverse osmosis (RO) high flux membrane in-house. The indigenously developed membrane is suitable for treatment of tertiary treated sewage water. 1 million liters/ day capacity plant has been commissioned at Chennai Petroleum Corporation Ltd (CPCL) Chennai. The use of this new membrane, which is non-

biodegradable and which has the ability to work over a wide pH range, would reduce capital investment and operating cost greatly.

2.3 Catalyzing civil aviation industry: SARAS - inaugural flight

CSIR has been rendering yeoman service to the Indian aerospace sector. Its contributions and excellence are acknowledged not only nationally but internationally as well. The light transport aircraft programme achieved a significant milestone on 4th February 2003 when its first prototype of SARAS rolled out. The prototype was named VT-XSD - SD in honour of Dr. Satish Dhawan, a doyen of aerospace & former Chairman of National Aerospace Laboratories (NAL) Research Council at whose instance NAL's Civil Aviation activities were initiated. Major testing activities have been completed for SARAS in preparation of the first flight. It needs to be emphasized that the first journey that began with a Light Combat Research Aircraft in the National Aerospace Laboratories, was taken forward to the series of HANSA aircrafts, resulting finally into an all composite aircraft HANSA-3, that was test certified in 2001, and is productionised and taken to the Indian skies already.

The Director General of Civil Aviation (DGCA) had given clearance to the flight trials of the aircraft and the maiden test flight took place on 29th May 2004 and many further test flights have taken place to check functioning of all systems and subsystems. The inaugural flight took place on 22nd August 2004 at Bangalore in the gracious presence of Honourable Minister of State for Science & Technology and Ocean Development, Shri Kapil Sibal.

2.4 Traditional knowledge: Efforts for protection and value addition

CSIR lead the Team India initiative for setting up the first ever Traditional Knowledge Digital Library (TKDL).
The TKDL would provide a search interface to retrieval of traditional knowledge information on International Patent Classification (IPC) and keywords in multiple languages. At global level it would act as a bridge between 'Sanskrit Slokas' and a patent examiner.

CSIR presented the concept of Traditional Knowledge Resource Classification (TKRC) to the IPC Union and it is now being recognized by the IPC Union. India has created approximately 200 subgroups for the classification of medicinal plants in IPC (under a new Group A61K 36/00) instead of existing single sub-group (A61K 35/78). These will be included in the next edition of IPC to be published in July 2005.

2.5 Science & Technology for the Society

As a socially conscious organization, CSIR continued its efforts to provide the S&T needed for the masses. During the year, it adopted villages to promote employment generation on one hand and developed diverse technologies to add to quality of life on the other hand. These technologies include: installation of 1200 Litre/hr Brackish water desalination plant in Kisari village of Rajasthan by CSMCRI, under a DST funded project; CSMCRI established a model cultivation for Jatropa curcus from which bio-diesel of international specification can be produced; Orchards are simultaneously being raised in Orissa (Huma & Mohuda villages) and Gujarat (Chorvadla village) to make elite germplasm available in sufficient quantity so

that cultivation can subsequently be taken up in larger (100-200 hectares) tracts of wasteland. The project has the potential to use wasteland, create several jobs, solve Indian's energy problems and reduce environmental pollution.

2.6 New Millennium Indian Technology Leadership Initiative

New Millennium Indian Technology Leadership Initiative (NMITLI) synergised the best competencies of publicly funded R&D organisations, academia and private industries. With over 50 private sector companies and over 150 institutes & laboratories networked together, NMITLI is the largest public-private partnership in India today.

Under NMITLI, an Investigational New Drug (IND) application from an oral herbal formulation for the treatment of psoriasis, one of the most common dermatological diseases affecting around 2% of the world population, has been filed for the first time in the country. Also, for the first time a versatile portable software for bioinformatics – Biosuite® has been developed. This is a multi-purpose tool for carrying out diverse bio-analyses ranging from gene analysis to comparative genomics.

The mammoth coordinated network programme on bio-actives involving twenty CSIR laboratories, thirteen universities and three well-known entities in the traditional system of medicine is contributing in the area of new drugs discovery. Dedicated discovery groups have discovered some new chemical entities and new herbal formulations. The discoveries covered are cancer, tuberculosis, filaria, malaria, ulcer, Parkinsonism & Alzheimer. Some interesting leads have been obtained on hepato-protective cum immuno-modulation as well as memory enhancement. Two entirely new anticancer preparations in the area of women's cancer are being developed further with an Indian firm. Also, short-term toxicity of two entirely new antiulcer preparations have been completed and clinical trials protocols have been worked out.

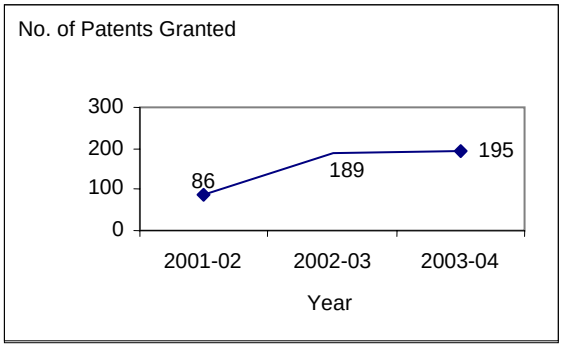
2.7 Contribution to New Knowledge

For the first time, CCMB scientists have discovered that interfering RNA can convert euchromatin in to heterochromatin, both components of chromosomes. This can, sometimes, result in virtually stopping the gene expression. The research carried out at CCMB on understanding the mechanism of gene silencing has been published in the prestigious journal 'Science'. This finding is of great importance in treatment of many diseases, particularly cancer.

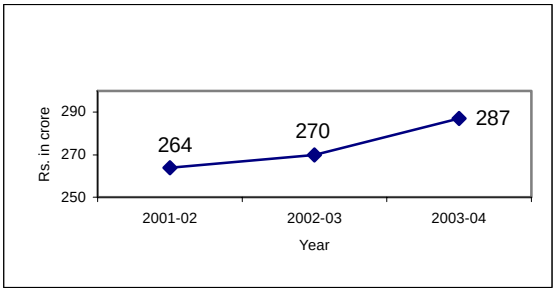
NCL has made a major contribution by designing novel structures like stacked sheets by using new channel guest system. It was challenging to design them (a) for special shapes and (b) of desired properties. This novel contribution has found a place on the cover page of prestigious Journal of Organic Chemistry.

2.8 All time high in CSIR's journey during the year

The year saw CSIR reach an all time high in science, patents & earnings. In terms of science, CSIR published 2188 papers in SCI journals, with an average impact factor per paper of 1.75. In terms of patents, it was granted 195 US patents (69% of the patents granted to Indians in India). In terms of its earnings, CSIR's external cash flow was Rs. 287 crores.



US Patents granted to CSIR



External Cash Flow Generated

3. SCIENTIFIC & TECHNICAL ACHIEVEMENTS

Some of the scientific & technical achievements sector-wise are provided in the following paragraphs:

3.1 Aerospace Science & Technology

SARAS

NAL's Light Transport Aircraft Programme (SARAS), which has been initiated as a major national aerospace programme to improve the connectivity of remote places particularly to the entire N-E region and other smaller towns of the nation, had completed a significant milestone of rollout on 4th February 2003. The Director General of Civil Aviation (DGCA) had given clearance to the flight trials of the aircraft and the maiden test flight took place on 29th May, 2004 and many further test flights have taken place to check functioning of all systems and subsystems. The inaugural flight took place on 22nd August 2004 at Bangalore in the gracious presence of Honourable Minister of State (Independent Charge) for Science & Technology and Ocean Development, Shri Kapil Sibal.

Mesoscale modeling for weather forecasting

NAL is working on a weather forecasting model of very specific relevance to the Indian atmosphere particularly in the Mesoscale. It can be used to predict weather better and will be a big advantage to farmers. In this area NAL has designed and developed optical Floswitch- the hardware component of the Mesoscale Modeling for monsoon related predictions. NAL Floswitch has the decisive edge on the connectivity, bandwidth and information processing capability and is technically superior to the commercially available systems anywhere in the world.

Shape Memory Alloys (SMAs) developed for aerospace applications

Ni-Ti based Shape memory Alloys (SMAs) have found active application in shape control of aerospace structures and various actuator applications. NAL has achieved capabilities for processing of Ni-Ti based actuator wires and springs from SMAs.

Cure Controller for bonded repair

Cure Controller is electronic equipment used for in-situ bonded repair of aircraft structures. Both metallic and composite structures can be repaired using this equipment. NAL has designed and developed two versions of cure controllers. One is microprocessor-based system capable of single zone control and the other is a notebook PC based system capable of multizone control. This system is the first of its kind in the country and provides an essential tool for onsite, in-situ repairs.

Acoustic Test Facility (ACT)

NAL has conducted detailed qualification tests of many space systems during the year using the ACT. The significant systems tested included two major flight hardware systems of GSLV& 2 staellites (IRS Pt & INSAT 3E).

The acoustic test facility has also developed gas jet noise generator whose perfomance is excellent and covers wide range of operations. This is the state-of the–art–system and not covered by any other system in the world. This system has been supplied to prestigious aerospace companies including Boeing, USA.

Automatic visual range assessor

The visual range is a parameter of central importance in flight operations, which determine whether a pilot may land, or take – off. NAL has designed and developed the Automatic Visual Range Assessor (AVRA); this system automatically assesses and reports visual range at 10-second intervals. The system has met the acceptability criteria successfully.

3.2 Biological Sciences & Technology

Gene silencing – A Hope for Cancer Control

When gene expression is completely stopped or drastically reduced, the phenomenon is called gene silencing. Scientists of CCMB have demonstrated that gene silencing in plants and animals can be achieved by interfering with the gene activity through the small RNA molecules the 'interfering RNA' (RNAi) at specific loci during the conversion of euchromatin to heterochromatin. This outstanding achievement has been reported in a prestigious Journal **Science** that disruption of RNAi interference mechanism in living cell blocks the formation and maintenance of heterochromatin, eventually leading to disruption of specific chromosome regions. Since, the diseases coupled with cell division and cell proliferation, such as various types of cancers, appear to be controlled by heterochromatin formation and it's functioning, understanding of the role of RNAi intervention in these processes might pave a way to use RNAi as a possible therapy for cancer and other related diseases, which involve cell cycle controls.

Disease Resistant Rice

In a unique collaborative effort by CCMB and Directorate of Rice Research (DRR), an applied agricultural research institute of the Indian Council of Agricultural Research (ICAR), Bacterial Leaf Blight (BLB) resistant Samba Mahsuri and Triguna Rice lines through the application of DNA Marker Technology has been developed. In past, several BLB resistant varieties were developed using traditional breading methods. But, that process takes normally more than 5-7 years for in corporation of resistance and 4-5 years for evaluation and commercial release of the variety. But, CCMB-DRR group in addition to using DNA markers for pyramiding BLB resistance genes from public domain for selection of disease resistant lines and also used markers distributed through out the rice genome to select the plants that are likely to have other qualities like that of original parent the Samba Mahsuri or Triguna. This innovation has substantially reduced the time required for development of durable resistance to a short period of less than three years which through conventional breeding would have taken at least 5-6 years.

Novel therapeutic strategies to tackle leishmaniasis

The relationship of the serotonin$_{1A}$ receptor with its membrane environment has been

explored by Fluorescence Recovery After Photo bleaching (FRAP) experiments on receptors heterologously expressed in intact cells. CCMB has shown, for the first time, that cholesterol depletion from macrophage plasma membranes using methyl-β-cyclodextrin results in a significant reduction in the extent of leishmanial infection. These results indicate a specific requirement of plasma membrane cholesterol in efficient attachment and internalization of the parasite to macrophage cells leading to a productive infection. This was supported by the fact that the reduction in the ability of the parasite to infect host macrophages can be reversed upon replenishment of cell membrane cholesterol. More importantly, these results are significant in developing novel therapeutic strategies to tackle leishmaniasis.

Bio-restoration of over burden dumps

The plantation of efficient soil binder and high photosynthetic plant species such as *Leonotis nepataefolia, Lantana camara, Sida acuta, Saccharam benghalensis, Vetevaria zizanoides, Lemon grass* among shrubby vegetation and *Cassia siamea, Dalbergia sissoo, Acacia auriculiformis, Ficus religiosa, F. benghalensis, Delonix regia, Switenia microphylla, Thuja orientalis, Saraca indica* from hardy species along with other suitable amendments have considerably improved the fertility status/biological activity and significantly reduced the erosional losses of the mine spoil. Bio-restoration of OB dumps/wasteland have been applied by CFRI to reclaim OB dumps of different coalfields in an eco-friendly manner, which can solve the vexing problem of ever-increasing GHGs from the surrounding environment, besides turning the overlaying waste dumps into a monetary source by means of plantation (social forestry).

Eugenol rich cultivar of Ocimum sanctum 'CIM-Ayu'

Tulsi (*Ocimum sanctum)* Family: *Lamiaceae* is known for traditional medicinal value and also the aromatic properties. It is used in Ayurvedic medicines and pharmaceutical preparations. Due to its anti-oxidant and anti-ageing properties, people use its fresh leaves daily in various ways. At present the production of plant herb and quality oil is quite low. The need was therefore felt to develop a high yielding cultivar for herb and essential oil with better quality. The cultivar CIM-Ayu of *Ocimum sanctum* has been developed by CIMAP through intensive breeding efforts possessing high yield of herb and essential oil with higher eugenol content.

Bamboo Micropropagation

As bamboos are cross pollinated and flowering cycles are long drawn, a lot of heterogeneity is observed in the seedling populations which may be important for bio-diversity conservation point of view but highly unsuitable for economic plantations. Therefore, prior selection of the seedlings in the field grown plants of *D. hamiltonii* was ensured in IHBT before attempting mass propagation both through nodal explants *in vivo* as well as through tissue culture. The selections were based on the growth performance of the seedlings in the field conditions and the propagation from mature plants of known physiological age ensured better performance in the field. As rooting of micro-shoots was inconsistent, an alternative method i.e. induction of somatic embryo genesis was employed. This is first report of prior selection and use of explants from mature culms of such plants for somatic embryo induction.

Rhododendron arboretum

A simple and convenient process was developed at lab scale at IHBT, to extract and enrich colour by removing highly hygroscopic, non colouring water soluble portion from *R. arboreum* flowers using polymeric resin to obtain brick-red colour free flowing non-hygroscopic solid (yield 3% in the raw material). It was readily soluble in alcohol/water. The solid was rich in phenolics and colour stability tests were done by UV spectroscopy. The solid is stable up to 150^0C, under sunlight for 4 hr. and to acidic medium.

Tea Diversified Products

A tea concentrate maker-cum-leaf deactivator of a batch capacity of 200L was developed and fabricated at IHBT for making tea concentrates both of green and black teas. The concentrate maker was successfully demonstrated in making 500L of black tea concentrate from low grade black orthodox teas for use in ready to drink teas.

Multipurpose essential oil distillation unit

A new type of essential oil distillation unit (capacity 10 q/batch) was designed primarily for steam distillation of patchouli oil at IHBT. The unit consists of common distillation tank with double condenser, double receiver and a cohobation column.

Transgenic Cotton Lines

Transgenic cotton cultivars that express δ - endotoxins have been globally accepted as a solution to enhancing cotton productivity, saving farmers from toxic exposure to the pesticides and providing an environmentally safe technology. NBRI has designed and chemically synthesized two genes coding for the insecticidal δ - endotoxin proteins targeted against pests that defoliate cotton crop and seriously damage the bolls. The genes have been deployed for the development of transgenic cotton lines. This is the first agronomically valuable transgenic technology developed in India that has been accepted by seed industry for commercialization. The cotton cultivars made transgenic with the NBRI δ - endotoxin genes provide a globally competitive agribiotech solution to the problem of insects in agriculture.

Seven reputed Indian cottonseed companies, including Nuziveedu Seeds, who own the largest market share and together represent 30% of Indian cottonseed market, have joined together to make a consortium. The NBRI Bt – cotton has been licensed to the consortium, registered as Swarnabharat Biotech Pvt. Ltd., Hyderabad.

Novel Biomarker for patients with Visceral leishmaniasis

A novel biomarker, which is disease specific (glycotope)on erythrocytes of patients with Visceral leishmaniasis. The potentiality of this discovery has been quickly identified by WHO for its global application and the technology has recently been transferred to an Indian Company, Zephyr Biomedical, Goa.(identified by WHO).

3.3 Chemical Sciences & Technology

Supramolecular chemistry

NCL has developed cavity and channel structures by employing molecules with functional groups such as -COOH, -$CONH_2$, -NO_2 etc. that form robust hydrogen bonds. Studies conducted on the development of

polymorphs and pseudopolymorphs through various crystallization procedures. Supramolecular assemblies of benzenetetracarboxylic acid with *aza* donor molecules like phenanthrolines, phenazine and bipyridyls with and without water molecule are characterized by single crystal X-ray diffraction methods. These assemblies occur in two classes - host-guest systems (with aza molecules being in the channels created by the acid molecules) and assemblies with infinite molecular tapes.

1 Million litres/day RO plant commissioned at CPCL, Chennai

CSMCRI has developed reverse osmosis (RO) membranes based on the state-of-the-art thin film composite (TFC) membrane technology for desalination of brackish water. The inherent advantages of the TFC membrane are its non-biodegradability, low compaction rate, and ability to work under a wide pH range, all of which have resulted in more robust and economical operation and longer membrane life. At present, CSMCRI membrane gives <95 per cent salt separation and 35-40 gallons per square foot per day permeation rate under standard conditions of testing, making it ideally suited for brackish water application.

CSMCRI has commissioned a one million litre per day desalination plant based on RO technique for treatment of tertiary treated sewage water at the Chennai Petroleum Corporation Ltd. (CPCL), Chennai, in November 2003.

Ultra pure salt

Ultra pure salt with Ca=0.01-0.03%; Mg=0.80.1% and SO_4=0.1.15% was produced by CSMCRI from sub soil brines on field scale using flocculating agents. The process is simple and can be implemented in any salt works.

Model cultivation for Jatropha curcus and production of bio-diesel of international specification from the oil

CSMCRI has successfully cultivated elite varieties of *Jatropha curcus* on marginal land to assess practically realizable seed yields. Scientists of CSMCRI have achieved a great feat in developing a simplified process for production of biodiesel from the oil complying with Euro 3 specifications for free fatty acid methyl ester.

While biodiesel complying with Euro 3 specification is produced in Europe from rapeseed oil, this is the first time that such biodiesel has been made from Jatropha oil. The bio-diesel has been evaluated at DaimlerChrysler AG and found to be matching all specifications. The cetane number has been established to be 58.5. Larger lots of bio-diesel are now being made for evaluation in India in a Mercedes Benz car. Orchards are simultaneously being raised in Orissa (Huma & Mohuda villages) and Gujarat (Chorvadla village) to make elite germplasm available in sufficient quantity so that cultivation can subsequently be taken up in larger (100-200 hectares) tracts of wasteland.

Saloni K- The Low Sodium Vegetable Salt

CSMCRI had developed *Saloni* vegetable salt in the year 2002 and the product has generated worldwide interest since it was first reported in the media in May 2003. CSMCRI has now developed *Saloni K*, a low sodium vegetable salt.

Institute has received orders from Kyoei Trading Co., Japan for supply of 100 kg

each of *Saloni* and *Saloni K* for test marketing in Japan and 100 kg each salt by Nisha Medical Stores, Bhavnagar. The most important aspect of the salt is that it is produced from vegetable waste and greatly contributes to improving the viability of cultivation of weed on saline wasteland, which is an important societal objective.

Nano Tubes

IICT has developed synthetic, peptide - based nanotubes that have a wide range of futuristic applications. This new class of compounds could be used for delivering DNA material for gene therapy and also making biochemical sensors. Nanotubes would help in developing a new generation of "molecular machines" and would benefit polymer, materials and electronics industries.

Electrodes for desalination of brackish water

CECRI has developed an electrode suitable for desalination of brackish water by electrodialysis with periodic current reversal. The electrode withstands periodic current reversal - half of the time, it has to function as anode and rest of the time it has to act as cathode. Very few electrodes are capable of performing this dual role. These electrodes have a valve metal substrate activated by a noble metal based coating. Accelerated life testing in an artificial desalination set up predicts over 10,000 current reversals without any potential escalation. The main user for this electrode is Defence Laboratory (under Defence Research & Development Organization), Jodhpur.

Low cost adsorbents for removal of arsenic from contaminated drinking water

ITRC has found that Iron hydroxide removes arsenic efficiently from contaminated water (arsenic spiked tap water). The utility of iron hydroxide coated charcoal for removal of arsenic was examined. Iron hydroxide coated charcoal was found to be less efficient as compared to iron hydroxide alone. As such, iron-coated sand for removal of arsenic from water was examined. The iron coated sand was studied for reuse and found to remove 75% - 60% of arsenic in a treatment period of 7 hours, for 5 consecutive days, consequent upon the use of 50 ppb arsenic spiked tap water.

Finger Printing of Coal

Introduction of nitro group substantially enhanced solubilization of coals in aqueous organic solvents. Heat treatment of the oxy-nitrated coal at $150\pm10^{o}C$ in air caused elimination of NO_2 and lowering of solubility in potent mixed solvents from 49.5% to 25% and from 56.2% to 29.3% in aqueous acetone and aqueous tetrahydrofuran respectively. A hypothetical route of nitro group elimination and a possible mechanism for reduction of solubility of oxy-nitrated coal consequent upon its thermal treatment in presence of air have been put forward for the first time by ITRC which is substantiated by FTIR spectra.

3.4 Engineering Sciences & Technology

Highly Sensitive explosive Detector

CSIO has developed a highly sensitive explosive detector. The instrument utilizes a twin chromatographic columns (one empty and other coated with stationary phase) coupled to two independent electron capture detectors. The empty column ECD immediately responds to electron capturing compound whereas coated column ECD responses according to the retention time of compound in coated column. The detection of explosives is made by utilizing their electron

capturing property, common to all organo-nitro compounds. The explosive detector developed at CSIO detecs vapors and particulates of low vapor pressure organic explosives such as TNT, EGDN, NG, PETN, RDX, HMX, RDX+TNT.

Clinical chemistry analyzer for blood biochemical parameters

CSIO has developed clinical chemistry analyzer, which is a high performance Micro-controller based photometric biochemistry analyzer used to measure various blood biochemical parameters such as Blood Glucose, Urea, Protein, Billrubin etc. that are associated with various disorders such as diabetes, kidney diseases, liver malfunctions and other metabolic derangements. The quantisation of these parameters is helpful in classifying such diseases and other appropriate circumstances results of the system are used for diagnostic purposes.

Micro electro Mechanical System (MEMS) surface micro-machined capacitive pressure sensor

CEERI has fabricated high sensitivity, low cost and surface micro machined capacitive pressure sensors with chip Size- 4mmx 3.2mm and thickness of 0.5mm. These sensors can find applications in number of strategic areas like space, atomic energy and defense. A variety of sensors are also needed in human health related miniaturized diagnostic instruments. The demand of these sensors is expected to grow extremely fast in times to come.

Rejuvenation of iron, copper and zinc mine spoil dump and mined land productivity through integrated biotechnological approach.

NEERI, under collaborative effort with DBT, Govt. of India, and Swedish Agency for Research Cooperation with developing countries, Sweden, has adopted a two-front Integrated Biotechnological Approach (IBA) for the prevention of heavy metal leaching from over heaps and for rejuvenation of their productivity through identification of appropriate blends of organic wastes and mine spoil for rhizospheric development. Under this project, three different mine sites (5 hectares each) of iron, copper and zinc were selected at Goa, MP and Rajasthan. Physico-chemical and microbiological analyses of mine spoil dumps tailings from these sites are carried out. The native flora of all these three sites is surveyed and plants in abundance and maximum frequency of occurrence are selected and planted at these sites.

A new technique for fire protection-direct foam injection (DFI).

The Direct Foam Injection Technique, conceptualized and indigenously developed by CBRI has been patented in India and USA. Detailed engineering is in progress for technology transfer in the oil sector in India.

First Beam / Stick of Micro TWT

CEERI has designed, developed & tested First Beam/Stick of Micro TWT. Beam transmission of development of 97% has been achieved. One of the major break through/ result achieved in the development of Micro-TWT for Microwave Power Module (MPM), in the country.

Evaluation of performance characteristics of road sections constructed using Natural Rubber Modified Bitumen (NRMB)

CRRI has conducted a detailed study, which shows that incorporation of 2-4% natural

rubber in bitumen improves properties of bitumen and bitumen mixes enhance the life of pavement surfacing. The better performance of test sections with NRMB in bituminous binder courses and wearing courses indicated that performance of roads with NRMB is better with the use of NR in bitumen modification. The use of natural rubber in this diversified application leads to better economic conditions for the rubber growers.

New sensors for trace moisture analyzer

CGCRI has developed a device to detect moisture in the range of 0-1000 ppmV based on micro and nano-porous alumina sensors. Important areas of applications of these trace moisture analyzers are in the measurement of moisture in gases of glove boxes as well as in industrial environment involving high quality welding, nuclear reactors, food packaging, pharmaceuticals, laser marking, submarine periscope, purging etc.

Pneumatically driven anesthesia ventilator

CSIO has developed a pneumatically driven Anesthesia Ventilator, which delivers breaths to supply a specific volume of breathing gas to a patient at a desired breathing rate. It also maintains required duration for inspiration and expiration.

Smart biosensor based on ion-sensitive field effect transistor (ISFET)

CEERI has fabricated ISFET biosensor using metal gate NMOS technology with the Glucose Oxidase (GOD) enzymes immobilized over the silicon dioxide- silicon nitride dual-dielectric gate in place of the conventional metal gate electrode. The device has biomedical applications e.g. in clinical pathology and food and beverage industry. Advantages include; small size, instant response, ruggedness, mass scale production, low-cost reliability. The device has impact on health care and food processing instrumentation.

Fluidized bed Separator

RRL-Bhopal has developed a fluidized Bed Separator for the separation of censopheres in the area of mineral processing. Preliminary results indicate that censopheres coarser than 45 microns can be selectively recovered using this separation system. The machine is also suitable for different classification and concentration of different minerals, coal, separation of contaminants from the polymeric waste products etc.

Process control automation for paper converter machine

CEERI has designed & developed a Distributed Control System (DCS) based Electronic Control System for online measurement of coat weight, coat moisture, roughness and sheet temperature to control the paper converter process to improve the quality of the coated paper. The system has been successfully installed and commercialized at M/s Rohit Pulp and Paper Mills Ltd., Vapi, Gujarat.

Radiation resistant optical components for CCTV nuclear camera

CGCRI has developed an optical system for an indigenous CCTV nuclear camera used for remote viewing of the interior of the reactor coolant tubes. This remote is very important for effective and timely servicing of the nuclear reactors. The system is required for

focusing, illumination mirror rotation, etc to aid viewing for remotized controls. The optical system has been successfully deployed at Heavy Water Reactors at kalpakkam and at kaiga of Nuclear power Corporations Ltd.

Optical Fibre Amplifier

CGCRI has developed an optical amplifier for light wave telecommunication network. This is based on CSIR technology particularly using erbium-doped optical fibre (EDF) and high power semiconductor pump laser source. The amplifier gain block with all necessary logic control and computer interface commensurate with CATV. Telecom standards has been designed & developed in collaboration with the industrial partner, NeST, Cochin. These devices will help "Fibre to Home" technology in India.

Natural Fibre Composite Door Shutters

CBRI has developed composite door shutters prepared by bonding the jute/sisal laminates face with plastics wood slab core. These door shutters confirm to IS: 4020-98 and exhibit superior performance as experienced in the in the existing alternatives for conventional doors. The weight of the door is approx. $12kg/m^2$, fixtures such as handles, locks and hinges can be fixed in the finished door shutters without adding any wooden blocks. The cost of the composite door (30mm thickness) is comparable to the conventional ones.

Structural concretes containing fly-ash aggregates

SERC has prepared a state-of-the-art report on use of Fly ash aggregates (FAA) covering various aspects such as production technology of FAA, characteristics of FAA including mix design and durability aspects. Laboratory trials were also made to prepare bonded FAAs using the modified concrete drum mixer using locally available fly ash.

Vulnerability analysis of framed structure against earthquake

From the post disaster damage survey carried out by SERC at Bhuj, it has been noticed that a large number of reinforced concrete framed buildings with open storey at ground floor level suffered extensive damage. Based on the studies conducted, SERC has proposed a methodology for generating acceleration response spectrum using fuzzy-random models of earthquake ground motions. The methodology will be useful for developing design response spectrums for the different seismic zones in India for different site conditions.

Fiber optic sensors applied for health monitoring of civil engineering structures

SERC scientists have evolved procedures for embedding fiber optic sensor in concrete. Performance studies of encapsulated sensor embedded in concrete cylinders indicate that cast epoxy sheets are best suitable as encapsulated fiber optic sensor at high strain ranges have also been carried out.

Multigrade Bitumen

CRRI and Bharat Petrolium Corporation Ltd. have jointly developed multigrade bitumen confirming to PG (SHRP) grade specifications. Two-multi grade bitumen confirming to PG-52 and PG-64 have been developed and evaluated for different properties. Products developed are premium products with reduced temperature susceptibility. It also indicates better adhesion properties than the conventional bitumen.

3.5 Food Science & Technology

Oryzanol extraction from rice bran oil soapstock

A simple and cost effective process for isolation of oryzanol has been developed by CFTRI. Conventional saponification process is carried out at elevated temperature and for longer duration. The present process is employed at lower temperature and for shorter duration with efficient removal of targeted impurities. The degradation of oryzanol is also minimal and hence the process is simple and easy to scale up with reduction of number and scale of unit operations involved in the overall process. The technology has been patented.

Blending of oils to enhance nutritional value of edible oils

Naturally occurring edible oils are not wholesome in terms of balanced fatty acid composition and in minor constituents, which have independent health benefits. Efforts have been put towards developing combinations of vegetable oils to provide fatty acid composition in the ratio of approximately 1:1:1 and 1:2:1 for saturated: monounsaturated:: polyunsaturated fatty acids for meeting the needs of health conscious individuals. Combinations have been chosen to provide desired levels minor constituents to act as nutraceuticals. Various oils containing essential fatty acids of ω6 and ω3 series have been chosen as base oils and blended in appropriate ratios with oils like rice bran oil, red palm oil and sesame oil to provide nutraceuticals like oryzanol, β-carotene, tocotrienols, sesamin and sesamolin. After ascertaining quality parameters as well as desired levels of fatty acid composition, six combinations of oils have been selected for large-scale trials. An enriched fraction of β-carotene, to be used as nutraceutical, has been extracted from red palm oil, a rich source, with organic solvents of different polarities.

In order to obtain an oil combination, which not only provides health benefits but also, suitable for use in frying dishes, combinations of oils were prepared at CFTRI. Combination of palm oil or mustard oil along with rice bran oil and sesame oil provided a stable frying oil. Combination of groundnut oil with rice bran oil or red palm oil provided good rheological stability.

3.6 Information Science & Technology

Traditional Knowledge Digital Library (TKDL)-Ayurveda

The concept of Traditional Knowledge resource Classification (TKRC) is now being recognized by the International Patent Classification (IPC) Union. India has created approximately 200 subgroups for the classification of medicinal plants in IPC instead of existing single sub-group. These will be included in the next edition of IPC to be published in July 2005.

Evaluation of design and technology upgradation scheme for handicrafts

NISTADS has studied and evaluated the impact of design and technology upgradation scheme on income enhancement of artisans, creation of additional employment, increasing exports of handicrafts, and in building the capacity of the artisans in terms of design and technological upgradation, infrastructure creation etc. the overall findings are that the scheme contributed significantly to the creation of additional employment, boosting exports and domestic product.

CSIR Electronic Journals Consortium

The CSIR e-journals consortium is a Tenth Five-year plan project which aims at providing electronic access to nearly 4500 worldwide S&T periodicals. CSIR entered into an agreement with M/s Elsevier Science, one of the largest publishers of S&T e-Journals for having access to its 1700 S&T journals among all the laboratories/ units/ centers of CSIR. NISCAIR's continued efforts have enabled significant increase in usage from July 2002 to October 2003. the total downloads by the laboratories were 11,266 in july 2002 which has increased to 90,104 in October 2003.

Analysis of energy scenario in India and other developing countries

Energy consumption in any country is directly linked to is industrialization, economic strength and the life style of its citizens. NISTADS in its study has attempted to analyze the experience of the three largest developing countries in the world by land area, namely, China, Brazil and India, in energy exploitation. The study discusses the need to develop self –sustaining units of energy, based on local inexhaustible sources, which are available abundance in our country. Energy from wind, solar are reliable, plentiful and environmentally friendly.

Information Products

Continuing its endeavors for developing value added IT products benefiting professionals, academicians and industry, unit for Research and Development of Information Products (URDIP) during the year 2003-04 has developed and added in the series a number of information products. These include;

- Health Heritage information product incorporates both traditional knowledge from practitioners of Ayurveda and the modern information made available through systematic research during the past 40 years on diverse medicinal palnts. A third CD ROM in the series containing information on 50 plants was released.

- PAMEP is a database of patents on aromatic, medicinal and economic plants. The database covers patent granted on about 300 plants.

- Ayuta Index's second volume in the series named as Hetu-Koshah was prepared and released in CD-ROM format. This product integrates widely scattered and distributed references form ayurveda classics on symptoms, causes and treatments in a retrievable form. This work was undertaken in collaboration with Tilak Maharastra Vidyapeeth, Pune.

- Patestate is a full text database of all the Indian and foreign patents that have been granted to CSIR. This completes the digitization of all the patents granted to CSIR from 1976-2000.

- Anusandhan (www. Anusandhan.net), a prototype of a Science and technology portal that will act as a single window of information on Indian science and technology developed. It covers the research activities of all the publicly funded R&D institution funded by Central and State Governments as well as academic institutions.

- Explorations (www.csirexplorations.com) are prototype of basic research portal that includes a digital library of Ph.D theses of CSIR research fellows at national laboratories and other academic

institutions. It will also include the reports of extra mural projects supported by CSIR to universities and papers published by CSIR scientists.

3.7 Leather Science & Technology

Non-zero Discharge Leather Processing

CLRI has developed a three step tanning methodology towards near zero discharge leather processing. Cow hides are dehaired using standard enzyme based dehairing method. The hides are treated with α–amylase 1% and water 100% for 3 h in a drum. Alternatively, the hides can be treated with 0.9% sodium hydroxide and 350% water in a drum; duration of treatment is one day. A pickle–basification free chrome tanning at pH 5.0 has also been developed with and without masking. The pH of the pelts is kept 5.0 using three different acids namely sulfuric, acetic and oxalic acid without sodium chloride. A polymeric matrix based on naphthalene sulfonic acid has been prepared using polycarboxylic acid without employing formaldehyde. The product enables pickleless tanning thereby reducing the pollution load in terms of TDS and chlorides.

Leather biotechnology

Leather industry generates enormous amounts of solid as well as liquid wastes causing ground and water pollution. Dehairing of skins and hides is one of the major sources of pollution. Enzymatic method of dehairing as an alternative to chemical method is gaining worldwide attention. A fungal strain isolated at secreting high levels of alkaline protease in short fermentation cycles was evaluated at CLRI. The dehairing of skins and hides in the absence of sulfide using NCL enzymes has been demonstrated in commercial tanneries.

3.8 Materials Science & Technology

Fine coal treatment pilot plant

CFRI has designed and commissioned the Fine Coal Treatment Pilot Plant (FCTPP) as a low profile building with state-of-the art process equipment for carrying out R&D studies on small/fine size coal. The most important feature of the plant is that entire installation including the existing plant can be operated from the control room through PLC. This facility may help to develop the optimum beneficiation circuits for the treatment of inferior coals both coking and non-coking.

Improved inorganic cement capsule developed for quick setting of bolts

CMRI has developed an inorganic composition for grouting the roof bolts. The composition contains all the requisite key features like instant grip, high early and ultimate strength, non-flammable, non-corrosive, non-allergic and has good self-life and performance of anchorage.

New method to utilize steel plant waste economically

Steel industry generates a lot of waste materials such as iron ore fines, mill scale, coke breeze, flue dust, SMS sludge, stock house dust, lime dust etc. The process of recycle has been major concrn of the iron and steel industry for many years. Since these wastes being fine in nature cannot be recycled directly. Various agglomeration techniques are adopted for making them suitable for recycling; among them the cold briquetting offers greater flexibility for particle size of materials and binders. RRL-Bhubaneshwar has conducted laboratory scale studies on cold briquetting using inorganic binders to achieve high green and cold crushing strength. On the

basis of the results, large scale trials on 30 tph capacity have been successfully conducted at the plant site of M/s Ispat Mettalics India Ltd. the briquettes produced during the trial run were found to be suitable for charging t blast furnace.

New technology to manufacture DRI blocks

RRL-Bhubaneshwar has developed a process to produce composite blocks of iron ore fines and solid waste fines using suitable binder combinations followed by reduction roasting in non-oxidizing/mild reducing condition in a coal fired furnace. These highly metallised DRI blocks can be charged into the induction furnace for steel making. This is a new and simple technology for making steel by utilizing waste fines generated in the mines as well as industries and is proposed for the first time in the country.

An improved method of underground extraction of coal from contiguous seams/ sections.

Underground extraction of clean coal from thick and contiguous seams/sections in presence of weak and laminated in-between is a major problem of the Indian coal mining industry. CMRI has conceived an idea of underpinning to facilitate safe and optimal extraction of coal from such seams/sections. The underpinning consolidates parting stability through reinforcement and provides additional thickness to the critical parting as the roof coal band of the thick bottom sections was stitched together with the parting.

This technology was introduced at Chirimiri Colliery of SECL for simultaneous extraction of zero seam with critical laminated parting of approximately 3mm thick. This method arrested failure/collapse of parting and provided support of high roof during workings of bottom section of approximately 6mm thick. This method has increased not only the life of the mine but also the minerable property in addition to manpower deployment opportunity.

Recovery of cenospheres from fly ash

RRL-Bhopal has developed a novel process for the recovery of cenospheres from fly ash. Indian coals contain high ash content and during generation of thermal energy by coal combustion a large quantity of fly ash is generated. The applications of fly ash are well known but they contribute to use of only about 15% of the total ash generated. Fly ash contains major amounts of hollow spheres at sizes below 10 microns. These hollow spheres have several important physical, chemical and mechanical properties like wear resistance, corrosion resistance, fire retardation, low bulk density and high strength. The cenospheres have been selectively separated and judiciously integrated to achieve maximum product quality. A process flow sheet for the recovery of cenospheres from different grades of fly ash has been developed.

3.9 Physical Science & Technology

Flexible Electro Magnetic Interference (EMI) Shielding Materials

NPL has designed and developed flexible Electro Magnetic Interference (EMI) shielding materials based on newly emerging technology of conducting polymers and conducting composites with LDPE, HDPE etc. Interest in applications for polyaniline for Electromagnetic interference (EMI) shielding and Electrostatic charge dissipation (ESD) has motivated NPL to set up a pilot plant for the bulk synthesis of polyaniline and its

analogues. A stainless steel double walled reactor of 200 liters capacity has been commissioned where the synthesis of polyaniline can be carried out at 0-5^{o}C. A semiautomatic injection moulding machine of 20-60 gms capacity has also been installed where one can make conducting polymer composites of dimensions 6" x 6". Composites of conducting polymers having both electrical and magnetic characteristics have also been prepared at NPL, which has applications in microwave range. Synthesis of conjugated polymers based on aromatic hydrocarbons for organic light emitting diode (OLED) applications have also been carried out.

Soft Lithography Techniques for micro and nano-fabrication

NPL has exploited Micro-patterning using micro contact printing (μCP), one of the variants of soft lithography to fabricate small structures on solid surfaces for micro fabrication, sensors-arrays, MEMS and biological applications. It is an alternate (non-photolithographic) technique to create patterns in metal thin films on a substrate with feature sizes in sub-micron to micron range. It comprises of soft contact printing of SAM precursor solution using an elastomer stamp that contains the relief structures. The SAM solution is transferred to the well-defined regions on substrates having micron and sub-micron sizes. The surfaces derivatized with SAM serves as nano-thick etch resist and the underivatized surface could be etched in standard metal etchants. Micro-contact printing can be used repeatedly without invoking the costly equipment required in photolithography and is experimentally convenient and cost effective. NPL is the first one in country to have initiated work on soft lithography and micro-contact printing.

First deterministic seismic hazard map of India and adjacent areas

CMMACS has prepared a seismic hazard map of the territory of India and adjacent areas using a deterministic approach based on the computation of synthetic seismograms complete with all main phases. The input data set consists of structural models, seismogenic zones, focal mechanisms and earthquake catalogues. The synthetic seismograms at a frequency of 1 Hz have been generated at a regular grid of 0.2° x 0.2° by the modal summation technique. Figure depicts the spatial distribution of the design ground acceleration in g. The estimated values of the peak ground acceleration are in agreement with the observed data available for the Himalayan region. Many parts of the Himalayan region have the DGA values exceeding 0.6 g. The epi-central areas of the great Assam earthquakes of 1897 and 1950 in the north-east India represent the maximum hazard with DGA values reaching 1.2-1.3 g. The peak velocity and displacement in the same region is estimated as 120-177 cm/sec and 60-90 cm respectively.

This is the first deterministic seismic hazard map prepared for India and adjacent areas. The realistic modelling of seismic hazard for the Indian Territory yields meaningful results validated by recent observations made in connection with events that occurred after 1998, the upper time limit of the catalogue we used. It also provides a powerful and economically valid scientific tool for seismic zonation and hazard assessment.

Long-range, High-resolution Forecast of Monsoon Rainfall with variable resolution GCM

CMMACS has presented an GCM configuration that appears to have considerable success in long-range forecasting of monsoon rainfall. The novel feature is the use of a zoom (variable resolution) centered over the monsoon region; this allows high spatial resolution over a domain of interest at a relatively low computational cost. Using climatological fields of monthly SST from AMIP (Atmospheric Model Intercomparison Project) and initial fields from NCEP (National Center for Environmental Prediction), CMMACS presented experimental forecasts for monsoon of 2003 (June –August) in C-MMACS website. The forecast for 2004 are online from 10th April 2004. Thus the lead of the forecast is more than two months for June rainfall and more than four months for August rainfall. While the initial (NCEP) fields are on an approximately 250 km x 250 km grid, the forecast fields, over the monsoon region, are at about 50 km x 50 km in resolution. The reliability of the forecasts is assessed in terms of 15-year model climatology for onset, monthly rainfall fields and inter-annual variability.

Quality System In NPL Standards

As a part of the WTO agreement all signatory nations are committed to remove barriers including technical barriers to international trade. One of the well identified barriers is in the field of standards and precision measurements. It has been decided that testing and calibration certificates issued by National Metrology Institutes (NMI) like NPL should be acceptable globally. To ensure this, a Mutual Recognition Arrangement (MRA) has been signed by 38 member countries of the 'Meter Convention'. Under this arrangement equivalence of National Standards has to be established. NPL is actively involved in the exercise of carrying out key comparisons to establish equivalence of Indian National Standards with the rest of the world. Asia Pacific Metrology Programme (APMP) accepts a quality system if it satisfies the following:

- The implementation of a Quality System satisfying ISO/IEC 17025, and
- Technical competence to provide Calibration and Measurement Service that can deliver the claimed uncertainties.

NPL has implemented the Quality System which has undergone peer review of experts from BIPM France, NIST USA, PTB Germany, and NML Australia. Our Calibration and Measurement Capabilities are 483 and entered in the Appendix 'C' of BIPM.

Quantum Hall Resistance Standard

Primary DC Standard of resistance based on Quantum Hall Effect (QHE) has been established by NPL to provide a powerful tool for calibration of standard DC resistors with combined uncertainty of 0.08 ppm. It is used worldwide to define, maintain and compare the unit of resistance. The metrological meaning of the QHE lies in the fact that the Quantized Hall Resistance is a function of fundamental constants 'h' and 'e' only and is independent of place and time

3.10 Science & Technology for the Society

Pollution Mitigation for Lime Kilns

Reduction of pollution from the lime burning kilns has been identified as a major concern

of the Indian lime industry. CBRI has developed an upgraded pollution control system in order to meet the stringent requirements for sensitive areas as well as for clusters of kilns in general and the most commonly used 10 tpd capacity building lime kilns in particular.

The salient technical features of the system are: (i) Scrubber with Packed Bed Demister System, (ii) Limestone as reusable packing material, (iii) Suitable for particle sizes less than 10 micron, (iv) Power failure not to affect kiln operation, (v) Water requirement: 4-5 Kl/Day and, (vi) Power requirement: 5 KW.

Kalam- A new Lemongrass for drought prone areas released by RRL, Jammu

A hardy drought tolerant strain CPK-F_2-38 rich in citral has been developed through hybridization and rigorous screening of the F_2 recombinants of *Cymbopogan pendulus* and *C.khasianus* hybrid. The variety has been named "Kalam". Its performance was evaluated in both irrigated and rainfed areas. The crop is perennial and lasts for five years. The citral percentage ranges from 78-83 and the quality of oil has been evaluated and accepted by the user industry.
On the momentous day of June 26th 2003, during the visit of His Excellency Bharat Ratna Dr. A. P. J. Abdul Kalam, to Regional Research Laboratory, Jammu, a potted plant of this newly named citral rich variety was handed over to the H. E. the President of of India by His Excellency Lt. General S. K. Sinha, the Governor of J & K state.

The returns of variety 'Kalam' is two and a half times higher than the traditional crops grown in drought prone areas. However, it gives three times higher yield under irrigated conditions and compares favourably well with the existing varieties.

Automatic compact model of pulse thresher-cum-winnower

RRL-Bhubaneshwar has developed an automatic compact model of pulse thresher-cum-winnower. This is a small machine, which uses a 3 hp electric motor or fuel engine. It threshes & winnows in one go of the crops of pulses. The machine is used for efficient threshing and winnowing of grains from the ripe crop of different pulses, such as green gram, black gram, arhar, horse gram, lentil etc. irrespective of shape & size of plants and grains. The machine requires 2 hp to 3 hp electric motor or fuel operated engine. It crushes the crop residue into small sizes during threshing, which is suitable for animal feed. As the grain loss in crop residue is almost nil, and rate of harvesting is 2 to 3 times over traditional methods, 50% harvesting cost is reduced and 10% yield is increased as compared to traditional methods. Threshing & winnowing capacity is 600 kg/hr dry crops. Three small scale units in Orissa have taken manufacturing and marketing license of this machine. Government of Orissa has declared subsidy for mitigation of this machine among farmers in the state of Orissa.

Transfer of Technologies in oils and spices (Agroprocesing)

RRL-Trivandrum has transferred the following technologies in oils and spices (Agroprocessing) area

- Processing of Fresh Ginger to make Ginger oil/Ginger Powder (4 parties)

- Red Palmolein (50 TPD) and Zero Trans shortening (3 parties)
- Technology on Refining of Rice Bran Oil of 50 TPD (5 parties)

These are being commercialized through project engineering companies.

The technology on processing of fresh ginger to make ginger oil/powder has competitive advantages in that fresh ginger is being processed as compared to dried ginger in the existing technology. This novel process has generated interest among industrialists and entrepreneurs, which has helped in the technology transfer. Also the product profile has marketing advantages on account of the aroma quality.
The red palmolein technology aims at using palm oil high in beta-carotene, which can act as Vitamin-A supplement. Moreover, the zero trans-shortening products obtained by the process have an emerging market in the country.

The technology on refining rice bran oil is based on a novel refining process as compared to the current technology and has technologically commercial attractiveness through the better product profile. India has a potential of 1.5 million metric tones (MMT) rice bran oil per annum and only less than 10% of it is exploited for edible use for want of economical industrial process. Rice bran oil being rich in bio-active micronutrients (oryzanol, tocols, sterols, squalene etc.) is considered most healthy edible oil. A novel process for simultaneous degumming and dewaxing was developed to reduce the phosphatide content to less than 5 ppm, a critical parameter for physical refining of rice bran for the first time. The technology was transferred to 5 industries for commercial production.

3.11 Human Resource Development

CSIR strives to promote and foster the upgradation of the stock of qualified, highly specialised scientists/engineers and technologists in R&D in all disciplines of S&T in the country. For that an integrated approach has been developed for the national human resource development for S&T by encouraging and promoting research in the universities and institutions of higher learning. 179 new proposals, out of 576 received, were recommended and 543 proposals were renewed during the year. It also supports organisations to hold symposia/seminars and conferences for promotion of scientific temper. 468 proposals were supported for scientific societies/ institutes etc. for organizing national/ international conferences/ symposia/ etc. CSIR supported 380 young researchers in form of travel grant for presenting research papers at International conferences abroad. In addition CSIR tries to reinstate the interest of science amongst youngsters through various programmes and activities.

To achieve this CSIR is running various programmes to promote science. Significant ones are Enterpreunership support to research scholars, Fellowship in trans-disciplinary areas, and CSIR Programme on youth for leadership in science. Around 1000 students have participated in the two open days programme organized by most of the CSIR laboratories. CSIR also supports selective NET qualified research fellows in the form of Shyama Prasad Mukherjee Fellowship. The selection is based on written examination followed by interview of NET qualified scholars. Six candidates were selected for the fellowship, two each in Physics & Chemistry and one each in Life Sciences & Mathematics during this year. CSIR has supported around 650 candidates through Senior Research Fellowship, Extended Senior Research

Fellowship, Associateship and Extended Research Associateship**.**

CSIR Diamond Jubilee Research Interns Award Scheme.

A new scheme- CSIR Diamond Jubilee Research Interns Award Scheme has been launched by CSIR. It is a preparative scheme through which young interns shall be trained in the tools, techniques and art of research under the supervision of experienced scientists in CSIR. The scheme has taken off and some of the labs have already taken interns. Amongst the 17 labs including Headquarters, which responded to our query, a total of 102 candidates have joined in 8 laboratories.

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