

Chapter 4

Analysis of Chemical Sciences Group Laboratories

4.0 List of laboratories under the Chemical Sciences Group

1. Central Electro Chemical Research Institute, Karaikudi
2. Central Salt and Marine Chemicals Research Institute, Bhavnagar
3. Central Leather Research Institute, Chennai
4. Indian Institute of Chemical Technology, Hyderabad
5. Indian Institute of Petroleum, Dehradun
6. National Chemical Laboratory, Pune
7. Regional Research Laboratory, Jorhat

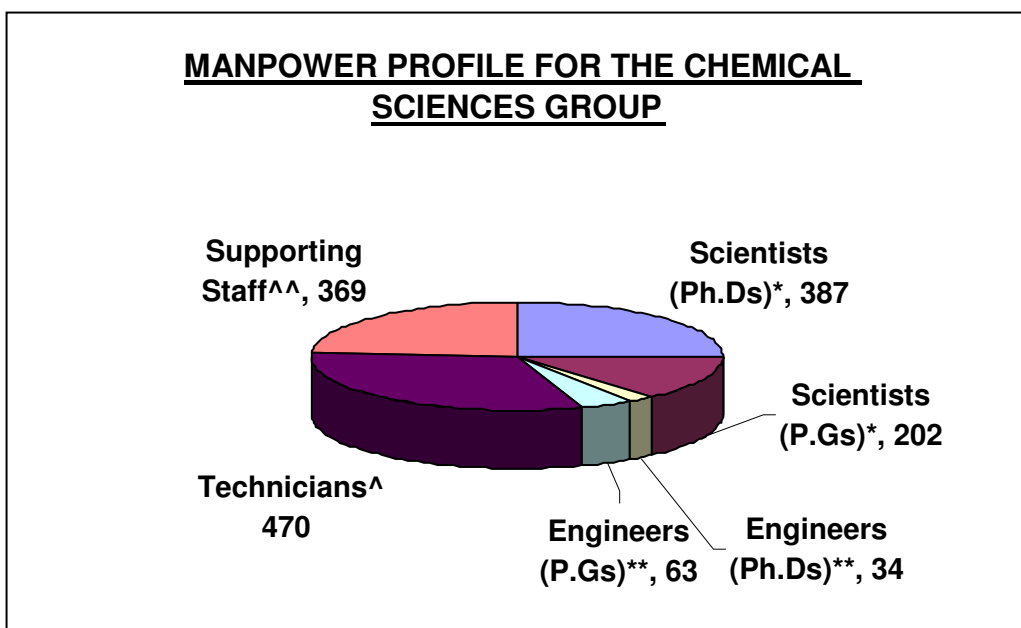
4.1 Overall Analysis of Chemical Sciences Group

4.1.1 Manpower Profile

The seven institutes categorized in the chemical sciences group cover varied areas of research in the area of chemical technology with specialized institutes in the areas of electro chemicals, salt and marine chemicals, petroleum, leather etc..

The Figure 4-1 below represents the manpower profile in terms of scientists, engineers, technicians and supporting staff of the chemical sciences group as a whole (data as received from all the individual institutes except NCL):

Figure 4-1



* The figure for the number of scientist with Ph. D. and P.G. qualifications does not include that of CLRI and NCL.

** The figure for the number of engineers with Ph. D. and P.G. qualifications does not include that of CLRI, CECRI and NCL.

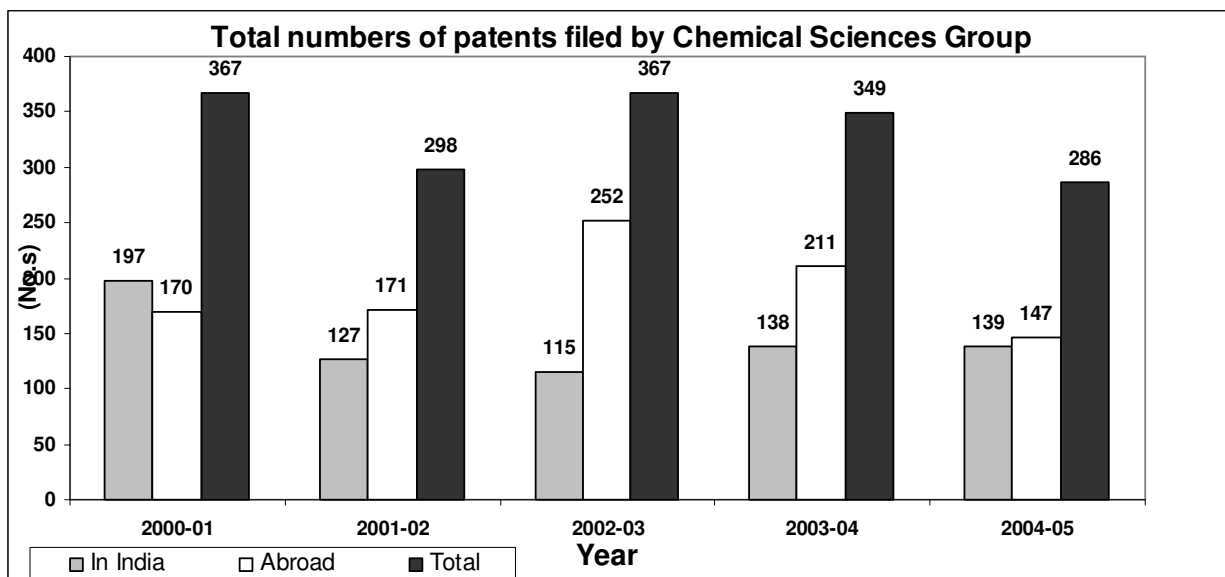
[^]The figure for the number of technicians does not include those for CLRI, CECRI and NCL.

^{^^}The figure for the number of Supporting staff does not include those for CLRI, IICT, CECRI and NCL.

4.1.2 Patents

The figure 4-2 below gives the total number of patents applied for and granted to the chemical sciences group as a whole for the period 2000-1 to 2004-05

Figure 4-2

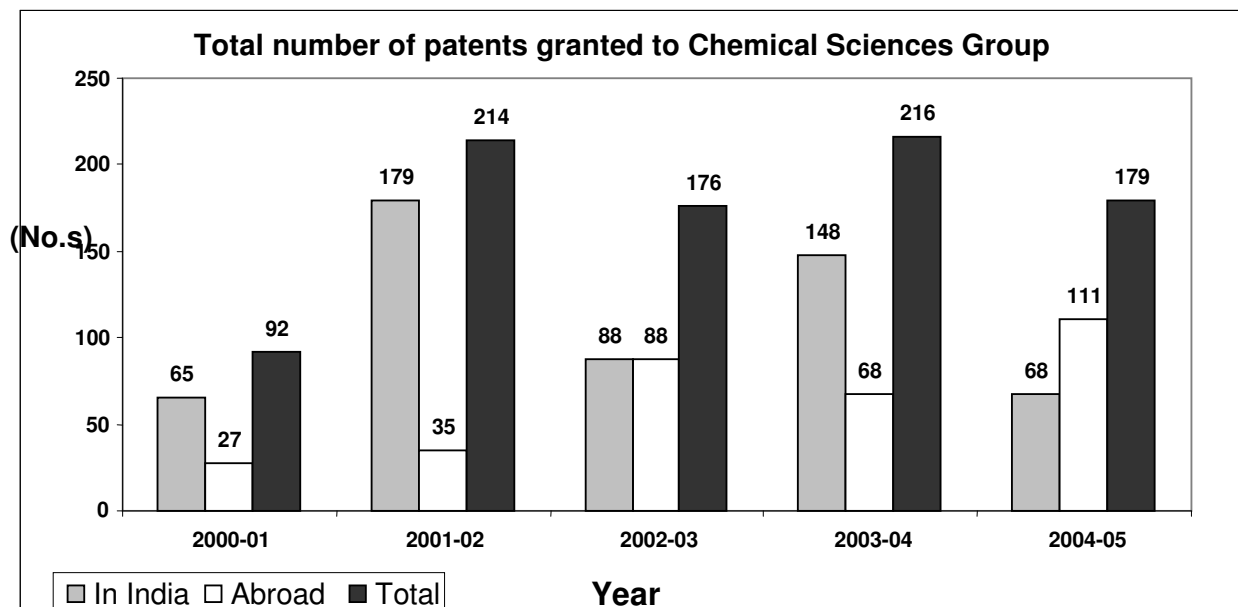


It may be seen that the Chemical sciences group filed maximum numbers of patents (in India & abroad) numbering 367 in the years 2000-01 and 2002-03. There is a steep fall in the number of patents filed in the year 2001-02. However after the year 2002-03 it is seen that the number of patents filed by the chemical sciences group are gradually decreasing.

Among the laboratories under the Chemical sciences group NCL has filed the maximum number of patents numbering 583 about 35% of the total of Chemical group, during the period 2000-01 to 2004-05 followed by IICT with 571 and CSMCRI with 193. The minimum number of patents has been filed by RRL (JT) numbering 54.

Figure 4-3 represents the total number of patents (in India and abroad) granted year wise to Chemical sciences group from the year 2000-01 to 2004-05.

Figure 4-3



The laboratories wise details of the patents filed in India and abroad are given below in table 4-1

Table 4-1
Patents filed by Chemical group of laboratories in India and abroad

| Year → Labs ↓ | 2000-01 | | 2001-02 | | 2002-03 | | 2003-04 | | 2004-05 | | Total | |
|------------------|---------|----|---------|----|---------|-----|---------|-----|---------|----|-------|-----|
| | I | A | I | A | I | A | I | A | I | A | I | A |
| CECRI | 13 | 3 | 9 | 2 | 11 | 15 | 12 | 1 | 10 | 5 | 55 | 26 |
| CLRI | 14 | 10 | 10 | - | 8 | 13 | 20 | 12 | 8 | 17 | 60 | 52 |
| CSMCRI | 6 | 5 | 4 | 30 | 7 | 38 | 15 | 24 | 19 | 45 | 51 | 142 |
| IICT | 40 | 72 | 44 | 92 | 46 | 139 | 17 | 60 | 26 | 35 | 173 | 398 |
| IIP | 12 | 16 | 9 | - | 8 | 6 | 11 | 2 | 6 | 3 | 46 | 27 |
| NCL | 92 | 63 | 43 | 43 | 27 | 41 | 59 | 112 | 61 | 42 | 282 | 301 |
| RRL(JT) | 20 | 1 | 8 | 4 | 8 | - | 4 | - | 9 | - | 49 | 5 |

I – India

A – Abroad

Source: CSIR

The laboratories wise details of the patents granted to India and abroad are given below in table 4-2

Table 4-2
Patents granted to Chemical group of laboratories in India and abroad

| Year → Labs ↓ | 2000-01 | | 2001-02 | | 2002-03 | | 2003-04 | | 2004-05 | | Total | |
|------------------|---------|----|---------|----|---------|----|---------|----|---------|----|-------|-----|
| | I | A | I | A | I | A | I | A | I | A | I | A |
| CECRI | 8 | 2 | 34 | - | 8 | 1 | 16 | - | - | 2 | 66 | 5 |
| CLRI | 3 | - | 5 | 2 | 4 | 6 | 7 | 3 | 3 | 4 | 22 | 15 |
| CSMCRI | 1 | - | 1 | - | 1 | 1 | 4 | 2 | 4 | 13 | 11 | 16 |
| IICT | 11 | 4 | 21 | 17 | 10 | 32 | 24 | 41 | 15 | 48 | 81 | 142 |
| IIP | 1 | 1 | 7 | - | 9 | 1 | 20 | 3 | 7 | 11 | 44 | 16 |
| NCL | 32 | 16 | 90 | 16 | 48 | 46 | 53 | 19 | 35 | 32 | 258 | 129 |
| RRL(JT) | 9 | 4 | 21 | - | 8 | 1 | 24 | - | 4 | 1 | 66 | 6 |

I – India

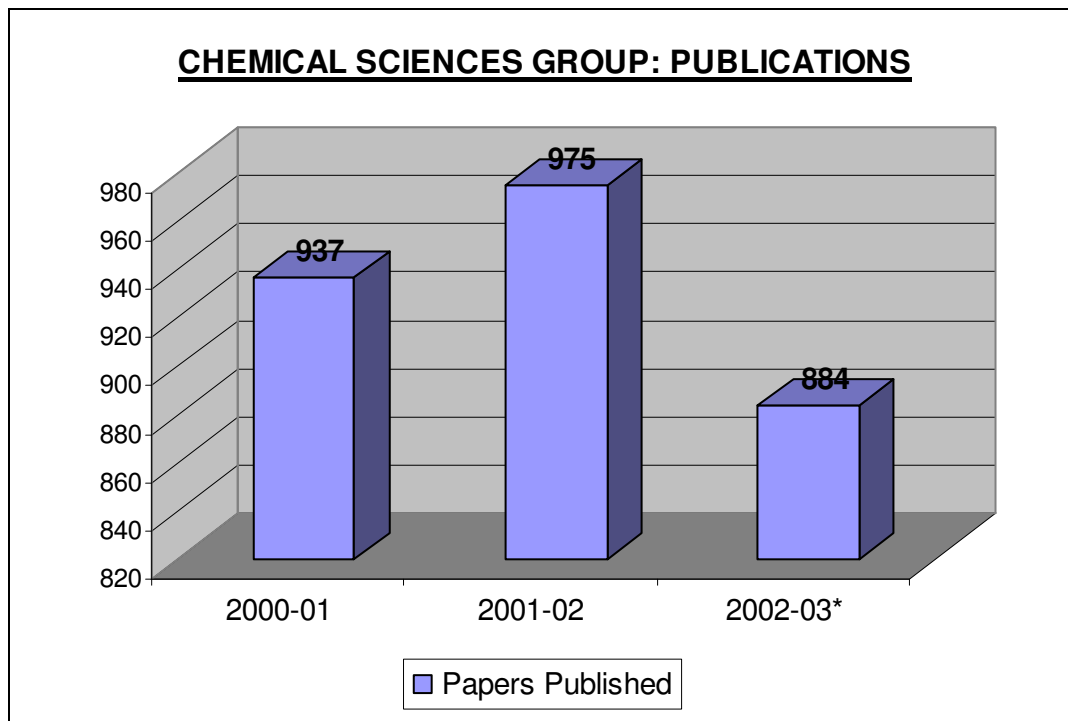
A – Abroad

Source: CSIR

4.1.3 Papers Published

The following Figure 4-4 represents the total number of papers published, for the chemical sciences group as a whole for 2000-01 to 2002-03 (data not received from CECRI):

Figure 4-4



* The figure for the number of papers published in the year 2002 – 03 does not include that for NCL and CLRI.

Although a slight increase in the number of publications from the Chemical Sciences group is seen from 2000-01 to 2001-02 by 0.4%, there is a decline in the number of publications in the year 2002-03. This decline is by 5.6% from the year 2000-01 and by 9% from the year 2001-02.

4.1.4 Areas of Core Competencies and Exportable R&D Services of the Chemical Sciences Group Laboratories are given in table 4-3

Table 4-3

| CHEMICAL SCIENCES | | | |
|--------------------------|---|---|--|
| S. No. | Name of laboratory | Area of Core Competency | Exportable R&D Services |
| 1. | Central Electro Chemical Research Institute | 1. Corrosion Science and Engineering | 1. Consultancy, sponsored (contract) projects and technical services in corrosion, electrochemical power sources, metal finishing, metallurgy, electroducts and electro catalysis. 2. Consultancy is pollution control in electrochemical process 3. Process Know how for electrochemical and electro-chemical materials 4. Training programmes and academic courses in electrochemical sciences and corrosion engineering |
| | | 2. Electrochemical Power Sources | |
| | | 3. Metal Finishing | |
| | | 4. Metallurgy | |
| | | 5. Electroducts and Electro catalysis | |
| | | 6. Electrochemical material science | |
| | | 7. Pollution control | |
| | | 8. Electro chemicals | |
| 2. | Central Salt & Marine Chemicals Research Institute | 1. Salt and marine chemicals | 1. Design and layout of solar salt works 2. Design installation and commissioning of salt washery and refinery 3. Process know how for marine chemicals such as bromine, potash and magnesia 4. Process know how for speciality inorganic chemicals such as precipitated silica and calcium carbonate, calcium silicate, organo clay, zeolite etc. 5. Process know how for sea weed cultivation (gelidiella, gracilaria, eucheuma), algal chemicals such as agar agar, sodium alginate, bacteriological agar, kappa-carrageenan, liquid sea weed fertilizer etc. |
| | | 2. Specialty inorganic chemicals and catalysis | |
| | | 3. Analytical sciences in the areas of salt and marine chemicals | |
| | | 4. Membrane science and technology | |
| | | 5. Sea-weeds (cultivation and products) chemicals | |
| | | 6. Desert economic and halophytic plants (waste land development) | |
| | | 7. Process design, engineering in the areas of salt and | |

| | | | |
|----|---|--|--|
| | | marine chemicals | <p>6. Process know how for cultivation of salt tolerant plants, plantation in wasteland such as jatropha, salicornia, jojoba and value addition such as herbal salt</p> <p>7. Process know how for desalination of brackish and seawater by membrane processes, RO for water treatment (sewage water)</p> <p>8. Process know how for ion-exchange resins for removal of arsenic and fluoride from contaminated water.</p> <p>9. Environment audit and environment impact assessment studies.</p> <p>10. Know how for solar Stills (for distilled water and also for drinking water in very remote areas)</p> |
| 3. | Central Leather Research Institute | <p>1. Leather process technology</p> <p>2. Leather chemicals and auxiliaries</p> <p>3. Products: leather technology</p> <p>4. Environmental technologies for leather</p> <p>5. Biological sciences for leather</p> <p>6. Engineering area for leather</p> <p>7. Nuclear magnetic resonance: leather technology</p> | <p>15. Training – leather and allied area</p> <p>16. Testing and evaluation –material testing, chemical analysis, testing for eco-testing, physical testing.</p> <p>17. Consultancy and technical services for leather processing, shoe design, and construction, leather apparels/ accessories development, environmental technology, Industrial safety and Risk assessment, chemical</p> |

| | | | |
|----|---|--|---|
| | | 8. Human resource development: leather technology | <p>engineering, leather economics</p> <p>18. Surveys and epidemiological studies– techno – economic surveys in the leather field.</p> <p>19. Technology transfer in leather technology.</p> <p>20. Turn key projects in leather technology</p> <p>7. Contract / sponsored research in the areas of leather technology</p> |
| 4. | Indian Institute of Chemical Technology | <p>1. Organic chemistry</p> <p>2. Natural product chemistry</p> <p>3. Nano technology</p> <p>4. Catalysis</p> <p>5. Lipid chemistry</p> <p>6. Novel drug delivery systems</p> <p>7. Process design & engineering</p> | <p>5. 1. Basic research work in the area of chemical technology</p> <p>7. 2. Process development in the area of chemical technology</p> <p>3. 3. Product development in the area of chemical technology</p> <p>9. 4. Process up gradation in the area of chemical technology</p> |
| | | | <p>30. Alternate process pathways in the area of chemical technology</p> <p>31. Technology transfer in the area of chemical technology</p> <p>32. Analytical services in the area of chemical technology</p> <p>8. Evaluation and characterization in the area of chemical technology</p> |
| 5. | Indian Institute of Petroleum Technology | <p>1. Refining technology</p> <p>2. Conversion process in petroleum technology</p> | <p>1. Evaluation of crude oils</p> <p>2. Evaluation (Pilot / lab scale) of catalysts for petroleum refinery</p> |

| | | | |
|----|-------------------------------------|--|---|
| | | 3. Chemical and biotechnology | <p>processes</p> <p>3. Analytical services for petroleum industry</p> <p>4. Performance evaluation of fuels, lubes, additives on IC engines including field trials</p> <p>5. Technology forecasting and assessment in the area of petroleum technology</p> <p>6. Assistance in technology selection and process know how in the area of petroleum technology</p> <p>7. Preparation of project profiles / reports in the area of petroleum technology</p> <p>33. Techno – economic feasibility studies in the area of petroleum technology</p> <p>34. Process improvement and revamping in the area of petroleum technology</p> <p>35. Process design and scale up in the area of petroleum technology</p> |
| | | 4. Analytical sciences in petroleum technology | |
| | | 5. Petroleum products application | |
| | | | |
| | | | <p>36. Training of personnel in the area of petroleum technology</p> <p>37. Information sourcing and services in the area of petroleum technology</p> <p>38. Process simulation and modelling in the area of petroleum technology</p> <p>14. Process integration and APC in the area of petroleum technology</p> <p>15. Problem identification and solution in the area of petroleum technology</p> |
| 6. | National Chemical Laboratory | 1. Catalysis | <p>1. Contract Research in chemical sciences</p> <p>2. Process development and consultancy</p> |
| | | 2. Biochemical science | |
| | | 3. Organic chemistry | |

| | | | |
|----|---|-------------------------------------|--|
| | | 4. Polymer science and engineering | services in chemical sciences |
| | | 5. Physical and materials chemistry | 3. Technical services in chemical sciences |
| | | 6. Chemical engineering science | 4. Testing and analysis in chemical sciences |
| 7. | Regional Research Laboratory, Jorhat | 1. Agrotechnology | 1. Expert services in survey and scientific analysis of natural products based on medicinal and aromatic plant |
| | | 2. Biotechnology / bioscience | 2. Seismic surveillance with high efficiency as part of international studies |
| | | 3. Environmental science | 3. Survey and utilization of valuable minerals |
| | | 4. Geoscience | 4. Testing / analysis of building materials minerals, petroleum products, food products, water and soil |
| | | 5. Engineering science | 5. Process development and consultancy service in chemical sciences |
| | | 6. Chemical science | |

4.2 Analysis of Individual Laboratories under the Biological Sciences Group

4.2.1 Central Electro Chemical Research Institute

Central Electrochemical Research Institute was founded on 25th July 1948 at Karaikudi in Tamilnadu, and it came into existence on the January 1953. During the last fifty years CECRI has been recognised as the premier institution for R&D in the field of electrochemical science and technology not only in India but also in the south east asia, with a total strength of over 600 personnel comprising scientists, engineers, technologists, skilled workers, administrative and other staff, with a combined laboratory space of 4, 00,000 sq.ft. in a campus of 300 acres. There are four extension centers of CECRI located at Chennai, Cochin, Mandapam and Tuticorin.

Major R&D programs at CECRI are in the areas of corrosion science and engineering industrial metal finishing, batteries (primary and secondary), electro-metallurgy, electropyrrometallurgy, electro chemicals (organic and inorganic), materials science, electrochemical instrumentation & pollution control. The programmes are directed towards development of new processes of products or novel use of electrochemistry. techniques, upgradation of the already developed technology and basic research. An excellent library, computer center, workshop, centralised characterisation and measurement laboratory lend active support to the research activities of the institute.

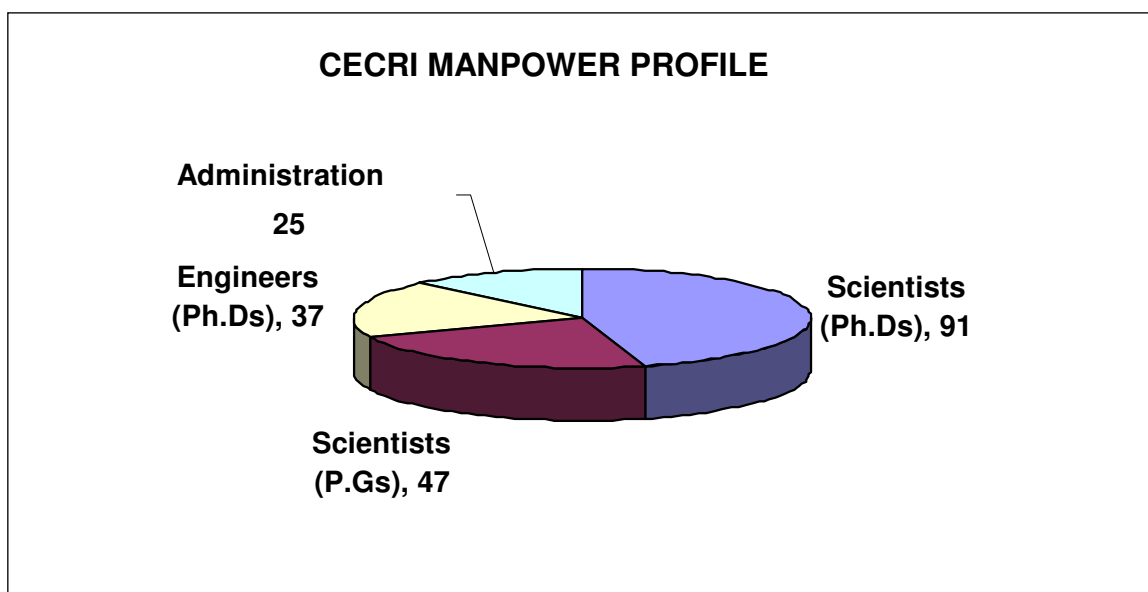
Over the years, 680 patents have been filed, 190 processes developed and 140 sponsored projects and 110 grant-in-aid projects have been undertaken. More than 140 processes have been released to 375 licensees for commercial exploitation. The institute staff has published more than 4000 research papers including several review articles in both national and international journals of repute, edited several books and conference proceedings and maintain intimate contacts with the academic institutions within and outside the country. Recognition of contribution made by CECRI to Indian industry has come in the form of 50 major and minor awards. Direct earnings by the way of foreign exchange savings and energy efficient electrochemical technologies including corrosion prevention amount to about Rs.500 crores.

CECRI also conducts short term refresher courses for the benefit of industry and educational institutions, brings out journals (Bulletin of Electrochemical Sciences, Corrosion Update and Battery News Letter) and runs a B.Tech. programme (Chemical and Electrochemical Engineering of Madurai Kamaraj University). The institute is alive to the societal obligations and actively participates in the Rural Science Forum , Science and Technology Entrepreneurship Development (STED), and Swadeshi Science Movement (SSM) and Ambedkar Nagar in collaboration with other agencies.

4.2.1.2 Manpower Profile

The following figure 4-5 depicts the manpower profile of CECRI:

Figure 4-5



4.2.1.3 Areas of Core Competency

The following have been identified by CECRI as their areas of core competency:

1. Corrosion science and engineering
2. Electrochemical power sources
3. Metal finishing
4. Metallurgy
5. Electrodeics and electrocatalysis
6. Electrochemical material science
7. Pollution control
8. Electrochemicals

The following table 4-4 depicts the available manpower in each one of these areas of core competency:

Table 4-4

| S.No. | Area of Core Competence | Manpower |
|--------------|-----------------------------------|-----------------|
| 1. | Corrosion science and engineering | 50 |
| 2. | Electrochemical power sources | 36 |
| 3. | Metal finishing | 22 |
| 4. | Metallurgy | 31 |
| 5. | Electrodics and electrocatalysis | 19 |
| 6. | Electrochemical material science | 11 |
| 7. | Pollution control | 6 |
| 8. | Electrochemicals | 32 |

4.2.1.4 Major R&D Facilities

The following R&D facilities support the above areas of competency:

1. Battery testing facility
2. Corrosion testing facility
3. Characterization and measurement facility

Offshore platform and marine electrochemistry center (OPMEC) at tuticorin for marine corrosion studies

4.2.1.5 Patents

The table 4-5 given below indicates the patents applied for and granted to CECRI in India and abroad during the period 2000-01 to 2004-05

Table 4-5

Patents filed by & granted to CECRI during 2000-01 to 2004-05

| Year | Patents Filed | | Patents Granted | |
|----------------|----------------------|---------------|------------------------|---------------|
| | In India | Abroad | In India | Abroad |
| 2000-01 | 13 | 3 | 8 | 2 |
| 2001-02 | 9 | 2 | 34 | Nil |
| 2002-03 | 11 | 15 | 8 | 1 |
| 2003-04 | 12 | 1 | 16 | Nil |
| 2004-05 | 10 | 5 | Nil | 2 |
| Total | 55 | 26 | 66 | 5 |

4.2.1.6 Potential Exportable R&D Services

CECRI has identified the following as their potential exportable R&D services:

1. Consultancy, sponsored (contract) projects and technical services in corrosion, electrochemical power sources, metal finishing, metallurgy, electrochemicals and electrocatalysis.
2. Consultancy in pollution control in electrochemical process
3. Process Know how for electrochemical and electro-chemical materials
4. Training programmes and academic courses in electrochemical sciences and corrosion engineering

4.2.1.7 Target Markets

The following target markets have been identified for the above services:

1. Chemical industries
2. Battery industries
3. Construction industries
4. Plating industries
5. Industries involved in metal recovery
6. Paint industries

4.2.1.8 Constraints and Suggestions

CECRI highlighted the lack of resources as the constraint that they faced in the export of R&D services. It was suggested that *more allocation of funds and liberalized regulations* can help to overcome these constraints for enhancing exports of R&D Services.

4.2.2 Central Salt and Marine Chemicals Research Institute

Central Salt Research Institute (now known as Central Salt & Marine Chemicals Research Institute) was inaugurated by Late Pandit Jawaharlal Nehru, the First Prime Minister of India on 10th April, 1954, as a constituent Council of Scientific and Industrial Research, New Delhi.

The research and development activities of the institute revolve around three areas where noteworthy targets have been projected:

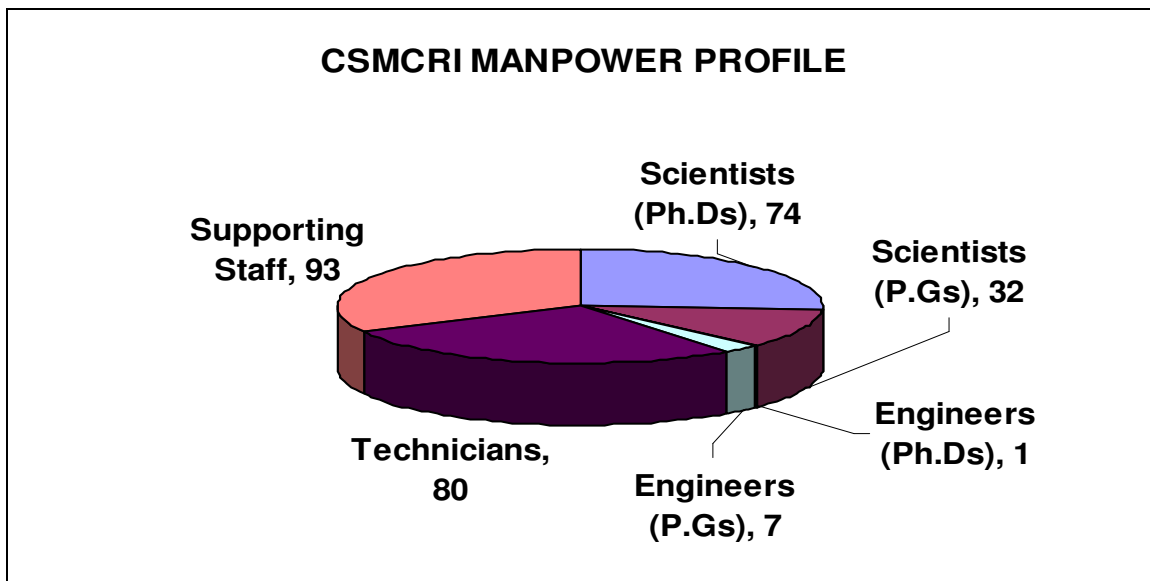
1. Inorganic chemicals, catalysis and new materials
2. Membrane science and separation technology.
3. Biosalinity

The mission of the institute and its people is to work in partnership with visionary sponsors and collaborators to generate the knowledge and innovations required for efficient utilization of indian coastal wasteland, sea water, marine algae, solar power and silicates. The institute also harnesses its capabilities in biosciences, chemical transformation, process engineering, environmental monitoring, separation science and analysis to address focused needs of industries and organizations in the region and beyond.

4.2.2.1 Manpower Profile

The following figure 4-6 depicts the manpower profile of CSMCRI:

Figure 4-6



4.2.2.2 Areas of Core Competency

The following have been identified by CSMCRI as their areas of core competency:

1. Salt and marine chemicals
2. Specialty inorganic chemicals and catalysis
3. Analytical sciences
4. Membrane science and technology
5. Sea-weeds (cultivation and products) chemicals
6. Desert economic and halophytic plants (waste land development)
7. Process design, engineering

The following table 4-6 depicts the available manpower in each one of these areas of core competency:

Table 4-6

| S.No. | Area of Core Competence | Manpower |
|--------------|--|-----------------|
| 1. | Salt and marine chemicals | 50 |
| 2. | Specialty inorganic chemicals and catalysis | 36 |
| 3. | Analytical sciences | 22 |
| 4. | Membrane science and technology | 31 |
| 5. | Sea-weeds (cultivation and products) chemicals | 19 |
| 6. | Desert economic & halophytic plants (waste land development) | 11 |
| 7. | Process design, engineering | 6 |

4.2.2.3 Major R&D Facilities

The following R&D facilities support the above areas of competency:

1. X'pert MPD powder X-Ray diffractometer with dual gonio meter having environmental chamber
2. Spectrum Gx, FT-IR system
3. Series II CHN S/O analyser 2400
4. Master sizer 2000, particle size analyser
5. ASAP 2010, BET surface area analyser
6. High pressure liquid chromatography (H.P.L.C.)
7. Digital NMR, Avance DPX 200
8. Scanning electro microscope(SEM / EDX), LEO – 1430 VP
9. Smart Apex – single crystal X-ray diffractometer
10. XRF Bruker AXs – XRF spectrometer – S4 Pioneer
11. Inductively coupled plasma (ICP) optical emission spectrometer, Optima 2000 DV
12. Thermal analysis
 - a. Thermo gravimetric analyser (TGA/SDTA/851^e)
 - b. Differential scanning calorimeter (DSC-822^e)
 - c. Dynamic mechanical analyser (DMA 861^e)
13. AAS atomic adsorption
14. UV/Visible/Near IR
15. Pilot plant facility

16. Library

17. Workshop

18. Glass blowing

4.2.2.4 Patents

The following table 4-7 gives the details of the number of patents filed by CSCMRI during 2000-01 to 2004-05:

Table 4-7

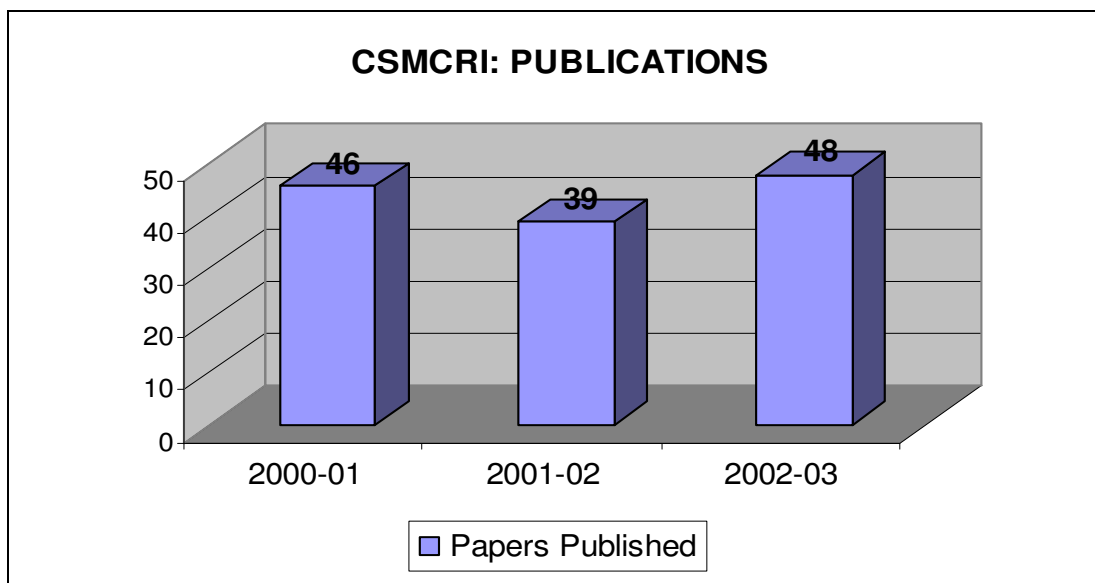
Patents filed by & granted to CSCMRI during 2000-01 to 2004-05

| Year | Patents Filed | | Patents Granted | |
|----------------|---------------|------------|-----------------|-----------|
| | In India | Abroad | In India | Abroad |
| 2000-01 | 6 | 5 | 1 | Nil |
| 2001-02 | 4 | 30 | 1 | Nil |
| 2002-03 | 7 | 38 | 1 | 1 |
| 2003-04 | 15 | 24 | 4 | 2 |
| 2004-05 | 19 | 45 | 4 | 13 |
| Total | 51 | 142 | 11 | 16 |

4.2.2.5 Papers

The following figure 4-7 gives the details of the number of papers published by CSCMRI during 2001 and 2003:

Figure 4-7



(For details about the publications of CSCMRI, refer to the website www.csmcri.org)

4.2.2.6 Potential Exportable R&D Services

CSMCRI has identified the following as their potential exportable R&D services:

9. Design and layout of solar salt works
10. Design installation and commissioning of salt washery and refinery
11. Process know how for marine chemicals such as bromine, potash and magnesia
12. Process know how for speciality inorganic chemicals such as precipitated silica and calcium carbonate, calcium silicate, organo clay, zeolite etc.
13. Process know how for sea weed cultivation (gelidiella, gracilaria, eucheuma), algal chemicals such as agar agar, sodium alginate, bacteriological agar, kappa-carrageenan, liquid sea weed fertilizer etc.
14. Process know how for cultivation of salt tolerant plants, plantation in wasteland such as jatropha, salicornia, jojoba and value addition such as herbal salt
15. Process know how for desalination of brackish and seawater by membrane processes, RO for water treatment (sewage water)
16. Process know how for ion-exchange resins for removal of arsenic and fluoride from contaminated water.
9. Environment audit and environment impact assessment studies.
10. Know how for solar Stills (for distilled water and also for drinking water in very remote areas)

4.2.2.7 Target Markets

The following target markets have been identified for the above services:

1. Developing countries
2. Tropical countries having coast line and waste land
3. Countries having scarce inland water resources

4.2.2.8 Constraints and Suggestions

CSMCRI highlighted the lack of market information, bureaucratic bottlenecks, International regulations, and Inferior quality of services as compared to competitors as the constraints that they faced in the export of R&D services.

4.2.3 Central Leather Research Institute

Central Leather Research Institute, the world's largest leather research institute was founded on 24 April, 1948. It was a land mark decision of the country born at the mid night of 15 August 1947, to invest into leather research. In 1947, there remained an untapped opportunity for India in leather sector for economic development, employment generation and export earnings. The missing link was addition of technology to the manufacturing base of Indian leather sector. CLRI was founded to develop an internal strength in the country to generate, assimilate and innovate technologies for leather sector.

CLRI in 1948, made an initiative with foresight to link technology system with both academy and industry. CLRI assumed the role of being a part of the University of Madras in imparting education in leather technology. CLRI, today, is a central hub in Indian leather sector with direct roles in education, research, training, testing, designing, forecasting, planning, social empowerment and leading in science and technology relating to leather.

CLRI is vying to emerge a global leader in leather research. The technological services of the institute are as durable as leather. Leather and allied research in CLRI form core areas of activities. There is critical strength for research and development in some critical areas of sciences and technology. Research in CLRI includes non-leather as well.

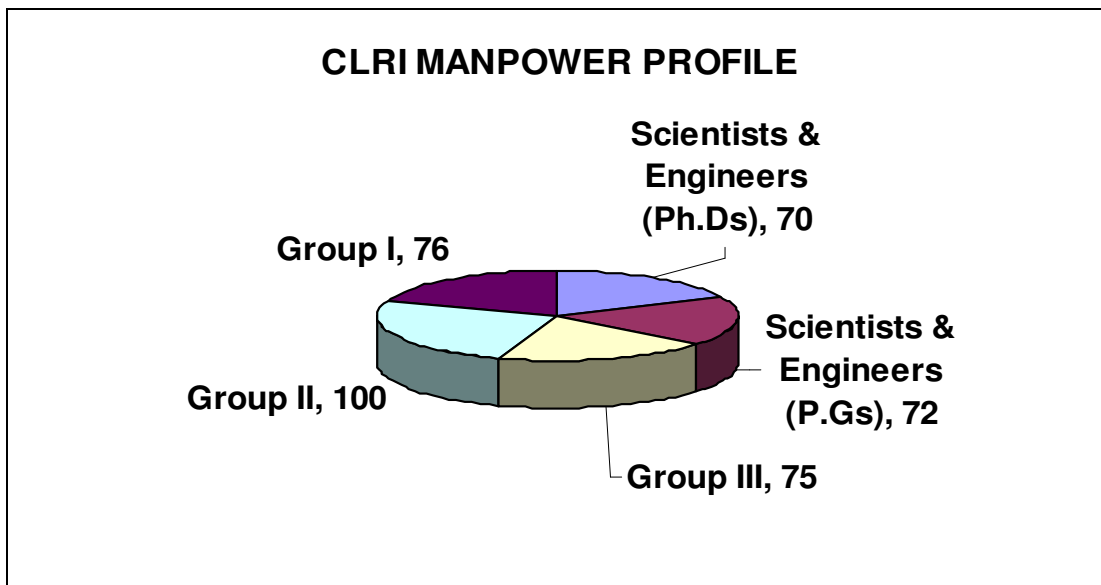
With a mismatched demand-supply gap for hides and skins, leather and non-leather have come to coexist and complement. CLRI strives to marry leather to its diverse functions. CLRI plays today a supermarket for leather related technologies. The strength of CLRI stems from the competence of the people, R&D infrastructure, linkages with the users. The mandate of CLRI is to seek excellence in research in frontier areas, to serve the national apex body in leather, to participate in HRD through direct role in education and training in leather related areas, to assess and forecast technology needs in the areas of leather technology, to serve as a reliable consultant to leather sector, to develop technologies and deliver to the industry through effective extension

network, to serve as a dependable source of technologies and to provide a technology supermarket for users .

4.2.3.1 Manpower Profile

The following figure 4-8 depicts the manpower profile of CLRI:

Figure 4-8



4.2.3.2 Areas of Core Competency

The following have been identified by CLRI as their areas of core competency:

1. Leather process technology
2. Leather chemicals and auxiliaries
3. Products: leather technology
4. Environmental technologies for leather
5. Biological sciences for leather
6. Engineering area for leather
7. Nuclear magnetic resonance: leather technology
8. Human resource development: leather technology

The following table 4-8 depicts the available manpower in each one of these areas of core competency:

Table 4-8

| S.No. | Area of Core Competence | Manpower |
|--------------|---------------------------------|-----------------|
| 1. | Leather process technology | 45 |
| 2. | Leather chemicals & auxiliaries | 44 |
| 3. | Products | 36 |
| 4. | Environmental technology | 20 |
| 5. | Biological sciences | 33 |
| 6. | Engineering area | 45 |
| 7. | Nuclear magnetic resonance | 03 |
| 8. | Human resource development | 10 |

4.2.3.3 Major R&D Facilities

The following R&D facilities support the above areas of competency:

1. Leather process technology – state-of-art R&D equipments and pilot tannery for processing raw hides / skins to make finished leather. Certification of leather forms the major area of competency.

2. Leather chemicals and auxiliaries - State-of-art R&D equipments for developing polymer, mineral based products, plant based products, which find multidimensional industrial application. The area is also equipped with pilot plant for necessary scaling up of R&D products. Analytical laboratory is an excellent facility in this area. Core competency in eco-testing is a major feature.

3. Products - state-of-art facilities along with pilot plant for developing footwear, leather goods, garments and other products. Fashion studio helps in creating conceptual designs. The area is also equipped with CAD / CAM facility. Fashion forecasting for global trend is a core competency in this area. Physical testing laboratory of international standard is a major facility in this area.

4. Environmental technologies and waste water / effluent treatment – the area is equipped with modern equipments and R&D facilities for environment related activities relating to EIA, waste utilization, water purification, effluent reduction.
5. Biological sciences – the area encompasses research in biomaterials, biophysics, biochemistry, biotechnology, microbiology and bioproducts utilization. Modern equipments and facilities are available for the R&D.
6. Engineering area – this area encompasses competence in the area of Safety and Risk analysis for chemical plants, design engineering / techno economic feasibility studies in leather, chemicals and allied sector.
7. Nuclear magnetic resonance (NMR) - State-of-art R&D equipments and expertise form the major facility.
8. Human resource development – CLRI has been a recognized center for training for different target groups. It functions as the leather technology department of Anna University, Chennai conducting undergraduate, post graduate as well as Doctoral programmes. It also provides various industry oriented tailor made training programmes.

4.2.3.4 Patents

The following table 4-9 gives the details of the number of patents filed by and granted to CLRI during 2000 and 2003:

Table 4-9

Patents filed by & granted to CLRI during 2000-01 to 2004-05

| Year | Patents Filed | | Patents Granted | |
|----------------|---------------|-----------|-----------------|-----------|
| | In India | Abroad | In India | Abroad |
| 2000-01 | 14 | 10 | 3 | Nil |
| 2001-02 | 10 | Nil | 5 | 2 |
| 2002-03 | 8 | 13 | 4 | 6 |
| 2003-04 | 20 | 12 | 7 | 3 |
| 2004-05 | 8 | 17 | 3 | 4 |
| Total | 60 | 52 | 22 | 15 |

The following table 4-10 depicts the patents generated in each area of core competency during 2000 and 2003:

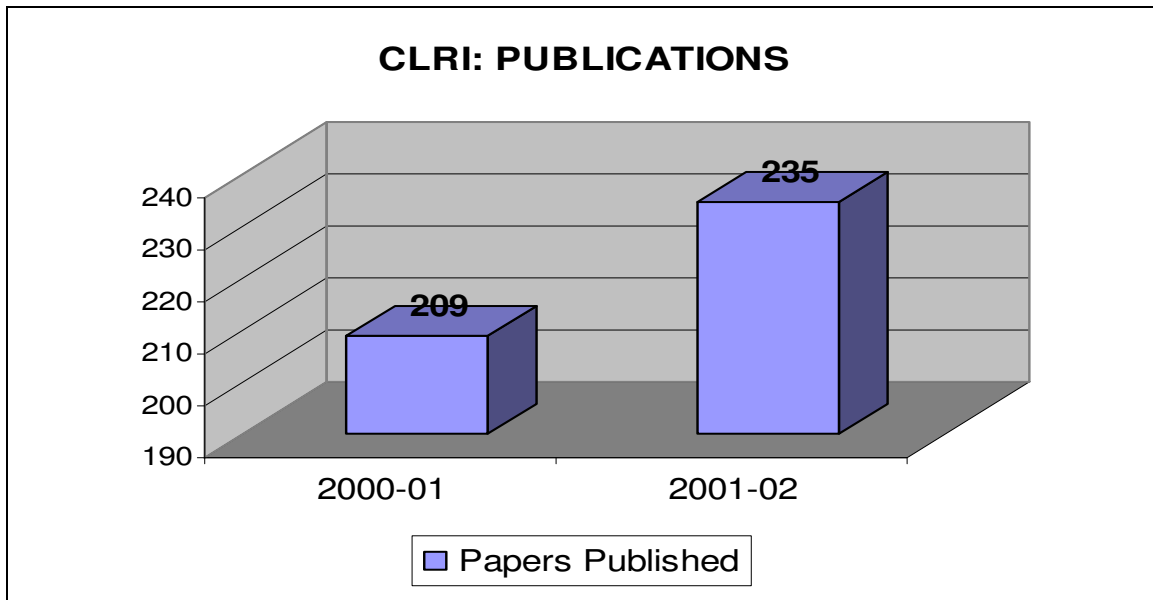
Table 4-10

| S.No. | Area of Core Competence | Patents |
|-------|---------------------------------|---------|
| 1. | Leather process technology | 06 |
| 2. | Leather chemicals & auxiliaries | 07 |
| 3. | Products | 02 |
| 4. | Environmental technology | 02 |
| 5. | Biological sciences | 11 |
| 6. | Engineering area including NMR | 05 |

4.2.3.5 Papers

The following figure 4-9 gives the details of the number of papers published by CLRI during 2000-01 and 2001-02.

Figure 4-9



(For details about the publications of CLRI, refer to the website www.clri.org)

4.2.3.6 Potential Exportable R&D Services

CLRI has identified the following as their potential exportable R&D services:

1. Training – since CLRI is the world's largest R&D institute in leather and allied area with core competence and expertise, enormous international market exists for this institute. Many training programmes in leather processing for African countries, Indonesia, Philippines, Nepal and Bangladesh have already been conducted.
2. Testing and evaluation – CLRI has facilities for material testing, chemical analysis, testing for eco-testing, physical testing as per international standards.
3. Consultancy and technical services for
 - a. Leather processing
 - b. Shoe design and construction

- c. Leather apparels/ accessories development
 - d. Environmental technology
 - e. Industrial safety and risk assessment
 - f. Chemical engineering
 - g. Leather economics
4. Surveys and epidemiological studies – CLRI can undertake techno – economic surveys in the leather field for international clients.
 5. Technology transfer – CLRI can offer its strong portfolio of technologies for transfer to international clients.
 6. Turn key projects – CLRI can offer this service to international clients depending on the specialization and the clients’ needs.
 7. Contract / sponsored research in the areas of leather technology

4.2.3.7 Target Markets

The following target markets have been identified for the above services:

1. Training – south east asian countries like China, Nepal, Sri Lanka, Bangladesh, Indonesia, Philippines, Maldives; african countries like Ethiopia, Nigeria, Sudan.
2. Testing and Evaluation - South east asian countries like China, Nepal, Sri Lanka, Bangladesh, Indonesia, Philippines, Maldives; african countries like Ethiopia, Nigeria, Sudan.
3. Consultancy - south east asian countries like China, Nepal, Sri Lanka, Bangladesh, Indonesia, Philippines, Maldives; african countries like Ethiopia, Nigeria, Sudan; european countries like Germany, France, the Netherlands.
4. Surveys and epidemiological studies - South east asian countries like China, Nepal, Sri Lanka, Bangladesh, Indonesia, Philippines, Maldives; African countries like Ethiopia, Nigeria, Sudan; european countries like Germany, France, the Netherlands.

5. Technology Transfer - south east asian countries like China, Nepal, Sri Lanka, Bangladesh, Indonesia, Philippines, Maldives; african countries like Ethiopia, Nigeria, Sudan; european countries like Germany, France, the Netherlands, UK, Italy, Austria, Switzerland.
6. Turn-key projects - south east asian countries like China, Nepal, Sri Lanka, Bangladesh, Indonesia, Philippines, Maldives; african countries like Ethiopia, Nigeria, Sudan.
7. Contract / sponsored research – Australia, south east asian countries like China, Nepal, Sri Lanka, Bangladesh, Indonesia, Philippines, Maldives; African countries like Ethiopia, Nigeria, Sudan; European countries like Germany, France, the Netherlands, UK, Italy, Austria, Switzerland.

4.2.3.8 Constraints and Suggestions

CLRI highlighted the lack of market information and lack of resources as the constraints that they faced in the export of R&D services. It was suggested that *proper efforts made to market technologies and technical services by a centralized nodal agency, who can provide information of segmentation and the existing demand in the respective segments along with strategic market research* can help to overcome these constraints for enhancing exports of R&D services.

4.2.4 Indian Institute of Chemical Technology, Hyderabad

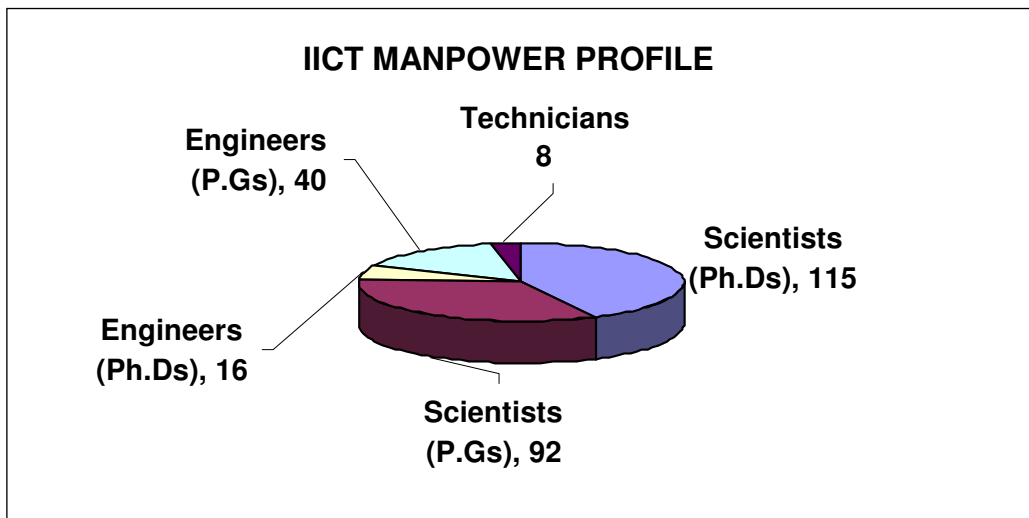
Indian Institute of Chemical Technology, Hyderabad is a premier R&D institute in India. The institute had its origin as the Central Laboratories for Scientific & Industrial Research (CLSIR), established in 1944 by the then Government of Hyderabad State. In 1956, the Central Laboratories came under the aegis of the Council of Scientific & Industrial Research (CSIR), New Delhi and was renamed Regional Research Laboratory, Hyderabad (RRL-H). The RRL-H was rechristened as the Indian Institute of Chemical Technology (IICT), Hyderabad in 1989, recognising the multidisciplinary activities and the expertise developed by the institute in the field of chemical technology. It has made significant contributions in the last six decades in that field and celebrating its Diamond Jubilee. Major areas of research at IICT are: natural products chemistry, agrochemicals, drugs & intermediates, speciality and fine chemicals, fluoroorganics, inorganic & physical chemistry (catalysis & material science), lipid sciences & technology, coal, gas & energy, chemical engineering and design & engineering.

IICT 's basic objectives have always been to carry out research in the chemical sciences leading to innovative processes for a variety of products necessary for human welfare such as food, health and energy and the conduct of R&D work is fully geared to meet the requirements of technology development, transfer and commercialisation. Process development work, particularly for bulk chemicals is carried out at appropriate pilot plant scale to collect techno-economic and design data. With the help of excellent design & engineering expertise available, the institute has been providing engineering designs for commercial plants with standard commercial guarantees. More than 150 technologies developed by IICT are now in commercial production. Its commitment to industry is reflected by way of several sponsored and consultancy projects received from the industry, year after year. With over 450 highly professional and dedicated scientists and technical officers/technicians, excellent laboratory and instrument facilities for research in chemical sciences and technology and allied sciences, IICT is known nationally as well as internationally for its contributions both in basic and applied research.

4.2.4.1 Manpower Profile

The following figure 4-10 depicts the manpower profile of IICT:

Figure 4-10



4.2.4.2 Areas of Competency

The following have been identified by IICT as their areas of core competency:

8. Organic chemistry
9. Natural product chemistry
10. Nano technology
11. Catalysis
12. Lipid chemistry
13. Novel drug delivery systems
14. Process design & engineering

The following table 4-11 depicts the available manpower in each one of these areas of core competency:

Table 4-11

| S.No | Area of Core Competence | Manpower |
|-------------|-------------------------------------|-----------------|
| 1. | Organic & natural product chemistry | 75 |
| 2.. | Nano technology | 37 |
| 3. | Catalysis | 45 |
| 4. | Lipid chemistry | 14 |
| 5. | Novel drug delivery system | 15 |
| 7. | Process design & engineering | 54 |

4.2.4.3 Major R&D Facilities

The following R&D facilities support the above areas of competency:

1. NMR spectrometers – 200,400,500 MHz
2. Spectrophotometers – UV-VIS, FT-IR, GC-FT-IR
3. Powder X-Ray diffractometer
4. Single crystal 4-circle X-Ray diffractometer
5. GC-MS
6. LC-MS
7. Atomic absorption spectrophotometer
8. ESCA
9. Microcalorimeters
10. High pressure DSC
11. TGA/SDTA
12. Reaction calorimeters
13. Scanning electron microscope with EDAX
14. HPLCs & GLCs
15. SEP BOX (SEPIA tec. Germany)
16. Elemental analyser & TOC analyser
17. Autoclaves
18. Universal testing machine

- 19. Molecular modelling
- 20. ASPEN plus
- 21. Multiple organic synthesisers

4.2.4.4 Patents

The following table 4-12 gives the details of the number of patents filed by and granted to IICT during 2000-01 to 2004-05

Table 4-12

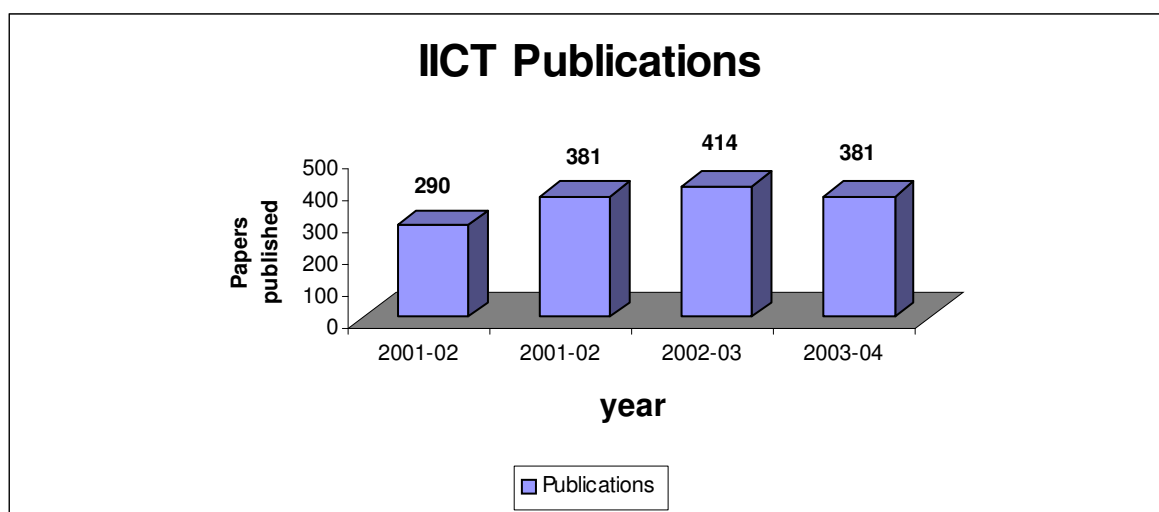
Patents filed by & granted to IICT during 2000-01 to 2004-05

| Year | Patents Filed | | Patents Granted | |
|----------------|---------------|------------|-----------------|------------|
| | In India | Abroad | In India | Abroad |
| 2000-01 | 40 | 72 | 11 | 4 |
| 2001-02 | 44 | 92 | 21 | 17 |
| 2002-03 | 46 | 139 | 10 | 32 |
| 2003-04 | 17 | 60 | 24 | 41 |
| 2004-05 | 26 | 35 | 15 | 48 |
| Total | 173 | 398 | 81 | 142 |

4.2.4.5 Papers

The following figure 4-11 gives the details of the number of papers published by IICT during 2001 and 2004:

Figure 4-11



(For details about the publications of IICT, refer to the website www.iictindia.org)

4.2.4.6 Potential Exportable R&D Services

IICT has identified the following as their potential exportable R&D services:

1. Basic research work in the area of chemical technology
2. Process development in the area of chemical technology
3. Product development in the area of chemical technology
4. Process up gradation in the area of chemical technology
5. Alternate process pathways in the area of chemical technology
6. Technology transfer in the area of chemical technology
7. Analytical services in the area of chemical technology
8. Evaluation and characterization in the area of chemical technology

4.2.4.7 Target Markets

The following target markets have been identified for the above services:

1. North America
2. Europe
3. South Asian countries

4.2.4.8 Constraints and Suggestions

IICT highlighted the lack of market information and cumbersome procurement Procedures as the constraints that it faced in the export of R&D services. It was suggested that the following can help to overcome these constraints for enhancing exports of R&D Services:

- *Wider publicity of capabilities*
- *Simplification of procurement procedures*
- *Ability to hire AR on a short notice*
- *Global market intelligence information needed for R&D services in core competency areas indicated.*
- *Business development/IPR/marketing procedures needed to be modified as per the requirements of WTO regime.*

4.2.5 Indian Institute of Petroleum, Dehradun

Established through an act of parliament in the year 1959, the Indian Institute of Petroleum (IIP) started functioning initially at New Delhi in 1960 and finally at Dehradun since 1963. In pursuit of excellence it sought initial organizational help from Institut Francais du Petrole (IFP), France, the world renowned petroleum research organization, under UNESCO programme during 1960 to 1964.

An ISO 9001 certified institute; it is devoted to multidisciplinary areas of research and development in the down stream sector of hydrocarbon and related industry. The institute has continued its efforts to grow into an internationally renowned R&D organization, providing quality research and innovative technologies for the national and international market place.

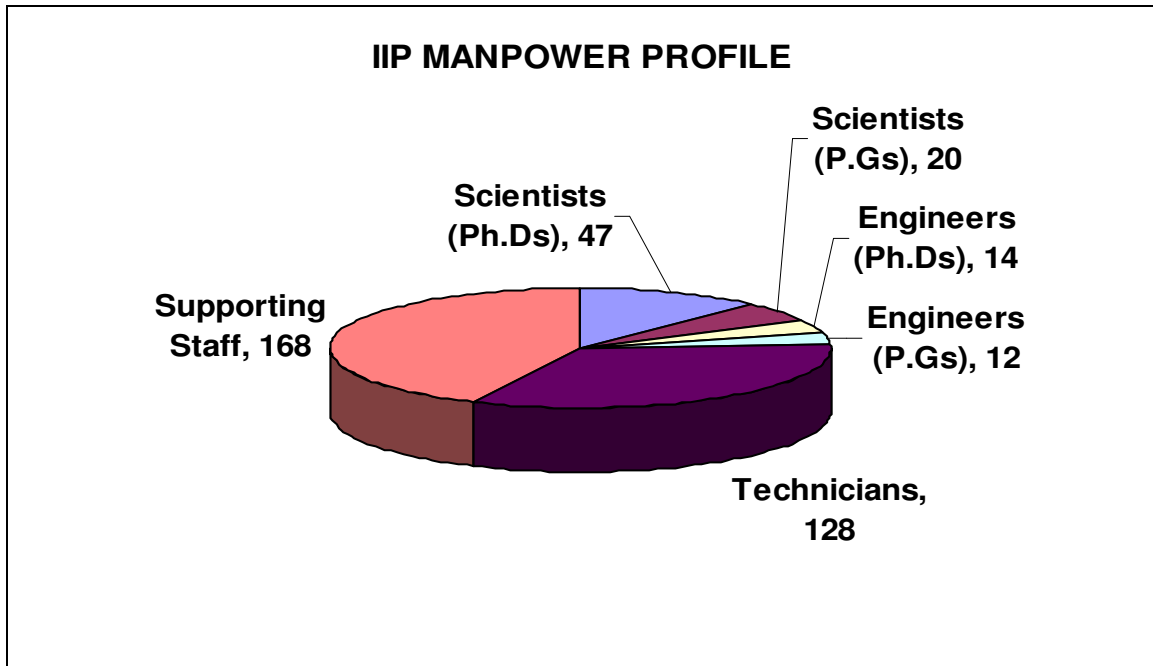
It has dedicated experienced and qualified R&D scientists supported by highly skilled technical personnel. It is equipped with comprehensive state-of-the-art R&D facilities including pilot plants. Institute is recognised by many universities to conduct research leading to doctorate degree.

The mandate of IIP is to undertake R&D work in petroleum refining, natural gas, petrochemicals, and utilization of petroleum products for developing novel, state-of-the-art technologies and products, to train technical personnel from Petroleum and related industry, to contact market demand surveys and techno-economic feasibility studies for related products, to assist Bureau of Indian Standards (BIS) in formulation of specifications for petroleum products and to provide technical services and assist the petroleum industry in absorption, adoption and selection of technologies.

4.2.5.1 Manpower Profile

The following figure 4-12 depicts the manpower profile of IIP:

Figure 4-12



4.2.5.2 Areas of Core Competency

The following have been identified by IIP as their areas of core competency:

1. Refining technology
2. Conversion process
3. Chemical and biotechnology
4. Analytical sciences
5. Petroleum products application

The following table 4-13 depicts the available manpower in each one of these areas of core competency:

Table 4-13

| S.No. | Area of Core Competence | Manpower |
|-------|--------------------------------|----------|
| 1. | Refining technology | 40 |
| 2. | Conversion process | 22 |
| 3. | Chemical and biotechnology | 22 |
| 4. | Analytical sciences | 29 |
| 5. | Petroleum products application | 34 |

4.2.5.3 Major R&D Facilities

The following R&D facilities support the above mentioned core competency areas:

- High pressure micro reactor
- Micro porous hollow membrane extraction unit
- Pilot reforming units
- Lab scale pressure swing adsorption unit with online gas chromatograph
- Laser particle size analyser
- Gas sweetening unit
- FCC micro activity test unit
- Bench scale liquid phase adsorption unit
- Micro pore analyser
- Propane deasphalting pilot plant
- Temperature programmed desorption / reduction unit
- Solvent dewaxing -deoiling pilot plant
- Process design software - Aspen plus
- Visbreaking pilot plant
- CFD package –fluent
- XRD / XRF
- Batch operations simulation - CHEMCAD
- Hydroprocessing pilot plants
- Nottingham asphalt tester
- Thermo gravimetric balance
- Asphalt rheometer
- High pressure VLLE still
- Glass packed solvent extraction columns
- Homogeniser for polymer impregnation
- Glass mixer settlers
- Micro -calorimetric acidity measurement unit
- Model pipeline
- Spray drier
- Optical microscope with image analyser
- Micro CCR determination apparatus
- Micro – extractor
- High Pressure reactors
- Down stream processing Equipment
- Biotechnological equipments
- Spectroscopy lab. – IR, UV, NMR, XRD, GC-MS, etc.
- Chromatography lab. – GC, HPLC, SFC
- Trace metal analysis

- Elemental analysis
- Standard analysis
- Exhaust emission analysers for raw and diluted gas for CO, CO₂, HC , NO & O₂ for diesel / gasoline /LPG /CNG engines
- Portable gas analysers for CO
- AVL, Hertman and Hartridge smoke meter
- Partial flow dilution tunnel for particulate measurement
- Ambassador engine test bench for performance evaluation of MFA for gasoline fuel
- State -of-the-art instrumented engine dynamometer test benches
- Heavy duty and light duty chassis, dynamometers for trucks /bus, light vehicles , cars, 3- wheelers and 2 - wheelers vehicles
- CFR engines : Octane and cetane rating units
- Distillation units
- Direct filter injection gas chromatograph (DFI-GC) for characterisation of SOF of exhaust particulates
- High speed data acquisition system for pressure -time cycle analysis of IC engines
- Standard engines test benches (L-38 , CLR, CLR-LTD , CAT 1 H₂/1G₂ and Bosch injector test rig) for performance evaluation of engine crankcase oils
- Fleet of test vehicles for field test performance of fuels , lubricants , additives and devices
- Thermogravimetry Analyser (TGA)
- Differential thermal analyser (DTA) for characterisation of catalysts

- Metrology instruments for measurement of engine components
- Friction & wear machines, 4 ball wear / EP tester and fatigue tester for evaluation of wear & EP characteristics of industrial lubricants
- FZG, IAE, Timken machine test rigs for evaluation of gear oils
- Standard test facilities for testing greases :Low temp, Torque, drop point, consistency, water wash out, rust preventive, hardness tester, wheel bearing, non contact surface profilometer, talysurf, jet mill etc
- Deposit Rating Devices_for assessment of engine deposits

4.2.5.4 Patents

The following table 4-14 gives the details of the number of patents filed by and granted to IIP during 2000-01 to 2004-05

Table 4-14

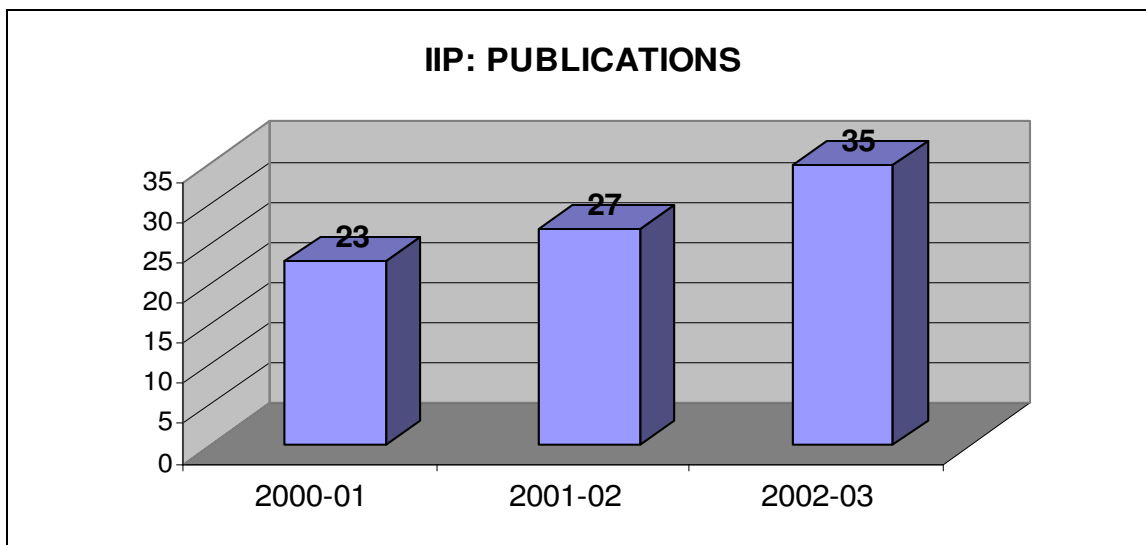
Patents filed by & granted to IIP during 2000-01 to 2004-05

| Year | Patents Filed | | Patents Granted | |
|----------------|---------------|-----------|-----------------|-----------|
| | In India | Abroad | In India | Abroad |
| 2000-01 | 12 | 16 | 1 | 1 |
| 2001-02 | 9 | Nil | 7 | Nil |
| 2002-03 | 8 | 6 | 9 | 1 |
| 2003-04 | 11 | 2 | 20 | 3 |
| 2004-05 | 6 | 3 | 7 | 11 |
| Total | 46 | 27 | 44 | 16 |

4.2.5.5 Papers

The following figure 4-13 gives the details of the number of papers published by IIP during 2000-01 to 2002-03

Figure 4-13



(For details about the publications of IIP, refer to the website www.icast.org.in/csir/iip.html)

4.2.5.6 Potential Exportable R&D Services

IIP has identified the following as their potential exportable R&D services:

1. Evaluation of crude oils
2. Evaluation (Pilot / lab scale) of catalysts for petroleum refinery processes
3. Analytical services for petroleum industry
4. Performance evaluation of fuels, lubes, additives on IC engines including field trials
5. Technology forecasting and assessment in the area of petroleum technology
6. Assistance in technology selection and process know how in the area of petroleum technology
7. Preparation of project profiles / reports in the area of petroleum technology
8. Techno – economic feasibility studies in the area of petroleum technology
9. Process improvement and revamping in the area of petroleum technology
10. Process design and scale up in the area of petroleum technology
11. Training of personnel in the area of petroleum technology

12. Information sourcing and services in the area of petroleum technology
13. Process simulation and modelling in the area of petroleum technology
14. Process integration and APC in the area of petroleum technology
15. Problem identification and solution in the area of petroleum technology

4.2.5.7 Target Markets

The following target markets have been identified for the above services:

1. Refineries in USA and in Asia
2. Petroleum plants in USA and in Asia
3. Natural gas process and marketing companies in USA and in Asia
4. Companies manufacturing specialty products in USA and in Asia

4.2.5.8 Constraints and Suggestions

IIP highlighted the bureaucratic bottlenecks, National regulations, lack of resources and obsolete rules and regulations, slow decision making and inadequate marketing and slow communication as the constraints that it faced in the export of R&D services. It was suggested that the following can help to overcome these constraints for enhancing exports of R&D services:

- *Corporate culture should be inculcated in the labs /Institutes*
- *Upgrading of infrastructure*
- *Upgrading skills for technology marketing*

4.2.6 National Chemical Laboratory

NCL, India is a research, development and consulting organisation with a focus on chemistry and chemical engineering. It has a successful record of research partnership with industry. NCL was established in 1950 and is well known as an interdisciplinary research centre with interest in polymer science, organic chemistry, catalysis, materials chemistry, chemical engineering, biochemical sciences and process development. It houses approximately 300 scientific staff with PhD. NCL has excellent infrastructure for measurement science and chemical information. The institute publishes the second largest number of papers in chemical sciences (~ 350), files the largest number of patents, both in India and abroad and produces the largest number of Ph.Ds in chemical sciences in India.

The Institute's mission is to carry out R&D in chemical and related sciences with a view to eventually deliver a product, process, intellectual property, tacit knowledge or service that can create wealth and provide other benefits to NCL's stakeholders; to build and maintain a balance portfolio of scientific activities as well as R&D programs to enable NCL to fulfill the demands of its stakeholders, present and future and to create and sustain specialized knowledge competencies and resource centers within NCL which can provide support to all stakeholders of NCL.

4.2.6.1 Core Competencies

The following areas have been identified by NCL to be their areas of core competency:

1. Catalysis
2. Biochemical sciences
3. Organic chemistry
4. Polymer science and engineering
5. Physical and materials chemistry
6. Chemical engineering science

4.2.6.2 Patents

The following table 4-15 gives the details of the number of patents filed by and granted to NCL during 2000-01 to 2004-05

Table 4-15

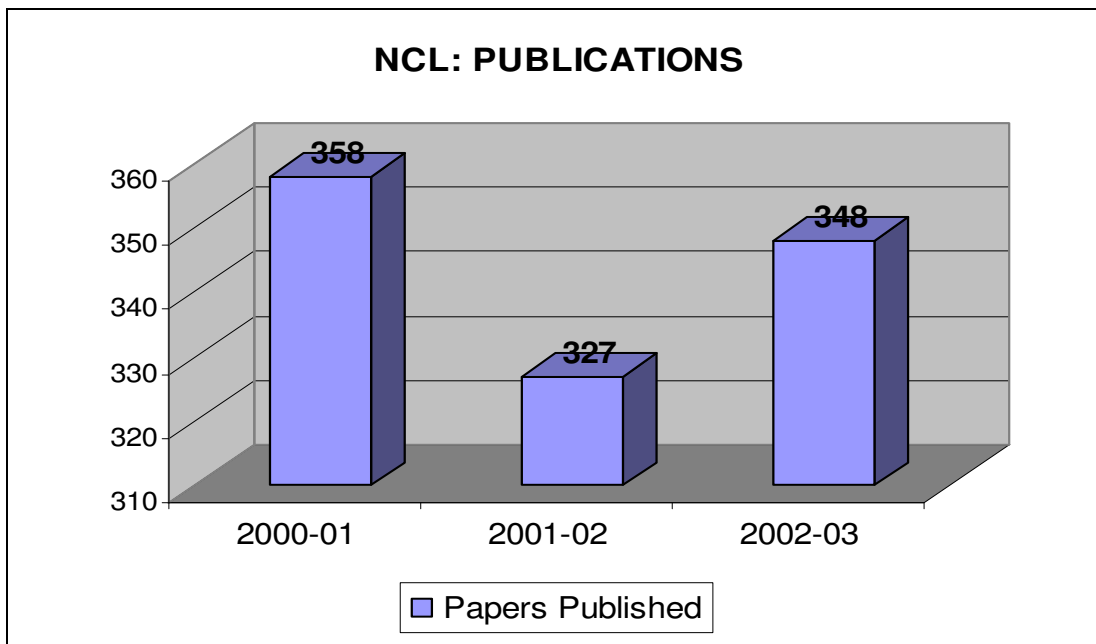
Patents filed by & granted to NCL during 2000-01 to 2004-05

| Year | Patents Filed | | Patents Granted | |
|----------------|---------------|------------|-----------------|------------|
| | In India | Abroad | In India | Abroad |
| 2000-01 | 92 | 63 | 32 | 16 |
| 2001-02 | 43 | 43 | 90 | 16 |
| 2002-03 | 27 | 41 | 48 | 46 |
| 2003-04 | 59 | 112 | 53 | 19 |
| 2004-05 | 61 | 42 | 35 | 32 |
| Total | 282 | 301 | 258 | 129 |

4.2.6.3 Papers

The following figure 4-14 gives the details of the number of papers published by NCL during 2000-01 to 2002-03

Figure 4-14



(For details about the publications of NCL, refer to the website www.ncl-india.org)

4.2.6.4 Potential Exportable R&D Services

The following have been identified by NCL as their exportable R&D services:

1. Contract research in chemical sciences
2. Process development and consultancy services in chemical sciences
3. Technical services in chemical sciences
4. Testing and analysis in chemical sciences

4.2.7 Regional Research Laboratory, Jorhat

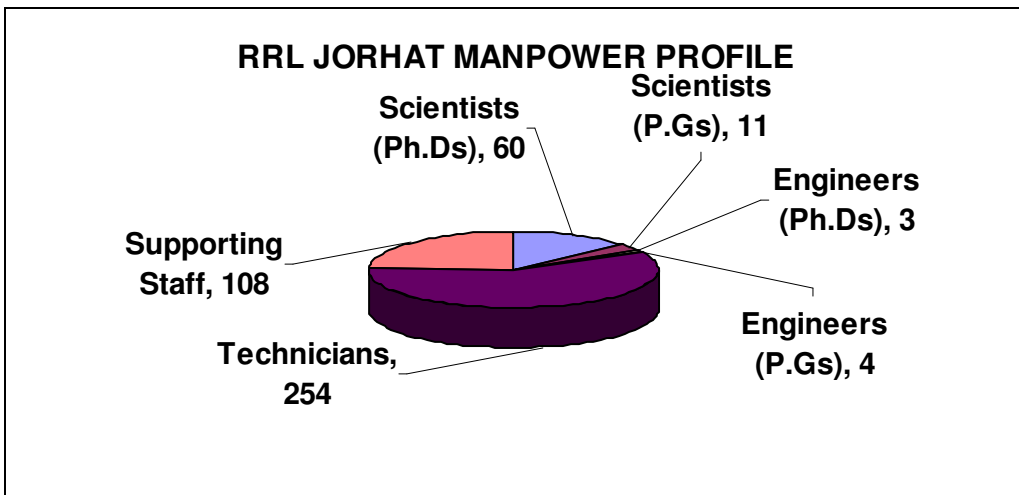
As one of the multidisciplinary CSIR laboratories established in 1961 the major thrust of R&D activities at Regional Research Laboratories has been to develop indigenous technology by utilising the immense natural wealth of India. The north eastern region of the country is bestowed with an abundance of material resources like petroleum, natural gas, mineral, tea as well as aromatic and medicinal plants in fact about fifty percent of total flora of India are available in this south eastern sub-himalayan region.

RRL Jorhat's dedicated team of scientists, engineers and entire staff are determined to play their modest role in meeting the challenges of tomorrow and participate in the national endeavor to achieve a better and cleaner quality of life by developing and commercialise technologies based on natural resources of the north-eastern region / India.

4.2.7.1 Manpower Profile

The following figure 4-15 depicts the manpower profile of RRL Jorhat:

Figure 4-15



4.2.7.2 Areas of Core Competency

The following have been identified by RRL Jorhat as their areas of core competency:

1. Agrotechnology
2. Biotechnology / bioscience
3. Environmental science
4. Geoscience
5. Engineering science
6. Chemical science

The following table 4-16 depicts the available manpower in each one of these areas of core competency:

Table 4-16

| S.No. | Area of Competence | Manpower |
|--------------|----------------------------|-----------------|
| 1. | Agrotechnology | 17 |
| 2. | Biotechnology / bioscience | 7 |
| 3. | Environmental science | 8 |
| 4. | Geoscience | 4 |
| 5. | Engineering science | 8 |
| 6. | Chemical science | 35 |

4.2.7.3 Major R&D Facilities

The following R&D facilities support the above areas of competency:

1. Pilot plant
2. Supercon magnet 300 MHz NMR
3. Universal testing Machine
4. Short path distillation unit
5. Reaction calorimeter unit
6. Online / realtime seismic network for disaster mitigation

4.2.7.4 Patents

The following table 4-17 gives the details of the number of patents filed by and granted to RRL Jorhat during 2000 and 2003:

Table 4-17

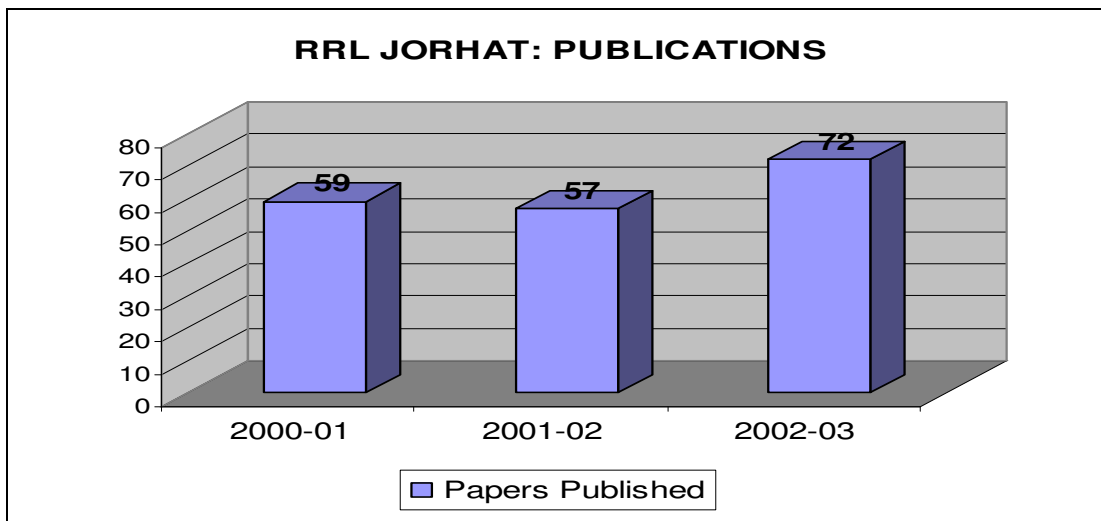
Patents filed by & granted to RRL(JT) during 2000-01 to 2004-05

| Year | Patents Filed | | Patents Granted | |
|----------------|---------------|----------|-----------------|----------|
| | In India | Abroad | In India | Abroad |
| 2000-01 | 20 | 1 | 8 | 4 |
| 2001-02 | 8 | 4 | 9 | Nil |
| 2002-03 | 8 | Nil | 5 | 1 |
| 2003-04 | 4 | Nil | 3 | Nil |
| 2004-05 | 9 | Nil | 16 | 1 |
| Total | 49 | 5 | 41 | 6 |

4.2.7.5 Papers

The following figure 4-16 gives the details of the number of papers published by RRL Jorhat during 2001 and 2003:

Figure 4-16



(For details about the publications of RRL Jorhat, refer to the website

<http://jorhat.nic.in/rrl.htm>)

4.2.7.6 Potential Exportable R&D Services

RRL Jorhat has identified the following as their potential exportable R&D services:

1. Expert services in survey and scientific analysis of natural products based on medicinal and aromatic plants
2. Seismic surveillance with high efficiency as part of international studies
3. Survey and utilization of valuable minerals
4. Testing / analysis of building materials minerals, petroleum products, food products, water and soil
5. Process development and consultancy services

4.2.7.7 Target Markets

The following target markets have been identified for the above services:

1. Asian and African countries

4.2.7.8 Constraints and Suggestions

RRL Jorhat highlighted the lack of market information and lack of resources as the constraints that they faced in the export of R&D services. It was suggested that the creation of databank and information dissemination can help to overcome these constraints for enhancing exports of R&D services.