Chapter 3

Biological Sciences Group Laboratories

3.0 List of laboratories under the Biological Sciences Group

1. Centre for Cellular and Molecular Biology, Hyderabad
2. Institute for Genomics and Integrative Biology, New Delhi
3. Institute of Himalayan Bioresource Technology, Palampur
4. Indian Institute of Chemical Biology, Kolkata
5. Central Drug Research Institute, Lucknow
6. Central Institute of Medicinal and Aromatic Plants, Lucknow
7. National Botanical Research Institute, Lucknow
8. Institute of Microbial Technology, Chandigarh
9. Regional Research Laboratory, Jammu
10. Indian Toxicology Research Centre, Lucknow
11. Central Food Technology Research Institute, Mysore

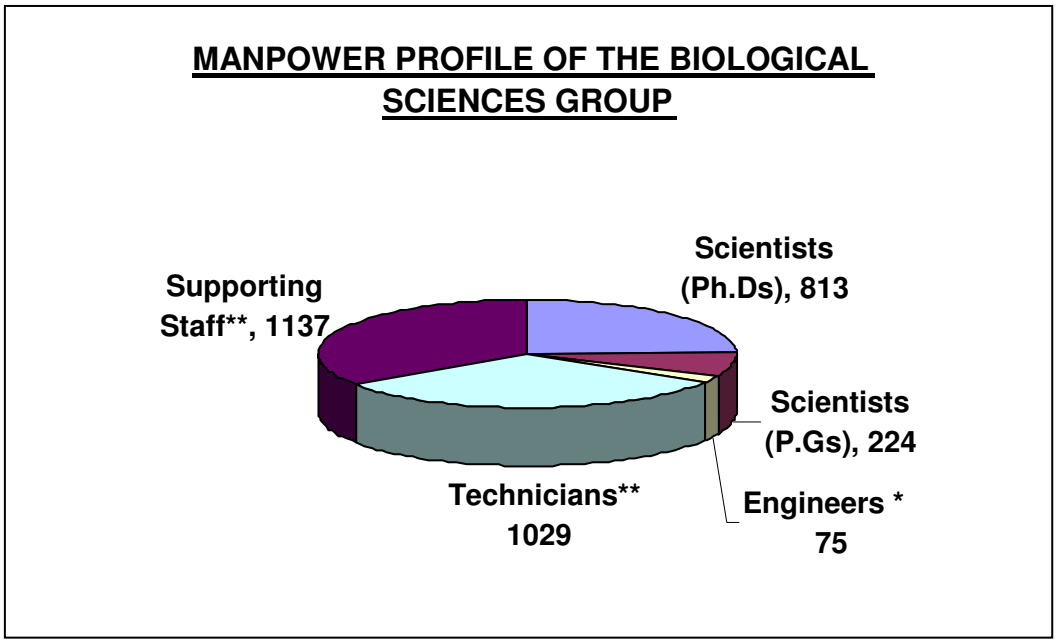
3.1 Overall Analysis of Biological Sciences Group

3.1.1 Manpower Profile

The eleven institutes categorized in the biological sciences group cover varied areas of research like molecular biology, genomics, drugs and pharmaceuticals, medicinal and aromatic plants, chemical biology, food technology, toxicology etc.

The figure 3-1 below presents the manpower profile in terms of scientists, engineers, technicians and supporting staff of the biological sciences group as a whole (data as received from all the individual Institutes):

Figure 3-1



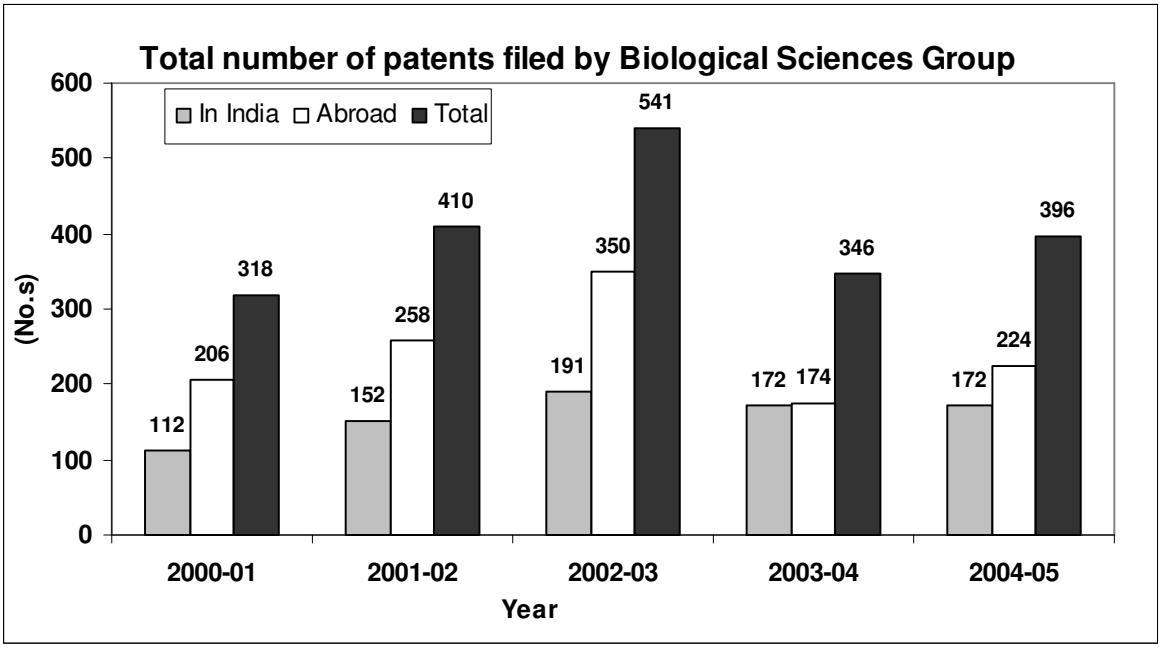
* The figure for number of engineers does not include that for IGIB, CIMAP, NBRI and IMTECH.

** The figure for the number of technicians and supporting staff does not include ITRC and RRL Jammu Tawi.

3.1.2 Patents

The following figure 3-2 represents the total number of patents applied for and the number of patents granted, for the biological sciences group as a whole for 2000–01 to 2004-05.

Figure 3-2

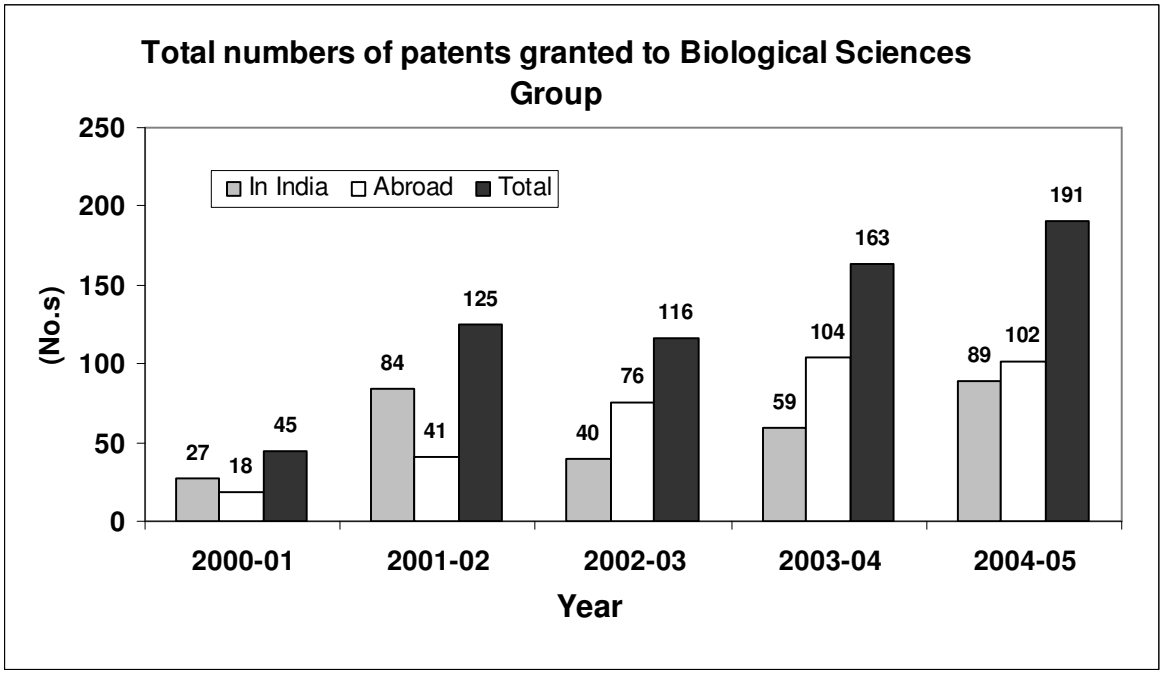


It is observed that there has been a steady increase in the number of Indian and foreign patents applied for by the biological sciences group from 318 to 410 an increase of 28.9% in the year 2001-02 and to 541, a further increase of 32%, in 2002-03. The number has however decreased to 346 in 2003-04 but has again slightly increased to 396 in 2004-05. The trend is the same for the patents filed abroad.

As far as the number of Indian patents granted are concerned, the number has increased from 27 in the year 2000-01 to 84 in the year 2001-02 but has decreased considerably to 40 in the year 2002-03 but has again increased to 59 in the year 2003-04 and to 89 in the year 2004-05.

The total number of patents granted abroad shows a steady increase in the number from 18 in the year 2000-01 to 104 in the year 2003-04. However the number of patents granted abroad (102) is almost the same in the year 2004-05. The year-wise detail of the patents granted to biological sciences group is shown in figure 3-3

Figure 3-3



Among the laboratories under the Biological sciences group CFTRI has filed the maximum number of patents numbering 774 about 37% of the total of Biological group, during the period 2000-01 to 2004-05 followed by CIMAP with 235 and RRL (J) with 208. The minimum number of patents has been filed by ITRC numbering 10 and that too in India only.

The laboratories wise details of the patents filed in India and abroad are given below in table 3-1

Table 3-1

Patents filed by Biological 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
CCMB	-	24	-	4	4	1	3	7	2	2	9	38
CDRI	10	8	17	27	11	28	15	14	21	27	74	104
CFTRI	61	26	100	60	122	105	104	66	59	41	446	298
CIMAP	10	38	11	31	12	65	11	10	18	29	62	173
IGIB	1	10	4	22	11	36	7	22	16	17	39	107
IHBT	5	63	3	36	5	24	4	8	10	27	27	158
IICB	2	18	1	9	5	22	6	11	4	6	18	66
IMT	-	6	2	11	6	5	4	7	3	-	15	29
ITRC	3	-	2	-	2	-	1	-	2	-	10	-
NBRI	3	13	2	10	1	19	7	20	23	32	36	94
RRL(J)	17	-	10	48	12	45	10	9	14	43	63	145

I – India

A – Abroad

Source: CSIR

The laboratories wise details of the patents granted to India and abroad are given below in table 3-2

Table 3-2

Patents granted to Biological 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
CCMB	-	1	1	-	-	3	1	1	-	2	2	7
CDRI	10	6	18	6	19	3	7	6	15	6	69	27
CFTRI	2	1	8	2	5	7	29	15	31	19	75	44
CIMAP	1	7	20	25	2	36	7	29	13	28	43	125
IGIB	1	1	9	1	2	6	7	8	13	7	19	23
IHBT	-	1	-	-	1	12	-	21	-	17	1	57
IICB	2	-	12	5	4	5	4	5	9	9	31	24
IMT	1	1	4	-	1	1	2	4	2	2	10	8
ITRC	2	-	3	-	-	-	2	-	-	-	7	-
NBRI	-	-	-	1	1	3	-	3	-	4	1	11
RRL(J)	8	-	9	1	5	-	3	12	16	8	41	21

I – India

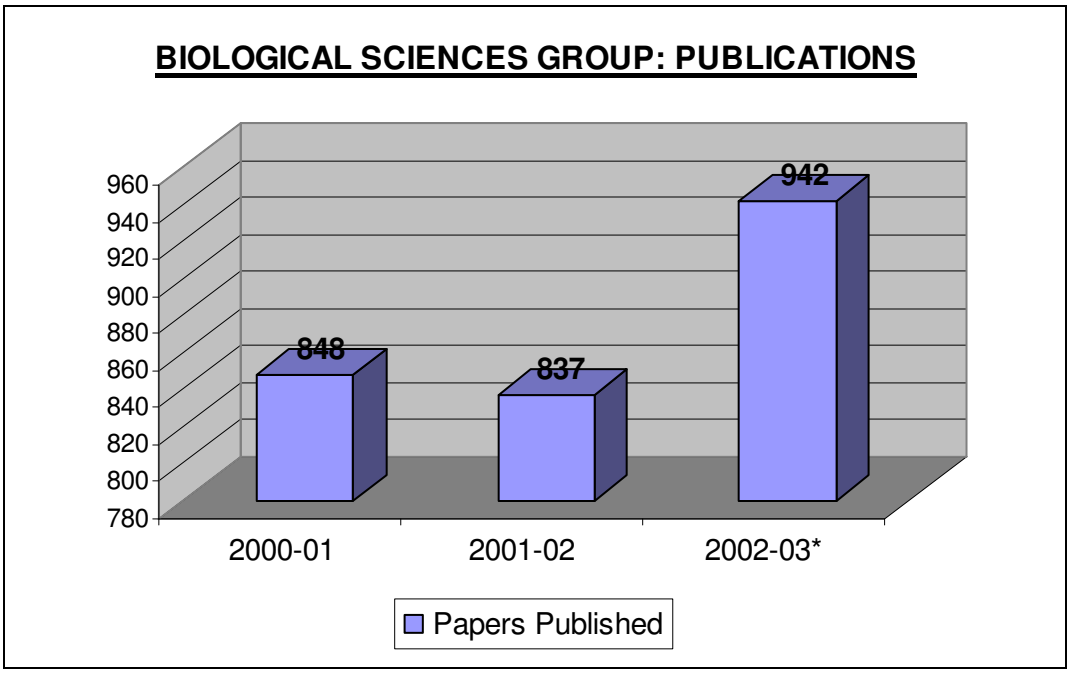
A – Abroad

Source: CSIR

3.1.3 Papers

The following figure3-4 represents the total number of papers published by the biological sciences group as a whole for 2000–01 to 2002-03.

Figure 3-4



- The figure for the number of papers published in the year 2003 – 03 does not include those for IHBT and RRL Jammu Tawi.

Although the group experienced a fall in the total number of publications from 2000-01 to 2001-02 of 1.2%, the group registered a sharp increase in the number of publications from 2001-02 to 2002-03 by 12.5%.

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

Table 3-3

BIOLOGICAL SCIENCES			
S. No.	**Name of laboratory**	**Area of Core Competency**	**Exportable R&D Services**
1.	**Centre for Cellular and Molecular Biology**	1. Biotechnology & biomedicine 2. Genetics & evolution 3. Cell biology & development 4. Molecular biology 5. Biochemistry & biophysics 6. Genomics 7. Bioinformatics	1. Novel assay system for screening of anti cancer drugs 2. Use of RNAi silencing technology
2.	**Institute for Genomics and Integrative Biology**	1. Immunology and molecular genetics of allergy including respiratory disorders 2. Genomics and molecular medicine 3. Nucleic acid and peptides 4. Genome Informatics (in-silico biology) 5. Gene expression, proteomics and structural biology	1. Sequencing services (for DNA and protein) 2. Genotyping services 3. MALDI TOF services 4.Primer design and synthesis 5. Gene chip and micro array analysis services
		6. Environmental biotechnology enzymes and simple diagnostics	6. Short Term courses in Bio-informatics 7. R&D consultancy services in biotechnology 8. IPR services involving customized prior art searches and patent drafting in genomics, proteonics and molecular genetics

3.	**Institute of Himalayan Bioresource Technology**	1. Tea sciences	1. Training i. Processing, evaluation and testing of natural products ii. Genomics, proteomics and development of transgenic plants iii. Viral diagnostics in plants iv. Pesticide residue analysis v. Survey and mapping in GIS environment vi. Tea husbandry, tea manufacture and development of diversified products
		2. Plant biotechnology	2. Testing and evaluation i. Evaluation of marker compounds of medicinal and aromatic plants ii. Quality evaluation of essential oils iii. Viral diagnosis in ornamental plants. iv. Pesticide residue analysis v. Soil analysis with respect to tea
		3. Floriculture	3. Turn Key projects i.Essential oil extraction ii.Production of steviosides iii.Establishment of tissue culture units iv.Rejuvination of abandoned tea gardens v.Value addition to herbals
		4. Natural Plant products	4. Survey of plant resources
		5. Biodiversity	5. Consultancy in i. Project formulation and feasibility

			reports ii. Database on bioresources iii. DNA fingerprinting of plant genetic resources iv. Cryopresevation of seed and plant tissues v. Floriculture vi. Setting up of tissue culture labs vii. Tea husbandry and quality tea manufacture viii. Value addition to herbals
		1. Technology transfer	6. Design Development of: i. Design of distillation unit for processing of aromatics and herbals ii. Implements for mechanization of tea farm operations
			7. Product development of : i.SOD and other stress tolerant genes ii.neutraceuticals iii.viral diagnosis kits iv.stevioside production v.diversified tea products
			8. Process development of : i. marker compounds from medicinal and aromatic plants and their identifications and evaluation ii.flavoring molecules iii.natural dyes and colors

			iv.preparation of β-aescin v.micropropagation of economically important plants and Protocol thereof. vi. transgenic plants and Protocol thereof.
4.	**Indian Institute of Chemical Biology**	1. Biotechnology 2. Synthetic, biophysical and natural products chemistry 3. Drug design & development and molecular modelling 4. Human genetics and genomics 5. Immunology 6. Infectious disease 7. Cellular physiology	19. Custom synthesis of organic molecules 20. Extraction and characterization of natural products 21. In vitro and in vivo testing (preclinical level) for diseases such as asthma, leukemia, type I & II diabetes, gastric ulcers, neurodegenerative diseases, narcotic addiction, infectious disease (leishmaniasis and cholera), as well as immunomodulators, antioxidants, antifertility agents, etc. 22. Diagnostics kits development & validation
5.	**Central Drug Research Institute**	1. Malaria filariasis, leishmaniasis 2. Reproductive healthcare 3. Cardiovascular, central nervous system and other disorders 4. Technology development (chemical technology, fermentation technology and pharmaceutical technology)	1. Analytical services of samples (synthetic, plants, marine) 2. Supply of cultures 3. Biological screening of samples 4. Regulatory pharmacology and toxicological studies

		5. Biological screening, clinical trials, pharmacokinetic studies 6. Regulatory pharmacology and toxicology	5. Supply of animals for experimentation 6. Supply of literature, information related to drugs and pharmaceuticals 7. Training to academia, industrial staffs (Indian as well as foreigners) and R&D institutions
6.	**Central Institute of Medicinal and Aromatic Plants**	1. Agrotechnology, variety development and improvement of medicinal and aromatic plants 2. Process, product development and value addition of medical and aromatic plants	1. Training for cultivation practices and processing technologies of medicinal and aromatic plants; advance biotechnology tools and techniques including genomics and plant tissue culture quality analysis and instrumentation; and bioinformatics. 2. Testing and evaluation: specialized testing, calibration and certification – based on compliance to the quality standards meeting ISO / IEC guide – 25 and EN-4500 criteria (CIMAP has been accredited by national accreditation board for testing and calibration laboratories, government of India in 1999 for biological and chemical testing.)
		3. Collection, Conservation and characterization of medicinal and aromatic plants 4. Quality Evaluation – phytochemicals, aroma chemicals and essential oils analyses	3. Consultancy i. Feasibility reports (technical-economic) on medicinal and aromatic plants cultivation practices and processing technologies. ii. Fabrication and installation of field distillation units for essential oil crops. iii. DNA fingerprinting and germplasm evaluation. iv. Organic farming and certification

			v. Biological activity testing 4. IPR Services: involving customised prior art searches and patent drafting related to plant varieties and natural products of medicinal and aromatic plants 5. Process technologies of medicinal and aromatic plants. 6. Distillation units upto 1 ton capacity meeting specific requirements for crops like geranium, rose, lemongrass, palmarosa, citronella, mint etc. on turnkey basis. 7. Product development for plant variety and chemotype development, herbal formulations and semi-synthetic phytomolecules and derivatives for drug development as sponsored/contract projects.
			8: Process development i. Agrotechnology for specific crops & agroclimates ii. Distillation of essential oils & fractionation of high value isolates & monoterpenes iii. Extraction, phytomolecule isolation & purification iv. Semi-synthetic derivatization of phytomolecules v. Bioactivity evaluation (in-vitro & in-vivo) vi. DNA fingerprinting for authentication of plant materials

			vii. Marker development for quality validation
7.	**National Botanical Research Institute**	1. Plant biodiversity & conservation biology	1. Training i. Biodiesel, bioenergy, biofuel ii. Phytoremediation iii. Neem iv. Pharmacognostical, phytochemical and ethnopharmacological identification of botanicals v. Survey, inventorying, documentation and biodiversity assessment, herbarium techniques and curation vi. Methods & approaches in plant taxonomy vii. Floriculture viii. Plant tissue culture
		2. Biomass biology & environmental sciences	2. Testing and evaluation i. Biodiesel, bioenergy, biofuel Phytoremediation ii. Neem iii. Biodiversity iv. Pharmacognostical, phytochemical and Ethnopharmacological identification of botanicals, standardization, QC, GLP's, GCP's, GMP's of herbal drugs, compound formulations
		3. Genetics and plant breeding & agrotechnology	3. Consultancy services i. Biodiesel, bioenergy, biofuel ii. Phytoremediation iii. Biodiversity iv. Pharmacognostical, phytochemical and

			Ethnopharmacological identification of botanicals, standardization, QC, GLP's, GCP's, GMP's of herbal drugs, compound formulations v. Medicinal and aromatic plants (Ex-situ conservation, Cultivation and post harvesting processing, organic cultivation techniques) vi. Floriculture vii. Plant tissue culture
		4. Bioinformatics	4. Contract / Sponsored research : i. Design development for QC, standardization development of novel herbal products ii. Process Development for phytoremediation, floriculture and plant tissue culture iii. Product development for neem, floriculture and pharmaceutical, cosmaceutical and nutraceutical
		5. Molecular biology & genetic engineering	5. Surveys and epidemiological studies a. Pharmacognostical, phytochemical and Ethnopharmacological identification of botanicals, standardization, QC, GLP's, GCP's, GMP's of herbal drugs, compound formulations b. Air pollution monitoring and management

			studies c. Study of biology of greenhouse gas emission from croplands and wetlands d. Water pollution monitoring and management e. Bioremediation and bio-utilisation of Industrial wastes
		6. Pharmacognosy & ethnopharmacology 7. Phytochemistry 8. Botanic garden & floriculture 9. Plant conservation & eco-education 10. Biotechnology & plant physiology	6. Turn key projects i. Hi-Tech low cost nursery ii. Herbal beer iii. Herbal lipstick 7.Technology Transfer: i. Plant Tissue culture ii. Plant growth promoting bacterial inoculants iii. Bt cotton for insect resistance iv. Floriculture plant tissue culture
8.	**Institute of Microbial Technology**	1. Molecular biology and microbial genetics 2. Protein science and engineering 3. Cell biology 4. Fermentation technology and applied microbiology	1. Contract research including consultancy in the area of microbial technology 2. Space to set-up business incubators 3. Fermentation support including scale up and down stream processing 4. High end training in the areas of bioinformatics, bio processing, strain isolation and characterization

9.	**Regional Research Laboratory, Jammu Tawi**	1. Prospecting biodiversity for its chemistry and bioactivity 2. Development of the bio enhancers of the plant origin 3. Cultivation, processing, improvement, conservation, and standardization of agro technologies of medicinal and aromatic plants 4. Prospecting biodiversity (plant and microbial) of North – west Himalayas	1. Screening of enzymes 2. Fermentation facility of RRL 3. Screening of plants and fractions thereof for specific biological activities 4. Standardization of herbal formulation and their quality control 5. Quality control assurance and analysis of drugs, pharmaceuticals minerals, coal, water etc. 6. Up scaling of lab processes using chemical engineering facilities.
10.	**Indian Toxicology Research Centre**	1. Toxicological studies of petroleum products and chemicals	1. Health and environmental monitoring a. Epidemiological surveys / studies on occupational diseases in industrial workers with remedial measures b. Survey for adulteration and contamination of food material c. Environmental & air monitoring studies d. Monitoring of noise level in industrial environmental and residential areas e. Environmental and ecotoxicological impact assessment studies
		2. Human exposure risk to food, agro-chemicals and mineral fibers	2. Analysis of pollutants i. Quality assurance studies for purity of herbal raw drugs and presence of contaminants ii. Analysis of residues of pesticides and

			metals in biological and environmental samples iii. Waste water analysis from industries iv. Analysis of serum samples of protein malnourished children for their anti-oxidant status i.e. SOD, glutathione peroxide total thiol content and TBARS levels
		3. Neurotoxicity and cardiotoxicity of pyrethroids, quinalphos, and organochlorines: mechanism and bio-makers	3. Safety evaluation i. Safety evaluation of drinking water and packaged water ii. Safety evaluation of agrochemicals dyes, food additives, plastics and polymers, petrochemicals, detergents, fibres and particulate matter iii. Long term toxicity studies for neurological, reproductive, tetratogenic, mutagenic, carcinogenic and phototoxic evaluation iv. Safety evaluation of herbal products
		4. Effects of pollutants on bio-diversity and environmental detoxification 5. Toxicocity evaluation, monitoring of pollutants and development of mathematical models for prediction of fate of chemicals in environmental compartments 6. Toxicity of inhaled vapours,	4. Disposal of wastes i. Microbial conversion of liquid wastes to commodities ii. Biodegradation of persistent pesticide iii. Bioremediation of contaminated sites

		aerosols and particulates	
11.	**Central Food Technology Research Institute**	1. Post – harvest technology 2. Food biotechnology 3. Traditional foods 4. Natural food additives 5. Food safety 6. Food microbiology 7. Genetically modified foods and nutrigenomics	60. Analysis of food samples 61. Technology transfer in the field of food technology 62. Training and human resource development in the field of food technology

3.2 Analysis of Individual Laboratories under the Biological Sciences Group

3.2.1 Centre for Cellular and Molecular Biology

The Centre for Cellular and Molecular Biology (CCMB) is the premier multidisciplinary research & development organisation of the Government of India. It was set up as a semi-autonomous Centre in 1977, became a full-fledged national laboratory during 1981-82, and was dedicated to the nation on 26 November, 1987 by the then Prime Minister of India late Shri Rajiv Gandhi. The ongoing research programmes at the CCMB are in three major categories - high quality basic research in the frontier areas of modern biology, research relevant to societal needs, and application-oriented research towards commercialisation. These include the areas of biomedicine & diagnostics, evolution & development, gene regulation in prokaryotes and eukaryotes, host-parasite interactions, membrane biology, protein structure, bioinformatics, functional genomics, theoretical biology, etc. CCMB has also taken lead in the dissemination of modern biological information through popularisation of science, science education in schools, and has been a meeting point for art and science. In recognition of its contribution to modern biology, CCMB has been chosen as a Centre of Excellence by Global Network for Molecular and Cell Biology and has been designated as a South Centre for Excellence for Research and Training by the Third World Academy of Sciences, Italy. Many prestigious international and national awards have come to CCMB including the CSIR Technology Award (twice) and FICCI Award for outstanding achievements in Science & Technology.

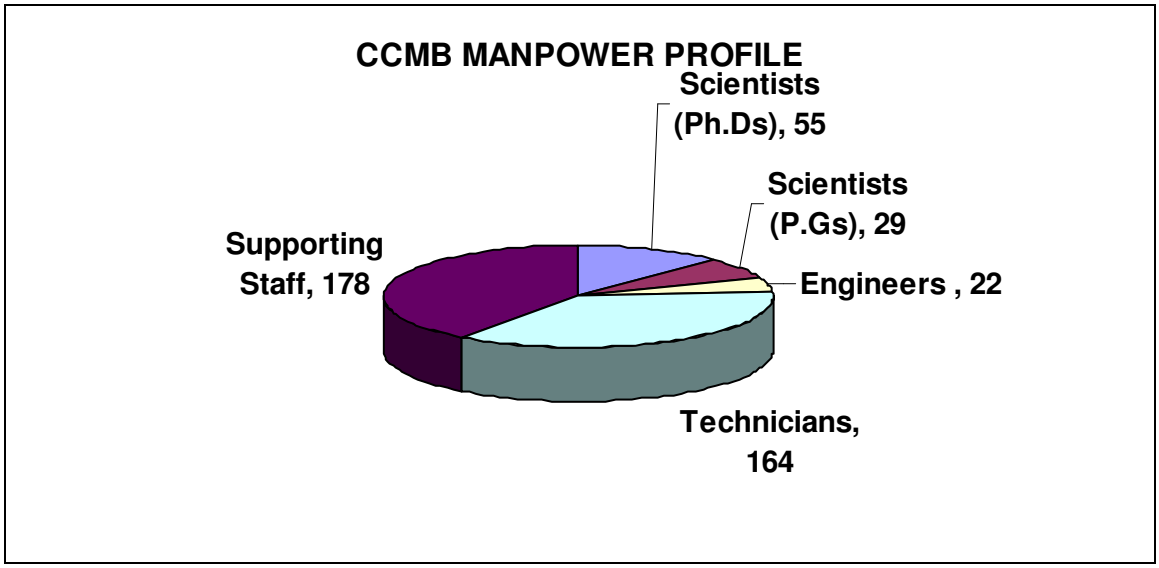
The objectives of the Centre are to conduct research in frontier and multi-disciplinary areas of modern biology and to seek potential applications of this work; to carry out exploratory work in areas of biology with a view to aid the development of biochemical and biological technology in the country on a sound basis; to train people in the advanced areas of biology to serve the needs of development in these areas, with special provision for short-term training of staff from other institutions in techniques for which adequate facilities may not exist elsewhere; to provide centralized facilities in the country for new and modern techniques in the inter-disciplinary areas of biology, and to ensure that these

facilities are so organized, maintained and administered that they can be put to maximal use by research workers from other laboratories and institutions in the country; to interact adequately with other institutions doing basic or applied work in areas related to the activities of the Centre and to collect, collate and disseminate information relevant to biological research.

3.2.1.1 Manpower Profile

The following figure 3-5 depicts the manpower profile of CCMB:

Figure 3-5



3.2.1.2 Areas of Core Competency

The following table 3-4 gives available manpower in each of the areas of core competency of the centre.

Table 3-4

S.No.	Area of Competence	Manpower
1.	Biotechnology & biomedicine	27
2.	Genetics & evolution	38
3.	Cell biology & development	13
4.	Molecular biology	24
5.	Biochemistry & biophysics	22
6.	Genomics	18
7.	Bioinformatics	4

3.2.1.3 R&D Facilities

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

1. Confocal laser scanning microscopy
2. Flow cytometry
3. DNA sequencing
4. Cell culture
5. Laboratory animals
6. Green house
7. Pisciculture
8. Electron microscopy
9. Oligonucleotide synthesis
10. Peptide synthesis
11. Protein analysis
12. Digital imaging
13. Microarray / DNA chips
14. Protoemics
15. X-Ray crystallography

16. Nanosecond fluorimeter
17. Laser densitometer
18. Gene transfer system
19. Cell fusion apparatus
20. Semen motility analysers
21. Automatic blotting system
22. Gel documentation system
23. ELISA micro plate reader
24. Phosphor imaging system
25. Fluorescence spectrophotometer
26. Circular dichroism spectrometer
27. Photo acoustic spectrometer

3.2.1.4 Patents

The following Table 3-5 gives the details of the number of patents filed by and granted to CCMB during 2000-01 to 2004-05

Table 3-5

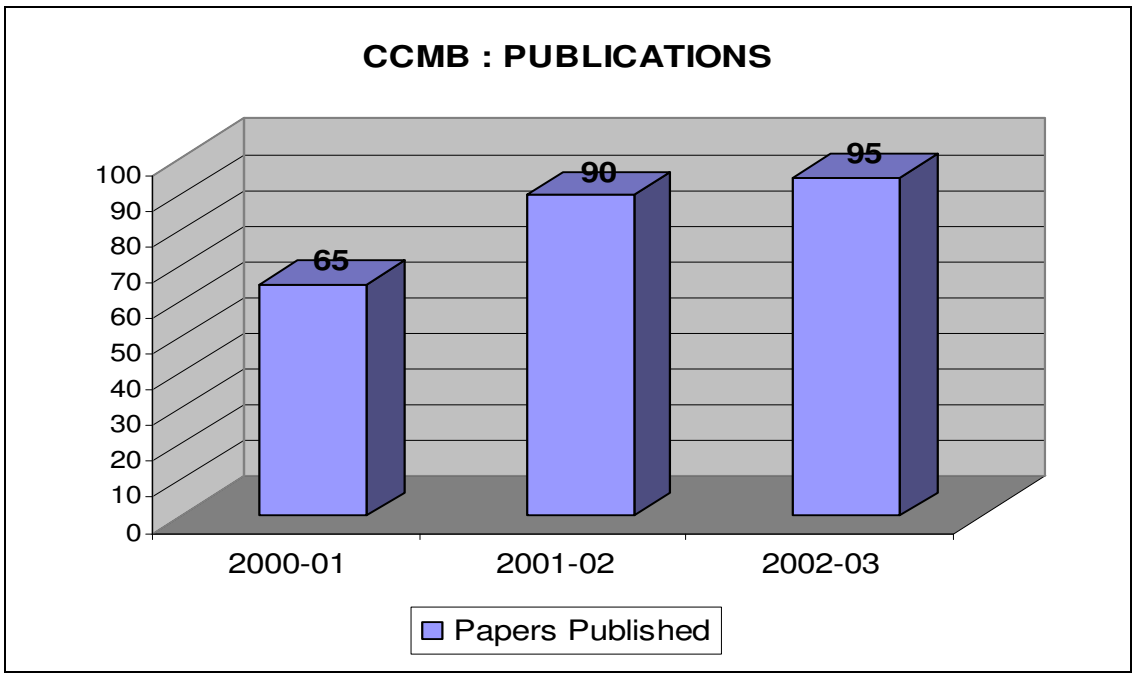
Patents filed by & granted to CCMB during 2000-01 to 2004-05

Year	Patents Filed		Patents Granted	
	In India	Abroad	In India	Abroad
2000-01	Nil	24	Nil	1
2001-02	Nil	4	1	Nil
2002-03	4	1	Nil	3
2003-04	3	7	1	1
2004-05	2	2	Nil	2
Total	**9**	**38**	**2**	**7**

3.2.1.5 Papers

The following figure 3-6 gives the details of the number of papers published by CCMB during 2000 and 2003:

Figure 3-6



(For details about the publications of CCMB, refer to the website www.ccmb.res.in)

3.2.1.6 Potential Exportable R&D Services

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

1. Novel assay system for screening of anti cancer drugs
2. Use of RNAi silencing technology

3.2.1.7 Target Markets

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

1. U.S.
2. Europe
3. Japan
4. Sri Lanka
5. China

3.2.2 Institute for Genomics and Integrative Biology

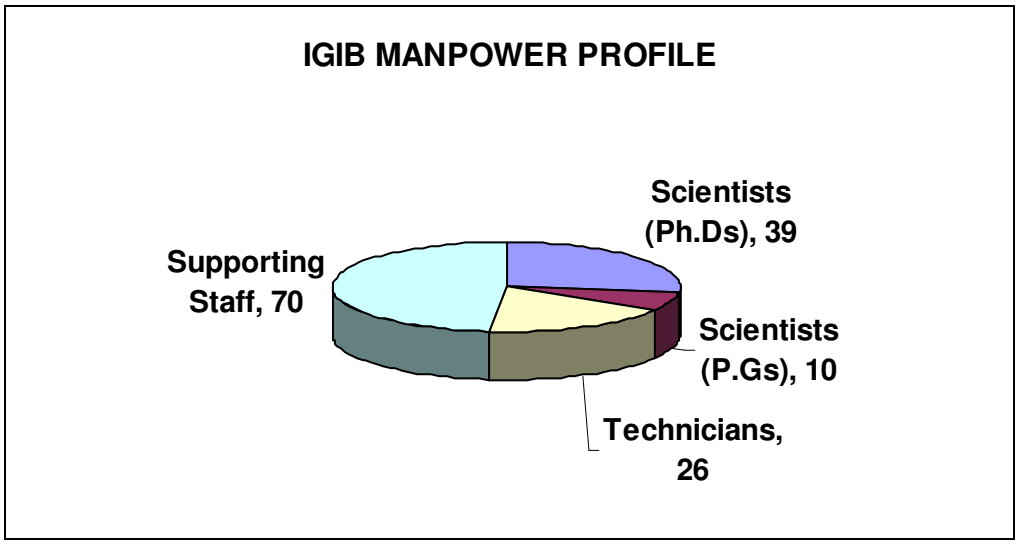
IGIB (Institute of Genomics and Integrative Biology) a premier institute and a constituent Laboratory of the Council of Scientific and Industrial Research (CSIR) carrying out research leading to generation of new knowledge and development of technologies in various areas of modern biotechnology with a special focus on genomics and genome informatics.

IGIB established originally as Centre for Biochemical Technology (CBT) was engaged in preparative biochemistry for isolation of fine biochemicals from natural resources viz., proteins, lipids, enzymes; synthesizing bioorganic compounds like peptides, oligonucleotides and preparing reagents required for recombinant - DNA research. As biochemical technology enters the genomics era, the Centre is in the process of transforming from a singular laboratory working in the area of biochemical research to a network laboratory, leading to the formation of a virtual institute of new biology and has been renamed as IGIB.

3.2.2.1 Manpower Profile

The following figure 3-7 depicts the manpower profile of IGIB:

Figure 3-7



3.2.2.2.Areas of Competencies

Table 3-6 gives the data on available manpower in the identified areas of core competency if the institute:

Table 3-6

S.No.	Area of Competence	Manpower
1.	Immunology and molecular genetics of allergy including respiratory disorders	7
2.	Genomics and Molecular Medicine	10
3.	Nucleic Acid and Peptides	4
4.	Genome Informatics (in-silico Biology)	4
5.	Gene expression, Proteomics and Structural biology	10
6.	Environmental Biotechnology	4
7.	Enzymes and simple diagnostics	2

3.2.2.3 Major R&D Facilities

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

1. Immunology and molecular genetics of allergy including respiratory disorders
    a. Small animal facility
    b. Fluorescence microscopes
    c. Fluorescence assisted cell sorter (FACS)
2. Genomics and molecular medicine
    - Atomic force microscope
    - Inverted microscope
    - Sequenom mass array facility
    - Automated DNA sequencing & genotyping facility
    - Multiple robotic workstations
    - Cell culture facility
    - Fluorescence assisted cell sorter (FACS)
    - BIACORE for ligand interaction studies
    - Microarray facility

3. Nucleic acid and peptides
    - MALDI-TOF facility
    - High throughput oligo nucleotide synthesis facility
    - Large scale and high throughput peptide synthesis facility
    - Peptide and protein sequencing facility
4. Genome Informatics (in-silico biology)
    - Cutting edge computational facility with silicon graphics workstations, ES 40 alpha clusters, linux clusters, several terabytes of storage and latest application software.
    - In-house developed software for comparative and functional genomics
    - In-house developed software for microarray data analysis
5. Gene expression, proteomics and structural biology
    - Atomic force microscope
    - Fluorescence spectrophotometer
    - CD spectrophotometer
    - MALDI-TOF-TOF
6. Environmental biotechnology
    - Robotic media preparator (AES)
7. Enzymes and simple diagnostics
    - Large scale protein purification facility

3.2.2.4 R&D facilities available for international market

The R&D facilities that can be offered for international market in various core competency areas are:

1. Genomics and molecular medicine
    - Sequenom Mass Array Facility
    - Automated DNA sequencing & genotyping facility
    - Gene chip and Microarray facility

2. Genome informatics (in-silico biology)
    - Software for comparative and functional genomics
    - Software for microarray data analysis
3. Gene expression, proteomics and structural biology
    - MALDI-TOF-TOF
    - Microarray facility
    - Automated DNA sequencing & genotyping facility
4. Nucleic acid and peptides
    - Peptide and protein sequencing facility
    - High throughput oligo nucleotide synthesis facility
    - High throughput peptide synthesis facility

3.2.2.5 Patents

Table 3-7 gives the details of the number of patents filed by and granted to IGIB during 2000-01 to 2004-05.

Table 3-7

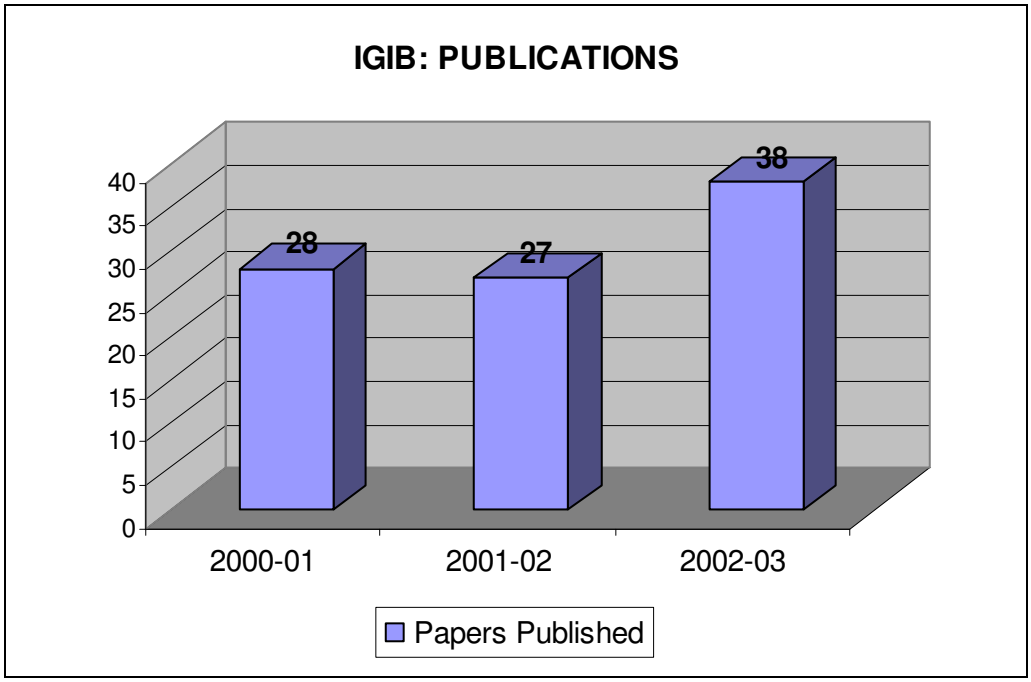
Patents filed by & granted to IGIB during 2000-01 to 2004-05

Year	Patents Filed		Patents Granted	
	In India	Abroad	In India	Abroad
2000-01	1	10	1	1
2001-02	4	22	9	1
2002-03	11	36	2	6
2003-04	7	22	4	8
2004-05	16	17	3	7
Total	**39**	**107**	**19**	**23**

3.2.2.6 Papers

The following figure 3-8 gives the details of the number of papers published by IGIB during 2000 and 2003:

Figure 3-8



(For details about the publications of IGIB, refer to the website www.igib.res.in)

3.2.2.7 Potential exportable R&D Services

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

1. Sequencing services (for DNA and protein)
2. Genotyping services
3. MALDI TOF services
4. Primer design and synthesis
5. Gene chip and micro array analysis services
6. Short term courses in bio-informatics
7. R&D consultancy services in biotechnology
8. IPR services
    a. Customized prior art searches
    b. Patent drafting

IGIB has identified training, consultancy services, IPR services and contract research as their area of interest, as is indicated from the exportable R&D services listed above.

3.2.2.8 Target Markets

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

1. Japan
2. CIS countries
3. Germany
4. USA
5. Singapore
6. Syria

3.2.2.9 Constraints & Suggestions

IGIB highlighted lack of market information, bureaucratic bottlenecks, international regulations and Lack of resources as the constraints that they 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:

- *Many of the CSIR laboratories including IGIB have the necessary skill sets and resources to market their services. However, it would be useful if CSIR could provide a common platform to reach out to global markets on behalf of CSIR TEAM, especially since more than one CSIR labs would be involved in a project. In this regard, centralized international business development and marketing wing of CSIR would be desirable. Business heads of leading laboratories should be core team members.*
- *CSIR labs at this juncture should also undertake benchmarking studies… where do they stand in the international arena in their stated areas of expertise. Based on the study / SWOT analysis, they could either develop augment) their capability or establish strategic partnerships / alliances with other CSIR labs / other institutes to*

bridge the gaps. This would greatly help in marketing of their services effectively, both within and outside the country.

- *It would be difficult to pinpoint specific kind of market survey / market intelligence information required by IGIB. What would be, however, of relevance is subscription to online commercial services offered by organizations such as BIO, Pharma. CSIR may consider subscribing to their online subscriptions on select basis for scientific journals.*

3.2.3 Institute of Himalayan Bioresource Technology

IHBT a constituent laboratory of CSIR, India is located at the picturesque town of Palampur perched in lap of majestic snow clad mountain of Dhauladhar. The institute has three main activities: research and development, HRD, and knowledge based services

The mission of IHBT is to provide an industrial R&D base for establishment, upgradation, and sustainable management of bio-resources from Himalyan region through agro technology, processing technology and biotechnology.

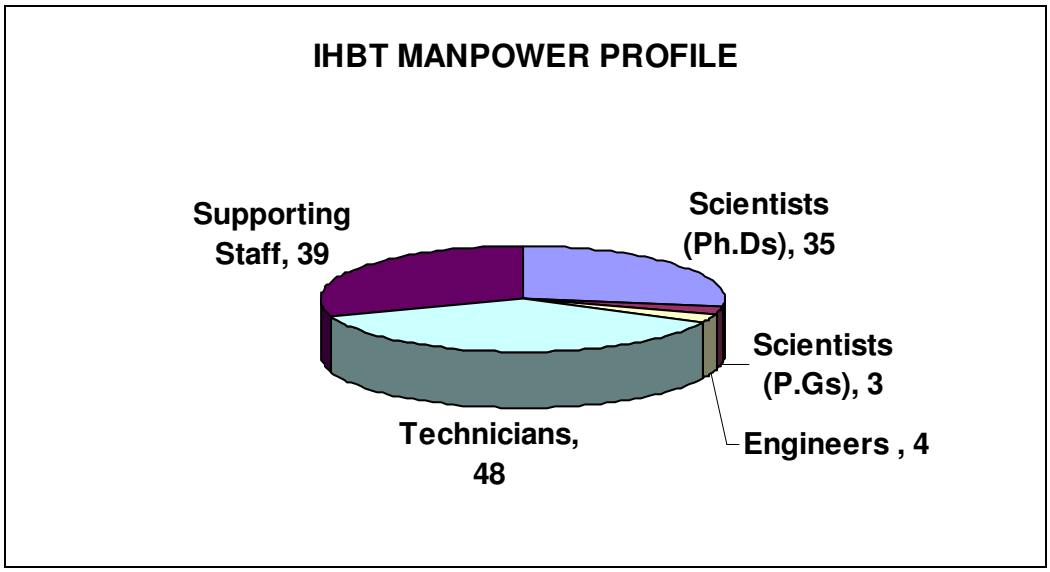
The Institute is working relentlessly on developing technologies for sustainable utilization of Himalayan bioresources, and in the area of tea, floriculture, bamboos and medicinal and aromatic plants. The institute received its new name Institute of Himalayan Bioresource Technology (IHBT) in 1997.

IHBT is constantly striving to generate new knowledge to fulfill its mission of sustainable management of bioresources in the Himalayan region by adopting a multidisciplinary approach in R & D activities. The institute has five divisions related to its core competencies engaged in research of high scientific impact.

3.2.3.1 Manpower Profile

The following figure 3-9 depicts the manpower profile of IHBT:

Figure 3-9



3.2.3.2 Core Competencies

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

1. Tea sciences

   Tea husbandary, farm mechanization, quality parameters of tea, agrotechnology and organic farming, pesticide residue and disease management

2. Plant biotechnology

   Plant molecular biology, functional genomics proteomics, transgenics, cell and tissue culture development biology.

3. Floriculture

Production of disease free planting materials, agrotechnology of ornamental plants, plant viral diagnostics, post harvest technology, genetic improvement of commercially important flowers

4. Natural Plant products

Quality standards of essential oils, natural colours, dyes, development of formulations from herbals, design of processes for extraction of herbals; agrotechnology of medicinal and aromatic plants

5. Biodiversity

Survey, mapping, GIS plant microbe Interaction, domestication and agrotechnology of economically important plants

Table 3-8 depicts the available manpower in each area of core competency:

Table 3-8

S.No.	Area of Competence	Manpower
1.	Tea Sciences	15
2.	Plant Biotechnology	15
3.	Floriculture	8
4.	Natural Plant Products	15
5.	Biodiversity	10

3.2.3.3 Main R&D Facilities

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

The 250 acre campus encompasses the state of art infrastructure for field and laboratory research. The campus enfolds well maintained tea demonstration plot, rose garden and floriculture field for undertaking research in the area of tea husbandry and manufacture, ornamentals, high value essential oil bearing and medicinal plants, bamboos and other industrially important plants. In addition to the

herbarium representing the flora of the region, live specimens of commercially important plants of Himalaya are maintained in the herbal garden. Facilities for tea manufacture and extraction of essential oil exist to process the produce from the tea and rose plantations and other aromatic plants of the Institute.

The laboratories for plant tissue culture, molecular biology, natural plant chemistry, pesticide residue analysis, virus testing, microbiology are well equipped with sophisticated instruments like:

1. NMR
2. Biolistic gun
3. Bioreactors
4. HPLC
5. GC
6. GC-MS
7. RCR machines
8. RT-PCR
9. Electrophoresis
10. Gel documentation systems
11. ELISA readers

Modern hardening facility, greenhouses, poly houses, and containment facility for transgenic plants also exist. Computer networking and state of the art library are also important assets.

3.2.3.4 Patents

Table 3-9 gives the details of the number of patents filed by and granted to IHBT during 2000-01 to 2004-05.

Table 3-9

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

Year	Patents Filed		Patents Granted	
	In India	Abroad	In India	Abroad
2000-01	5	63	Nil	1
2001-02	3	36	Nil	Nil
2002-03	5	24	1	12
2003-04	4	8	Nil	21
2004-05	10	27	Nil	17
Total	**27**	**158**	**1**	**51**

3.2.3.5 Publications

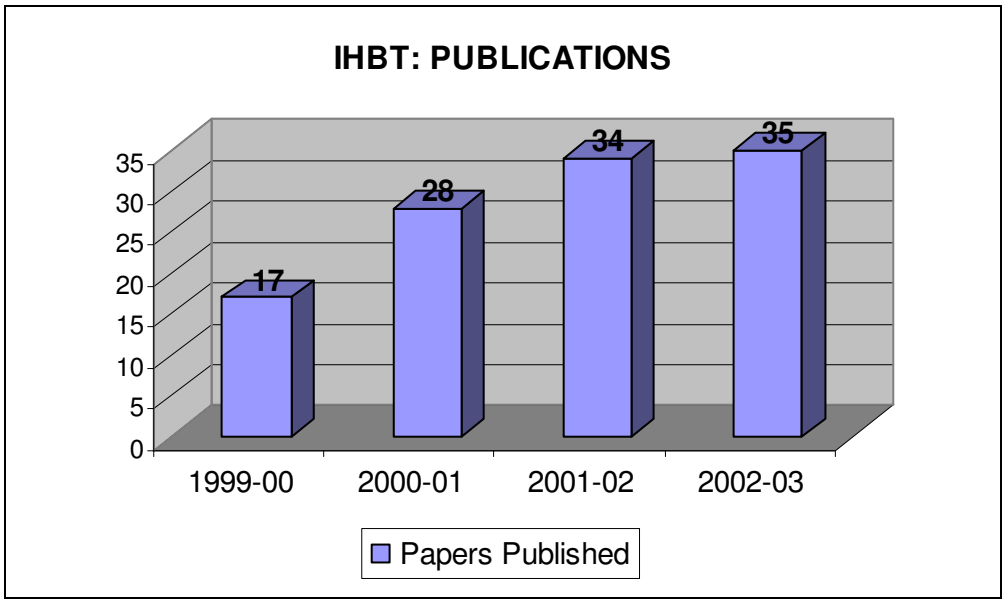
Table 3-10 gives the details of the number of publications by IHBT during 2000 and 2003 as per the areas of core competency:

Table 3-10

S.No.	Area of Competence	Papers
1.	Tea sciences	20
2.	Plant biotechnology	21
3.	Floriculture	33
4.	Natural plant products	10
5.	Biodiversity	25

However the following figure 3-10 gives the details of the number of papers published by IHBT during 2000-01 to 2002-03.

Figure 3-10



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

3.2.3.6 Potential exportable R&D services

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

1. Training

i. Processing, evaluation and testing of natural products
ii. Genomics, proteomics and development of transgenic plants
iii. Viral diagnostics in plants
iv. Pesticide residue analysis
v. Survey and mapping in GIS environment
vi. Tea husbandry, tea manufacture and development of diversified products

2. Testing and evaluation

i. Evaluation of marker compounds of medicinal and aromatic plants
ii. Quality evaluation of essential oils
iii. Viral diagnosis in ornamental plants.
iv. Pesticide residue analysis

v. Soil analysis with respect to tea

3. Turn Key projects

i. Essential oil extraction
ii. Production of steviosides
iii. Establishment of tissue culture units
iv. Rejuvination of abandoned tea gardens
v. Value addition to herbals

4. Survey of plant resources

5. Consultancy in

i. Project formulation and feasibility reports
ii. Database on bioresources
iii. DNA fingerprinting of plant genetic resources
iv. Cryopresevation of seed and plant tissues
v. Floriculture
vi. Setting up of tissue culture labs
vii. Tea husbandry and quality tea manufacture
viii. Value addition to herbals

6. Design Development of:

i. Design of distillation unit for processing of aromatics and herbals

ii. Implements for mechanization of tea farm operations

7. Product development of :

i. SOD and other stress tolerant genes
ii. neutraceuticals
iii. viral diagnosis kits
iv. stevioside production

v. diversified tea products

8. Process development of :

i. marker compounds from medicinal and aromatic plants and their identifications and evaluation
ii. flavoring molecules
iii. natural dyes and colors
iv. preparation of β-aescin
v. micropropagation of economically important plants and Protocol thereof.
vi. transgenic plants and Protocol thereof.

IHBT has identified testing and evaluation services, training, consultancy services, survey and epidemiological studies, technology transfer, contract research and turn key project consultancy as their area of interest, as is indicated from the exportable R&D services listed above.

3.2.3.7 Target Markets

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

1. Europe,
2. USA,
3. Japan,
4. Canada,
5. South east Asia,
6. South Africa,
7. Middle East

3.2.3.8 Constraints & suggestions

IHBT highlighted lack of market information, lack of exposure to international exhibitions, lack of advertisement and proper for a of the developed technologies, and no dedicated marketing personnel as the constraints that they faced in the export of R&D services. It was suggested that to overcome these constraints for enhancing exports of R&D services, since a number of technologies are developed as a spin-off from major products, adequate market demand / information may not be available in the lab. In such cases, hiring of consultants / services of professionals may help in marketing the product / technology.

3.2.4 Indian Institute of Chemical Biology

The Indian Institute of Chemical Biology was established in 1935 as the first non official centre in India for biomedical research and was included within the aegis of CSIR in 1956. IICB today is engaged in research on diseases of national importance and biological problems of global interest, employing sophisticated state-of-the-art technology in keeping with the rapid and unprecedented momentum that life science research has gained globally over the last 50 years. The scientific staff has expertise in a variety of areas including chemistry, biochemistry, cell biology, molecular biology, neurobiology and immunology which promotes productive interdisciplinary interaction.

IICB is one of the major laboratories in India which initiated, right from its inception, multidisciplinary concerted efforts for conducting basic research on infectious diseases, specifically leishmaniasis and cholera, along with the development of technologies for the diagnosis, immunoprophylaxis, and chemotherapy of the diseases. A neurobiology group is involved in research on the development of the vertebrate brain and also the genesis of human movement disorders. Bioactive substances from natural sources and chemically synthesized new molecules are being explored as potential drugs. Other areas being actively pursued are gastric hyperacidity and ulcer, muscular dystrophy and related disorders, macromolecular structure function analysis, development of targeted drug delivery systems, sperm biology and protein chemistry and enzymology.

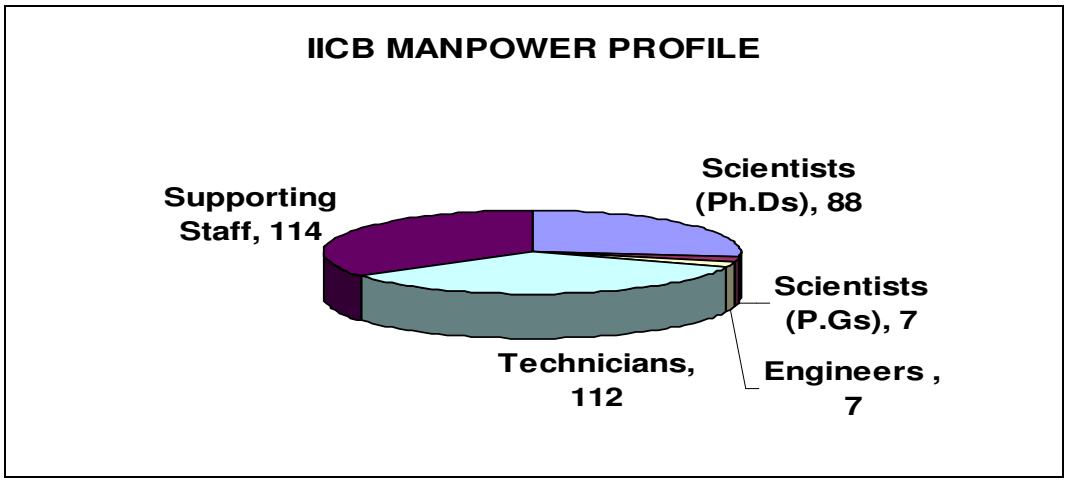
The institute has developed an oral vaccine for cholera, herbal products for controlling gastric ulcer, empirical treatment for vitiligo, diagnostic kits for malignancy and hormonal disorders, fungal enzymes of industrial importance, radiopharmaceuticals for evaluation of the functional status of renal and hepatobiliary systems and a device for early detection of Parkinson's disease. Although the strength of IICB has always been basic biomedical research, during the last decade emphasis is being given on goal oriented research directed

towards commercial exploitability. Efforts are now on to convert the knowledge gained over the years through high quality basic research into wealth.

3.2.4.1 Manpower Profile

The following figure 3-11 depicts the manpower profile of IICB:

Figure 3-11



3.2.4.2 Core Competencies

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

1. Biotechnology
2. Synthetic, biophysical and natural products chemistry
3. Drug design & development and molecular modelling
4. Human genetics and genomics
5. Immunology
6. Infectious disease
    a. Molecular biology of v. cholearae & other enteric pathogens
    b. Molecular and cellular biology of leishmania parasite
7. Cellular Physiology :
    a. Cell biology
    b. Molecular endocrinology
    c. Neurobiology
    d. Reproductive biology

The following table 3-11 depicts the available manpower in each one of these areas of core competency:

Table 3-11

S.No.	Area of Competence	Manpower
1.	Biotechnology	10
2.	Synthetic, biophysical and natural products chemistry	24
3.	Drug design & development and molecular modelling	9
4.	Human genetics and genomics	5
5.	Immunology	7
6.	Infectious disease	10
7.	Cellular physiology	24

3.2.4.3 Main R&D Facilities

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

1. Spectrofluorimeter
2. FTIR
3. Digital polarimeter
4. Non-invasive blood pressure monitor
5. UV – Vis spectrophotometer
6. HPLC/ FID / UV / FD / ECD
7. FPLC
8. Sorval RC5B
9. Gas analyser
10. -70℃ deep freezer
11. Ultracentrifuge
12. CHEF mapper
13. Lyophilizer
14. Confocal microscopy
15. LCMS-MS
16. Transmission electron microscope
17. 300 MHz NMR spectrometer

18. Fluorescence activated cell sorter
19. Semi-automatic dispensing facility
20. Patch-clamp facility
21. GC-Mass spectrometer
22. Protein sequencer
23. Modernized animal house
24. 600 MHz NMR

3.2.4.4 Patents

The following table 3-12 gives the details of the number of patents filed by and granted to IICB during 2000-01 to 2004-05.

Table 3-12

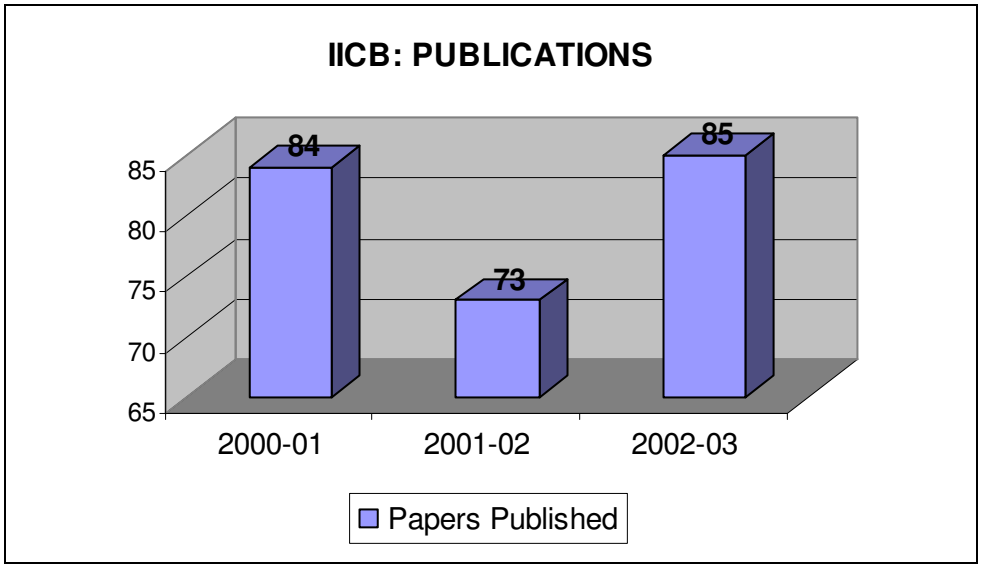
Patents filed by & granted to IICB during 2000-01 to 2004-05

Year	Patents Filed		Patents Granted	
	In India	Abroad	In India	Abroad
2000-01	2	18	2	Nil
2001-02	1	9	12	5
2002-03	5	22	4	5
2003-04	6	11	4	5
2004-05	4	6	9	9
Total	**18**	**66**	**31**	**24**

3.2.4.5 Papers

The following figure 3-12 gives the details of the number of papers published by IICB during 2000-01 to 2002-03.

Figure 3-12



(For details about the publications of IICB, refer to the website www.iicb.res.in)

3.2.4.6 Potential exportable R&D services

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

1. Custom synthesis of organic molecules
2. Extraction and characterization of natural products
3. In vitro and in vivo testing (preclinical level) for a number of diseases such as asthma, leukemia, type I & II diabetes, gastric ulcers, neurodegenerative diseases, narcotic addiction, infectious disease (Leishmaniasis and cholera), as well as activities such as immunomodulators, antioxidants, antifertility agents, etc.
4. Diagnostics kits development and their validation
5. Testing and evaluation services and contract research in the above areas
6. Medical biotechnology services to pharmaceutical industries in global market.

3.2.4.7 Constraints & Suggestions

It was suggested by IICB that to overcome the constraints for enhancing exports of R&D services in its areas of interest, *there should be regular international meet with participants from genuine international buyers and the CSIR / institutes personnel. The resources should be met and matched with international competition. Time taken for arranging resources should be effectively reduced to meet dead-lines, and effective delivery. The situation that we depend fully on foreign supply for fine chemicals and sophisticated equipments should be looked into seriously and alternative measures should be worked out.*

3.2.5 Central Drug Research Institute

Central Drug Research Institute is one of the first and few laboratories that were established in India right after its independence. CDRI was formally inaugurated on 17th Feb 1951 by the then Prime Minister of India, Pandit Jawahar Lal Nehru.

CDRI is considered to be a pioneer research organization in the field of biomedical research where all the infrastructure and expertise are available to develop a drug right from its concept to market. The very latest techniques and methodologies are employed for developing drugs, diagnostics and vaccines to combat diseases prevalent among mankind in general and Indian population in particular.

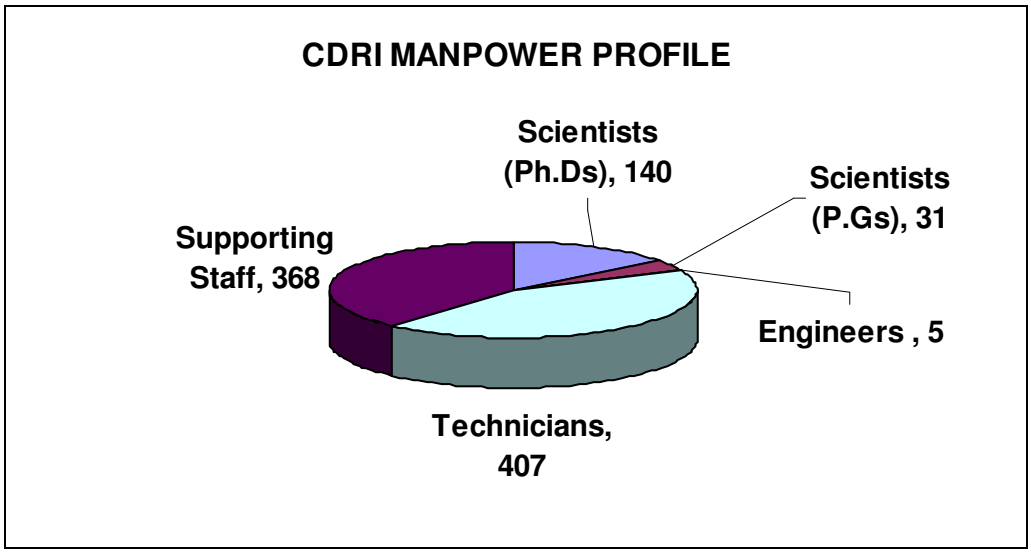
CDRI is a multidisciplinary research laboratory consisting of scientific personnel of various areas of biomedical sciences. For administrative and scientific purposes the Institute's manpower has been grouped into 17 R & D divisions and few divisions providing technical and scientific support. Two data centres and one field station located outside CDRI are providing operational support.

CDRI's mission is to strengthen and advance the field of drug research in India. The Institute has the following charter of activities: the development of new drugs and diagnostics; undertaking cellular and molecular studies to understand disease processes and reproductive physiology; the development of contraceptive agents and devices; the systematic evaluation of medicinal properties of natural products; the development of technology for drugs, intermediates and biologicals; the dissemination of information in the field of drug research , development and production; and providing consultancy and development of technical manpower.

3.2.5.1 Manpower Profile

The following figure 3-13 depicts the manpower profile of CDRI:

Figure 3-13



3.2.5.2 Areas of Core Competencies

Table 3-13 depicts the available manpower in each area of core competency of CDRI:

Table 3-13

S.No.	Area of Competence	Manpower
1.	Malaria filariasis, leishmaniasis	17
2.	Reproductive healthcare	14
3.	Cardiovascular, central nervous system and other disorders	30
4.	Technology development (chemical technology, fermentation technology and pharmaceutical technology)	73
5.	Biological screening, clinical trials, pharmacokinetic studies	12
6.	Regulatory pharmacology and toxicology	32

3.2.5.3 Main R&D Facilities

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

1. Multiple organic synthesizer
2. Highthroughput HPLC-MS
3. Single bead fourier transform infrared microscopy

4. Environmental screening electron microscope (ESEM and TEM)
5. DNA microarray
6. NMR (200, 300, 600 MHz), Mass
7. X – Ray diffractometer
8. National laboratory animal centre (NLAC)
9. National information centre for drugs and pharmaceuticals (NICDAP)
10. Sophisticated analytical instrumentation facility

3.2.5.4 Patents

The following table 3-14 gives the details of the number of patents filed by and granted to CDRI during 2000-01 to 2004-05.

Table 3-14

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

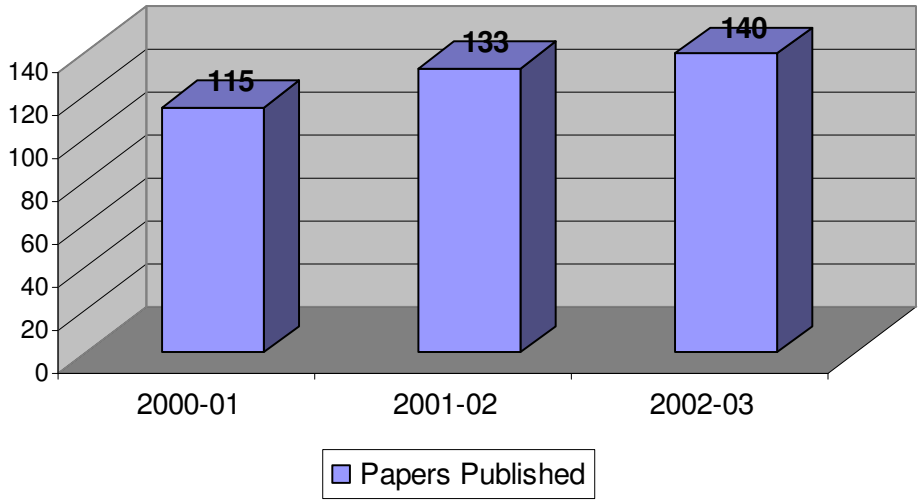
Year	Patents Filed		Patents Granted	
	In India	Abroad	In India	Abroad
2000-01	10	8	10	6
2001-02	17	27	18	6
2002-03	11	28	19	3
2003-04	15	14	7	6
2004-05	21	27	15	6
Total	**74**	**104**	**69**	**27**

3.2.5.5 Papers

The following figure 3-14 gives the details of the number of papers published by CDRI during 2000 and 2003:

Figure 3-14

CDRI: PUBLICATIONS



(For details about the publications of CDRI, refer to the website www.cdriindia.org)

3.2.5.6 Potential exportable R&D services

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

1. Analytical services of samples (synthetic, plants, marine)
2. Supply of cultures
3. Biological screening of samples
4. Regulatory pharmacology and toxicological studies
5. Supply of animals for experimentation
6. Supply of literature, information related to drugs and pharmaceuticals
7. Training to academia, industrial staffs (Indian as well as foreigners) and R&D institutions

CDRI has identified testing and evaluation services, training, consultancy services, surveys and studies and contract research as their area of interest, as is indicated from the exportable R&D services listed above.

3.2.5.7 Target Markets

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

1. South east Asian countries including India
2. All African countries
3. European countries
4. USA

3.2.5.8 Constraints & Suggestions

CDRI highlighted lack of market information, and international regulations as the constraints that they faced in the export of R&D Services. It was **s**uggested that there is a need for market and economic surveys and artificial intelligence by Informatics experts and regular horizontal flow of information by them to the R&D scientists and business development personnel.

3.2.6 Central Institute of Medicinal and Aromatic Plants

Central Institute of Medicinal and Aromatic Plants (CIMAP) was set up on March 26, 1959 by the Council of Scientific and Industrial Research.

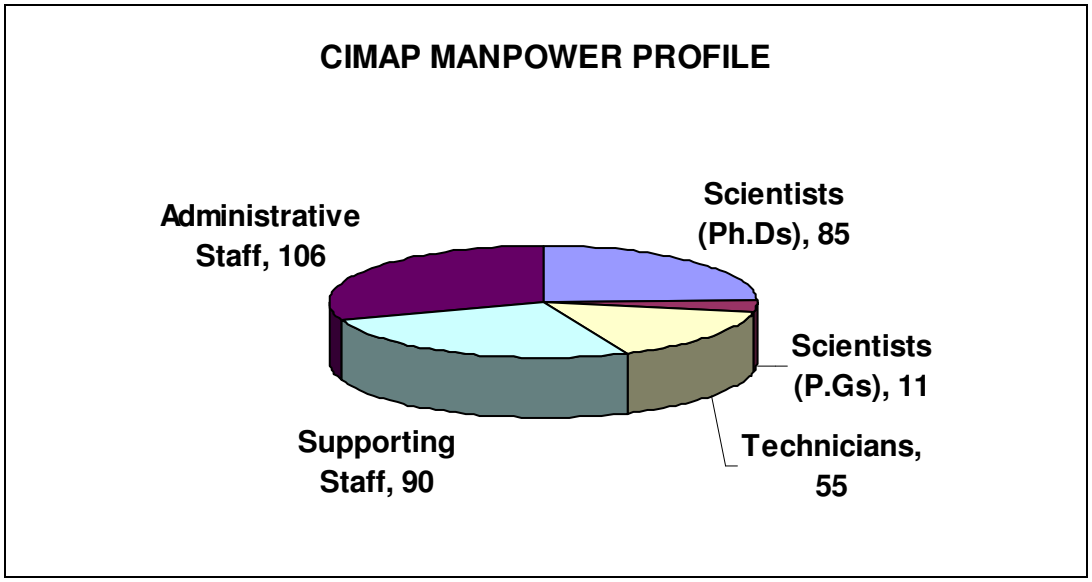
CIMAP's mandate is the genetic improvement, cultivation, production and chemical processing of economically important medicinal, nutraceutical, essential oil, dye, gum and agrichemical yielding plants; the characterization of biodiversity and conservation of genetic resouces of medicinal and aromatic plants (MAPs) and other plants of interest; the defining of genes relating to the yield determining steps of metabolic pathways concerned with chemicals of interest and their modulation; the development and commercialization of phytocellular technologies for plant compounds of pharmaceutical value; the construction of edible vaccine plants; the detection and characterization of new anti-microbial, anti-cancer/ or pesticidal chemicals of herbal origin and their commercialization; the production of seeds and other propagating materials of selected genotypes of domesticated MAPs; the formulation of the products of common use for rural development; the development of technologies for utilization of agro-wastes of industrial plants; the building up of MAP related databases; and the development of human resources for R&D in the basic and applied areas of MAP science.

The development of agrotechnologies and chemical and processing technologies for economically important medicinal and aromatic plants, both indigenous and exotic, is an important goal of the institute. Basic research in the areas of genetic resources, biotechnology, cytogenetics, phytochemistry, plant physiology, biochemistry, plant protection, pharmacognosy and molecular biology forms an important and integral part of the overall R&D programme of the institute.

3.2.6.1 Manpower Profile

The following figure 3-15 depicts the manpower profile of CIMAP:

Figure 3-15



3.2.6.2 Core Competencies

Table 3-15 depicts the available manpower in each identified area of core competency of CIMAP:

Table 3-15

S.No.	Area of Competence	Manpower
1.	Agrotechnology and variety development and improvement	19
2.	Process, product development and value addition	15
3.	Plant biotechnogy and related techniques	17
4.	Pest and disease management of MAPs	8
5.	Collection, conservation and characterization of MAPs	9
6.	Quality evaluation – phytochemicals, aroma chemicals and essential oils analyses	5

3.2.6.3 Main R&D Facilities

The following R&D facilities support the above areas of competency as the State of Art research facility for biotechnology, quality and analytical testing equipped with:

1. NMR
2. GC-MS
3. HPLCs
4. GLCs
5. Digital polarimeter
6. FT-IR
7. Electron microscope
8. Automated DNA sequencer
9. DNA – RNA synthesizer
10. Microarray system
11. Transgenic green house
12. Bioreactors
13. Super critical fluid extraction systems
14. Pilot plant
15. Tissue Culture
16. Molecular biology laboratories for genomics, proteomics and metabolome research

3.2.6.4 Patents

Table 3-16 gives the details of the number of patents filed by and granted to CIMAP during 2000-01 to 2004-05.

Table 3-16

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

Year	Patents Filed		Patents Granted	
	In India	Abroad	In India	Abroad
2000-01	10	38	1	7
2001-02	11	31	20	25
2002-03	12	65	2	36
2003-04	11	10	7	29
2004-05	18	29	13	28
Total	**62**	**173**	**43**	**125**

Table 3-17 depicts the patents granted during 2000-03 as per the areas of core competency:

Table 3-17

S.No.	Area of Competence	Patents granted in India	Patents granted in foreign countries
1.	Agrotechnology and variety development and improvement	-	12
2.	Process, product Development and value addition	24	47
3.	Plant Biotechnogy and related techniques	-	12
4.	Pest and Disease Management of MAPs	-	2

3.2.6.5 Papers

The following figure 3-16 gives the details of the number of papers published by CIMAP during 2000-01 to 2002-03

Figure 3-16

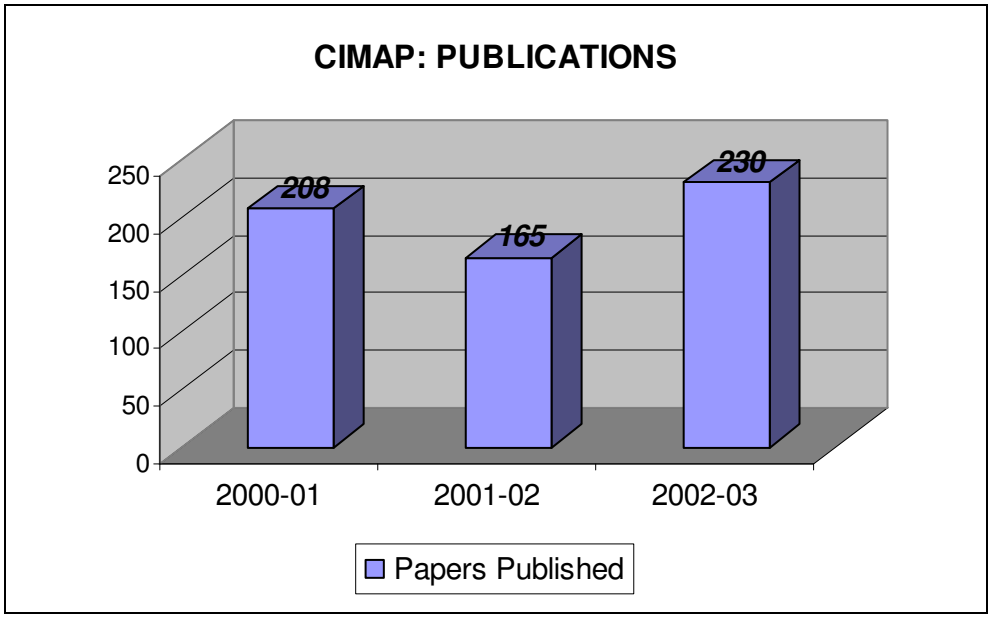


Table 3-18 depicts the papers published during 2001-03 in each one of these areas of core competency:

Table 3-18

S.No.	Area of Competence	Papers Published
1.	Agrotechnology and variety development and improvement	177
2.	Process, product Development and value addition	69
3.	Plant Biotechnogy and related techniques	79
4.	Pest and Disease Management of MAPs	39
5.	Collection, Conservation and characterization of MAPs	58
6.	Quality Evaluation – phytochemicals, aroma chemicals and essential oils analyses	47

(For details about the publications of CIMAP, refer to the website www.cimap.res.in)

3.2.6.6 Potential exportable R&D services

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

1. Training for cultivation practices and processing technologies of medicinal and aromatic plants; advance biotechnology tools and techniques including genomics and plant tissue culture quality analysis and instrumentation; and bioinformatics.

2. Testing and evaluation: specialized testing, calibration and certification – based on compliance to the quality standards meeting ISO / IEC guide – 25 and EN-4500 criteria (CIMAP has been accredited by national accreditation board for testing and calibration laboratories, government of India in 1999 for biological and chemical testing.)

3. Consultancy

i. Feasibility reports (technical-economic) on medicinal and aromatic plants cultivation practices and processing technologies.
ii. Fabrication and installation of field distillation units for essential oil crops.
iii. DNA fingerprinting and germplasm evaluation.

iv. Organic farming and certification
v. Biological activity testing

4. IPR Services: involving customised prior art searches and patent drafting related to plant varieties and natural products of medicinal and aromatic plants

5. Process technologies of medicinal and aromatic plants.

6. Distillation units upto 1 ton capacity meeting specific requirements for crops like geranium, rose, lemongrass, palmarosa, citronella, mint etc. on turnkey basis.

7. Product development for plant variety and chemotype development, herbal formulations and semi-synthetic phytomolecules and derivatives for drug development as sponsored/contract projects.

8: Process development

i. Agrotechnology for specific crops & agroclimates
ii. Distillation of essential oils & fractionation of high value isolates & monoterpenes
iii. Extraction, phytomolecule isolation & purification
iv. Semi-synthetic derivatization of phytomolecules
v. Bioactivity evaluation (in-vitro & in-vivo)
vi. DNA fingerprinting for authentication of plant materials
vii. Marker development for quality validation

CIMAP has identified testing and evaluation services, training, consultancy services, IPR Services, contract research, technology transfer and turn key projects as their area of interest, as is indicated from the exportable R&D services listed above.

3.2.6.7 Target Markets

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

1. Third world / developing countries
2. Europe, USA, Canada
3. North Korea and South Korea
4. Asian countries

3.2.6.8 Constraints & Suggestions

CIMAP highlighted lack of market information, bureaucratic bottlenecks, international regulations and National regulations as the constraints that they faced in the export of R&D Services.

It was suggested that to overcome the constraints in enhancing the exports of R&D services, CSIR can develop a system like MIS where market information is easily available for access. The resources in terms of more trained manpower and finance would need to match activity in demand as these two are the major component of exporting R&D services. National regulations need to be simplified and a single window coordinated by CSIR may be established. Laboratories may be encouraged to organize international interactive meet every three years where persons from industry, academies / universities / institutions and manufacturing units be invited for sharing their experiences and elaborating their needs and expectations from CSIR laboratories. This type of meets should be distinct from organizing a seminar / symposia with the business as the focal point of interaction. Networking of CSIR laboratories to project a stronger knowledge and product portfolio complete in all respects using diverse expertise and infrastructure base of CSIR as whole can be directly a catalyst to generate international collaborations and partnerships.

3.2.7 National Botanical Research Institute

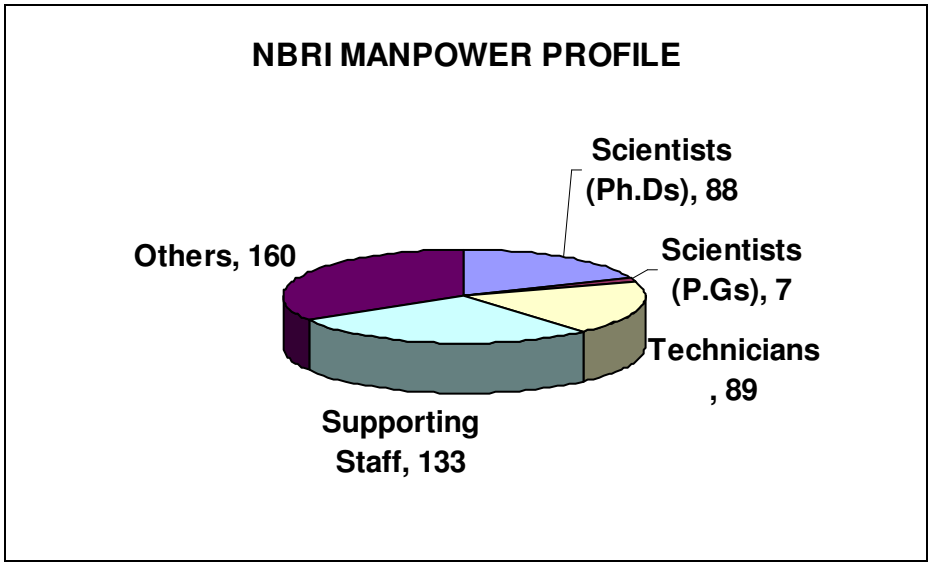
National Botanical Research institute is premier plant based multidisciplinary, state-of-art national R&D Centre of CSIR undertaking research from classical taxonomy to cutting edge areas of modern biology-including both applied and basic research in the fields of biochemistry, bioinformatics, biotechnology, conservation biology, cytogenetics, environmental sciences, ethnopharmacology, floriculture, molecular biology and genetic engineering, pharmacognosy, pharmacy, physiology, phytochemistry, plant biodiversity, plant breeding, plant wealth utilization, taxonomy, microbiology and tree biology, with the end in view of conservation and sustainable utilization of the non crop plant genetic resources of the country.

CSIR took over National Botanic Garden in 1953 and expanded the scope of the institute into multidisciplinary plant research centre and renamed it as the National Botanical Research Institute in 1978. NBRI is now an internationally well-known research centre in India and it focuses on both basic and applied aspects of plant sciences. While working on biodiversity, bioinformatics, biomass biology, biotechnology, conservation, ethnopharmacology, floriculture, plant physiology, genetics & plant breeding, molecular biology & genetic engineering, natural product development etc., it caters to the need of almost every aspect of plant research in South Asian region in general and India in particular. Both basic and applied research programmes in all the above said plant sciences are dealt by NBRI scientists. The institute offers consultancy and technology on various aspects of plant sciences including information technology.

3.2.7.1 Manpower Profile

The following figure 3-17 depicts the manpower profile of NBRI:

Figure 3-17



3.2.7.2 Areas of Competencies

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

1. Plant Biodiversity & Conservation Biology
2. Biomass Biology & Environmental Sciences
3. Genetics and Plant Breeding & Agrotechnology
4. Bioinformatics & Library
5. Molecular Biology & Genetic Engineering
6. Pharmacognosy & Ethnopharmacology
7. Phytochemistry
8. Botanic Garden & Floriculture
9. Plant Conservation & Eco-Education
10. Biotechnology & Plant Physiology

Table 3-19 depicts the available manpower in each of the core competency of NBRI:

Table 3-19

S.No.	Area of Competence	Manpower
1.	Plant biodiversity & conservation Biology	14
2.	Biomass biology & environmental sciences	14
3.	Genetics and plant breeding & agrotechnology	10
4.	Bioinformatics & library	2
5.	Molecular biology & genetic engineering	15
6.	Pharmacognosy & ethnopharmacology	8
7.	Phytochemistry	6
8.	Botanic garden & floriculture	7
9.	Plant conservation & eco-education	6
10.	Biotechnology & plant physiology	13
11.	Experimental agro fields	5

3.2.7.3 Main R&D Facilities

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

1. Gas chromatograph
2. GLC
3. TLC
4. UVITEC Gel documentation systems
5. Atomic absorption spectrophotometer
6. Phytochem for antioxidant activity
7. High performance thin layer chromatography (HPTLC)
8. High pressure liquid chromatography (HPLC)
9. PCR for genetic engineering
10. Well-maintained blind garden and eco educator centre
11. ILDIS data base
12. Rich library

13. Experimental farm sites – 100 acres

3.2.7.4 Patents

The following table 3-20 gives the details of the number of patents filed by and granted to NBRI during 2000-01 to 2004-05.

Table 3-20

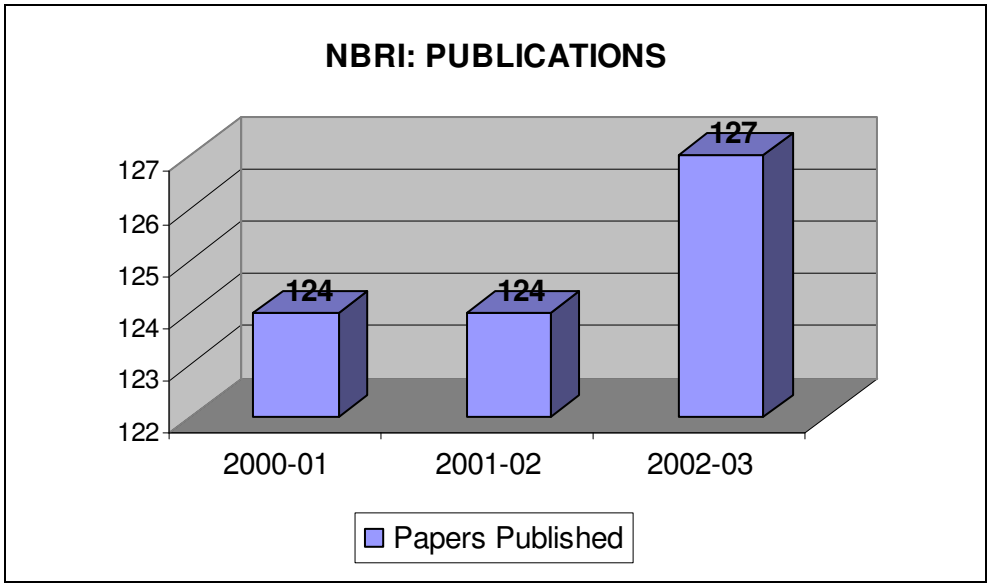
Patents filed by & granted to NBRI during 2000-01 to 2004-05

Year	Patents Filed		Patents Granted	
	In India	Abroad	In India	Abroad
2000-01	3	13	Nil	Nil
2001-02	2	10	Nil	1
2002-03	1	19	1	3
2003-04	7	20	Nil	3
2004-05	23	32	Nil	4
Total	**36**	**94**	**1**	**11**

3.2.7.5 Papers

The following figure 3-18 gives the details of the number of papers published by NBRI during 2000-01to 2002-03

Figure 3-18



(For details about the publications of CCMB, refer to the website www.nbri-lko.org)

3.2.7.6 Potential exportable R&D services

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

1. Training

i. Biodiesel, bioenergy, biofuel
ii. Phytoremediation
iii. Neem
iv. Pharmacognostical, phytochemical and ethnopharmacological identification of botanicals
v. Survey, inventorying, documentation and biodiversity assessment, herbarium techniques and curation
vi. Methods & approaches in plant taxonomy
vii. Floriculture
viii. Plant tissue culture

2. Testing and evaluation

i. Biodiesel, bioenergy, biofuel Phytoremediation
ii. Neem
iii. Biodiversity
iv. Pharmacognostical, phytochemical and Ethnopharmacological identification of botanicals, standardization, QC, GLP's, GCP's, GMP's of herbal drugs, compound formulations

3. Consultancy services

i. Biodiesel, bioenergy, biofuel
ii. Phytoremediation
iii. Biodiversity

iv. Pharmacognostical, phytochemical and Ethnopharmacological identification of botanicals, standardization, QC, GLP's, GCP's, GMP's of herbal drugs, compound formulations

v. Medicinal and aromatic plants (Ex-situ conservation, Cultivation and post harvesting processing, organic cultivation techniques)

vi. Floriculture

vii. Plant tissue culture

4. Contract / Sponsored research:

i. Design development for QC, standardization development of novel herbal products

ii. Process Development for phytoremediation, floriculture and plant tissue culture

iii. Product development for neem, floriculture and pharmaceutical, cosmaceutical and nutraceutical

5. Surveys and epidemiological studies

a. Pharmacognostical, phytochemical and Ethnopharmacological identification of botanicals, standardization, QC, GLP's, GCP's, GMP's of herbal drugs, compound formulations

b. Air pollution monitoring and management studies

c. Study of biology of greenhouse gas emission from croplands and wetlands

d. Water pollution monitoring and management

e. Bioremediation and bio-utilisation of Industrial wastes

6. Turn key projects

i. Hi-Tech low cost nursery

ii. Herbal beer
iii. Herbal lipstick

7. Technology Transfer:

ii. Plant Tissue culture
iii. Plant growth promoting bacterial inoculants
iv. Bt cotton for insect resistance
v. Floriculture plant tissue culture

NBRI has identified Training, Testing and evaluation, consultancy services, Turnkey projects, Technology transfer, Surveys and studies and Contract Research as their area of interest, as is indicated from the exportable R&D services listed above.

3.2.7.7 Target Markets

NBRI has identified industrial houses (national and international), rural community, R&D institutional, and collaborative partners in foreign countries as target markets for its R&D services

3.2.7.8 Constraints and Suggestions

It was suggested that to overcome the constraints in enhancing the exports of R&D services, *it would be better to have more information about the prospective collaborative partners along with their profile.*

3.2.8 Institute of Microbial Technology

The mandate of the Institute of Microbial Technology (IMTECH) is to provide integrated research, development and design base for microbial technology; to undertake basic and applied research and development programmes in established and newly emerging areas of relevant biotechnology including genetic engineering; to optimise the existing microbial processes currently available and in use in the country; to develop and maintain gene pool resources and genetic stocks of microbial cultures and other cell lines. This could also serve as a reference centre to assist other centres; to establish facilities for biochemical engineering, instrumentation development including microprocessor systems, a computer centre and development of mathematical models for process parameters; to establish facilities for design of process equipment and bioreactors; to impart training in microbiology, microbial technology and biochemical engineering; to conduct training and refresher courses for research workers and technologists; to establish documentation and information retrieval and dissemination facilities and a data bank to meet the needs of the Institute; to establish and maintain effective linkages with industry and educational institutions; and to develop capabilities for producing design and engineering packages for industrial plants.

During the past five years or so the Institute has initiated several cutting edge research programmes. These aim to address some of the pressing R&D problems in IMT mandated area of expertise. This has not only created highly motivated research groups but has also resulted in a number of highly cited publications. During this period the Institute maintained its position among the first 5 CSIR laboratories in terms of the average impact factor of papers published.

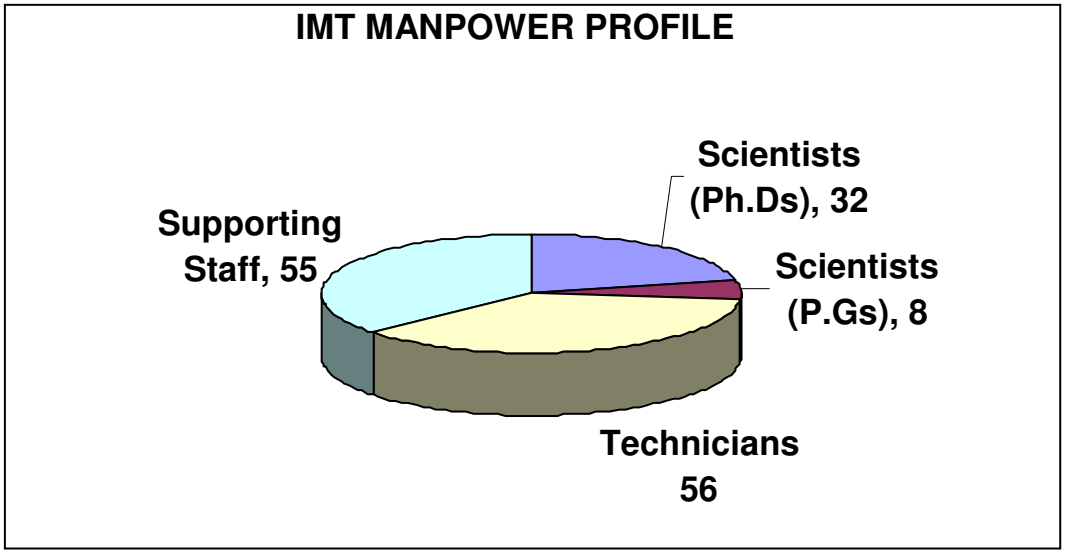
Besides excellent research done, IMTECH further strengthened its links with the industry with the ultimate goal of taking its research to the market place. The ambit of the CSIR programme on discovery of molecules from fungal and microbial sources under IMT coordination was further extended.

Further, during this period the Institute tied up with several sponsors; two large multinationals, five large Indian companies, one public sector company and several small to medium sector companies. Many of the projects signed were successfully completed. It is a matter of satisfaction that the Institute enjoys credibility amongst its target clientele for the quality and timely completion of the projects. In addition to these contracts research projects the Institute successfully completed several scope grant-in-aid projects funded by various government agencies. The Institute offered bio-incubator facility to a large Indian company, who could use it for a one year period and successfully developed a product, which is now in extended clinical trails.

3.2.8.1 Manpower Profile

The following figure 3-19 depicts the manpower profile of IMT:

Figure 3-19



3.2.8.2 Areas of Core Competencies

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

1. Molecular biology and microbial genetics
2. Protein science and engineering
3. Cell biology
4. Fermentation technology and applied microbiology

Table 3-21 depicts the available manpower in each one of these areas of core competency:

Table 3-21

S.No.	Area of Competence	Manpower
1.	Molecular biology and microbial genetics	35
2.	Protein science and engineering	20
3.	Cell biology	10
4.	Fermentation technology and applied microbiology	10

3.2.8.3 Main R&D Facilities

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

1. Scanning and transmission electron microscopes
2. HPLC / FPLC
3. Gel documentation system
4. Gas Chromatograph
5. Image plate detector
6. Image analyzer
7. MALDI-TOF
8. Gamma irradiator
9. Protein sequencer and peptide synthesizer
10. Alpha digital
11. Silicon indigo and sun computer systems
12. Modern facilities to identify, preserve, and maintain microorganisms
13. Protein X-ray crystallography facility
14. DNA sequencer
15. FT-IR spectrophotometer
16. Confocal microscope and FACS machine
17. LN2 plant
18. P3 laboratory facility
19. Well maintained animal house

3.2.8.4 Patents

The following table 3-22 gives the details of the number of patents filed by and granted to IMT during 2000-01 to 2004-05.

Table 3-22

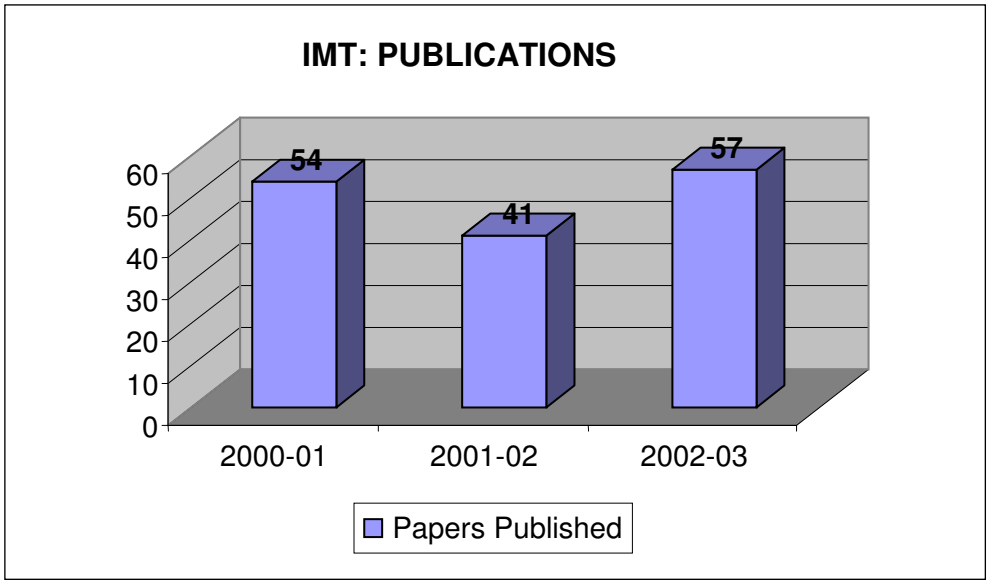
Patents filed by & granted to IMT during 2000-01 to 2004-05

Year	Patents Filed		Patents Granted	
	In India	Abroad	In India	Abroad
2000-01	Nil	6	1	1
2001-02	2	11	4	Nil
2002-03	6	5	1	1
2003-04	4	7	2	4
2004-05	3	Nil	2	2
Total	**15**	**27**	**10**	**8**

3.2.8.5 Papers

The following figure 3-20 gives the details of the number of papers published by IMT during 2000 -01 to 2002-03

Figure 3-20



(For details about the publications of IMT, refer to the website www.imtech.res.in)

3.2.8.6 Potential exportable R&D services

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

1. Contract research including consultancy in the area of microbial technology
2. Space to set-up business incubators
3. Fermentation support including scale up and down stream processing
4. High end training in the areas of bioinformatics, bioprocessing, strain isolation and characterisation

IMT has identified training, consultancy services and contract research as their areas of interest, as is indicated from the exportable R&D services listed above.

3.2.8.7 Constraints and Suggestions

According to IMT, the target market identified for the above services could be in any region. IMT highlighted lack of market information, Bureaucratic bottlenecks, not very competitive as compared to foreign labs and lack of resources as the constraints that they faced in the export of R&D Services.

It was suggested that to overcome the constraints in enhancing the exports of R&D services, the following should be undertaken:

- *To enhance the export of R&D services, we need to respond very quickly and for that debureaucratisation of our enabling structures is required.*
- *Our national regulations are not very conducive to tie-ups.*

3.2.9 Regional Research Laboratory Jammu Tawi

RRL Jammu, a multidisciplinary research institute engaged in R & D on bio prospecting of natural molecules; biotechnology- fermentation and enzyme technology, microbial biodiversity, moleculelar biology and gene cloning; natural products chemistry; cultivation and utilization of drugs and essential oil bearing plants and chemical engineering and design backup for packaging of technologies.

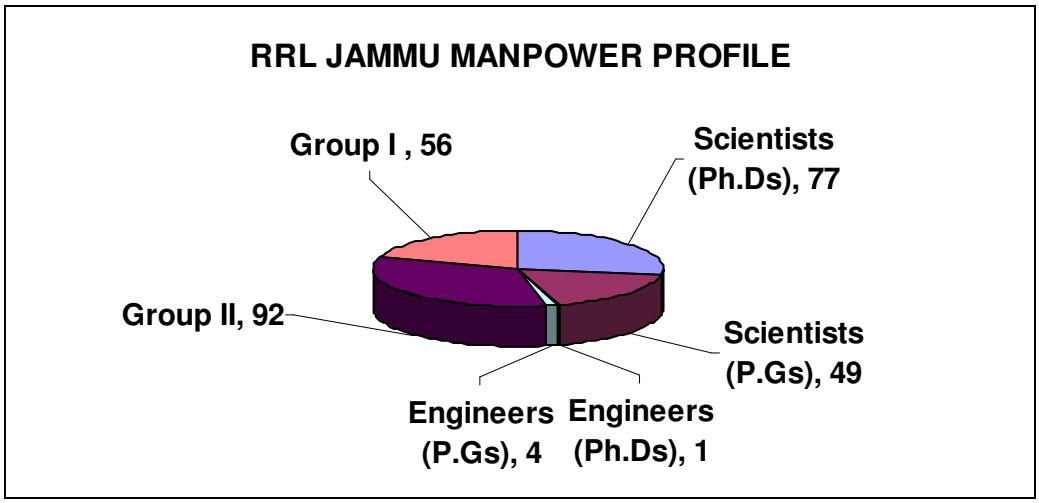
Regional Research Laboratory (RRL), Jammu a constituent of Council of Scientific & Industrial Research, New Delhi, is one of the premier institutes engaged in two major areas of research namely, drug, design and development and microbial biotechnology. however, overall aim of this Institute is to boost the industrial development of the north western region of the country. The laboratory was established in 1941 as a low key research and production centre known as drug research laboratory of J&K state and was later taken over by CSIR in December 1957. Col. Sir Ram Nath Chopra, Prof. of Pharmacology was its Founder Director. He was an outstanding luminary in the field of medical education and research and has been widely acclaimed as the father of Indian pharmacology.

The objectives of the laboratory widened and research programmes related to utilization of all the natural resources were taken up, may these be of biological or mineral origin upon take over. To day, RRL Jammu is recognized as a leading Institute in natural product chemistry and its chemical technology and biotechnology. The focus of research in RRL is on medicinal and aromatic plants, their conservation and genetic improvement, tissue culture, plant based drug development, their quality control and standardization. In the area of biotechnology, the institute well known for its contribution in fermentation technology and enzymology - and state of the art molecular biology leading to cloning of genes and their expression for industrial uses. It is supported by strong central instrumentation, of latest generation, upto date library and informatics centres supported by intra and internet facilities are available in this laboratory.

3.2.9.1 Manpower Profile

The following figure 3-21 depicts the manpower profile of RRL Jammu Tawi:

Figure 3-21



3.2.9.2 Areas of Competency

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

1. Prospecting biodiversity for its chemistry and bioactivity
2. Development of the bioenhancers of the plant origin
3. Prospecting biodiversity (plant and microbial) of North – west Himalayas
4. Cultivation, processing, Improvement, conservation, and standardization of agro technologies of medicinal and aromatic plants
5. Quality control and assurance

Table 3-23 depicts the available manpower in each one of these areas of core competency:

Table 3-23

S.No.	Area of Competence	Manpower
1.	Prospecting biodiversity for its chemistry and bioactivity	10
2.	Development of the bioenhancers of the plant origin	4
3.	Prospecting biodiversity (plant and microbial) of north – west Himalayas	5
4.	Cultivation, processing, improvement, conservation, and standardization of agro technologies of medicinal and aromatic plants	10
5.	Quality control and assurance	5

3.2.9.3 Main R&D Facilities

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

1. Screening of enzymes
2. Fermentation pilot plant facility up to 3KL scale
3. Screening plants and fractions thereof for specific biological activities
4. Standardization of herbal formulation and their quality control
5. Quality control assurance and analysis of drugs, pharmaceuticals, minerals, coal, water etc.
6. Up scaling of lab processes using chemical engineering facilities

3.2.9.4 Patents

The following table 3-24 gives the details of the number of patents filed by and granted to RRL Jammu Tawi during 2000-01 to 2004-05.

Table 3-24

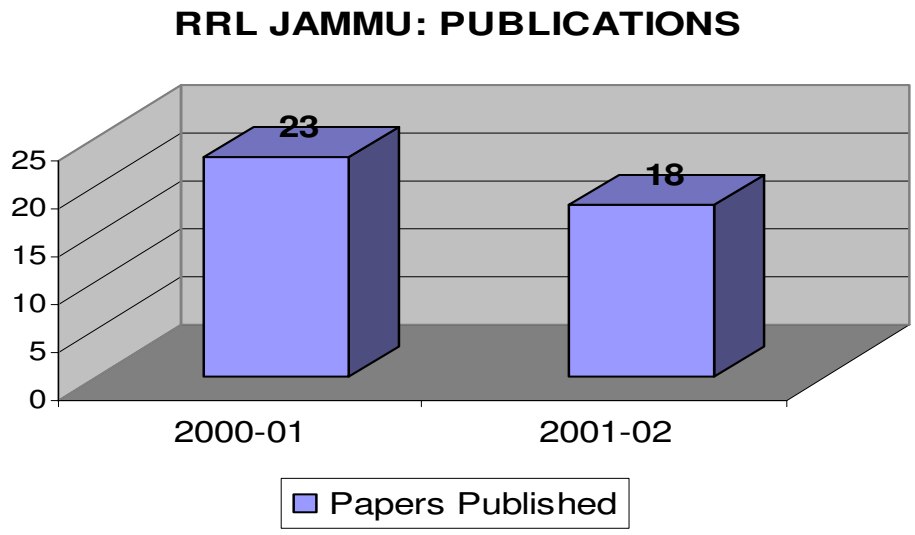
Patents filed by & granted to RRL (J) during 2000-01 to 2004-05

Year	Patents Filed		Patents Granted	
	In India	Abroad	In India	Abroad
2000-01	17	Nil	8	Nil
2001-02	10	48	9	1
2002-03	12	45	5	Nil
2003-04	10	9	3	12
2004-05	14	43	16	8
Total	**63**	**145**	**41**	**21**

3.2.9.5 Papers

The following figure 3-22 gives the details of the number of papers published by RRL Jammu Tawi during 2000-01 and 2001-02

Figure 3-22



(For details about the publications of RRL Jammu Tawi, refer to the website www.rrljammu.org)

3.2.9.6 Potential exportable R&D services

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

1. Screening of enzymes
2. Fermentation facility of RRL
3. Screening of plants and fractions thereof for specific biological activities
4. Standardization of herbal formulation and their quality control
5. Quality control assurance and analysis of drugs, pharmaceuticals
6. Minerals, coal, water etc.
7. Up scaling of lab processes using chemical engineering facilities.

RRL Jammu Tawi has identified testing and evaluation services, consulting Services, and contract research as their areas of interest, as is indicated from the exportable R&D services listed above.

3.2.9.7 Target Markets

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

1. Europe
2. USA
3. China
4. Germany

3.2.9.8 Constraints and Suggestions

RRL Jammu Tawi highlighted lack of market information and lack of resources as t he constraints that they faced in the export of R&D services.

It was suggested that to overcome the constraints in enhancing the exports of R&D services, the following should be undertaken:

- *Identify the available exportable service*
- *Identify the niche in the exportable manpower and facilities in CSIR*
- *Send specialized groups to identify the market and for discussions*
- *Infuse confidence in the customers and develop customer satisfaction for whatever service we provide.*

3.2.10 Indian Toxicology Research Centre

Established in 1965, the Industrial Toxicology Research Centre (ITRC), Lucknow, a constituent laboratory of Council of Scientific & Industrial Research (CSIR) is dedicated to provide health safeguards to industrial and agricultural workers through its rich knowledgebase, created painstakingly over the years. The main campus is located on Mahatma Gandhi Marg in the city, while the other campus is in village Gheru on Lucknow-Kanpur highway about 22 km from the main campus.

The business of ITRC is to create new knowledge about health and chemicals. It is a unique and important scientific resource in toxicology safety research and testing. The laboratory, through its scientific expertise, provides complete facilities for toxicological research, environmental & health risk assessment and analysis & toxicity testing services conforming to good laboratory practices using national and international guidelines employing latest test systems, biomarkers, analytical instruments and mathematical models.

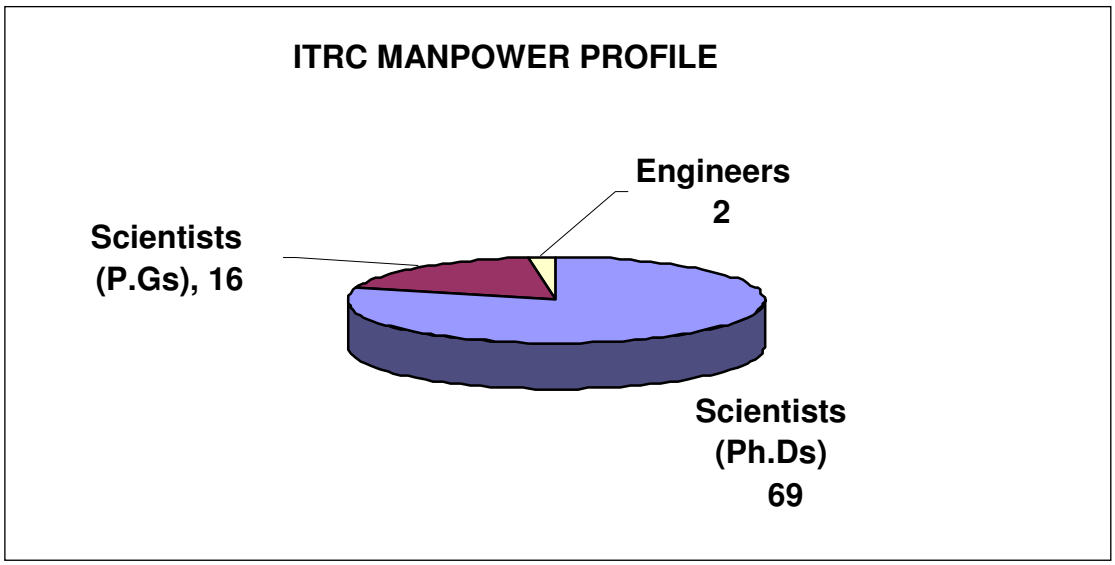
The strength of the centre lies in the knowledgebase and analytical as well as experimental skills built over the last three decades in the areas of health risk assessment, preventive toxicology, predictive toxicology, environmental toxicology, inhalation toxicology and analytical toxicology. The centre is also equipped with state of the art facilities in the field of molecular toxicology and regulatory toxicology.

The objectives of the centre are the identification of occupational health hazards due to exposure to chemicals in industries, mines, agricultural fields and general environment by undertaking health and environmental surveys; undertaking studies for working out the mode of action of toxic chemicals/pollutants; the development of simple/rapid diagnostic tests for disorders caused by industrial and environmental chemicals; the safety evaluation of chemicals used in industry, agriculture and everyday life; to suggest remedial/preventive measures to safeguard health and environment from pollutants; the collection, storage and dissemination of information on toxic chemicals; and human resource development to deal with industrial and environmental problems.

3.2.10.1 Manpower Profile

The following figure 3-23 depicts the manpower profile of ITRC:

Figure 3-23



3.2.10.2 Core Competencies

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

1. Toxicological studies of petroleum products and chemicals
2. Human exposure risk to food, agro-chemicals and mineral fibers
3. Neurotoxicity and cardiotoxicity of pyrethroids, quinalphos, and organochlorines: mechanism and bio-makers
4. Effects of pollutants on bio-diversity and environmental detoxification
5. Toxicocity evaluation, monitoring of pollutants and development of mathematical models for prediction of fate of chemicals in environmental compartments
6. Toxicity of inhaled vapours, aerosols and particulates

3.2.10.3 Patents

The following table 3-25 gives the details of the number of patents filed by and granted to ITRC during 2000-01 to 2004-05:

Table 3-25

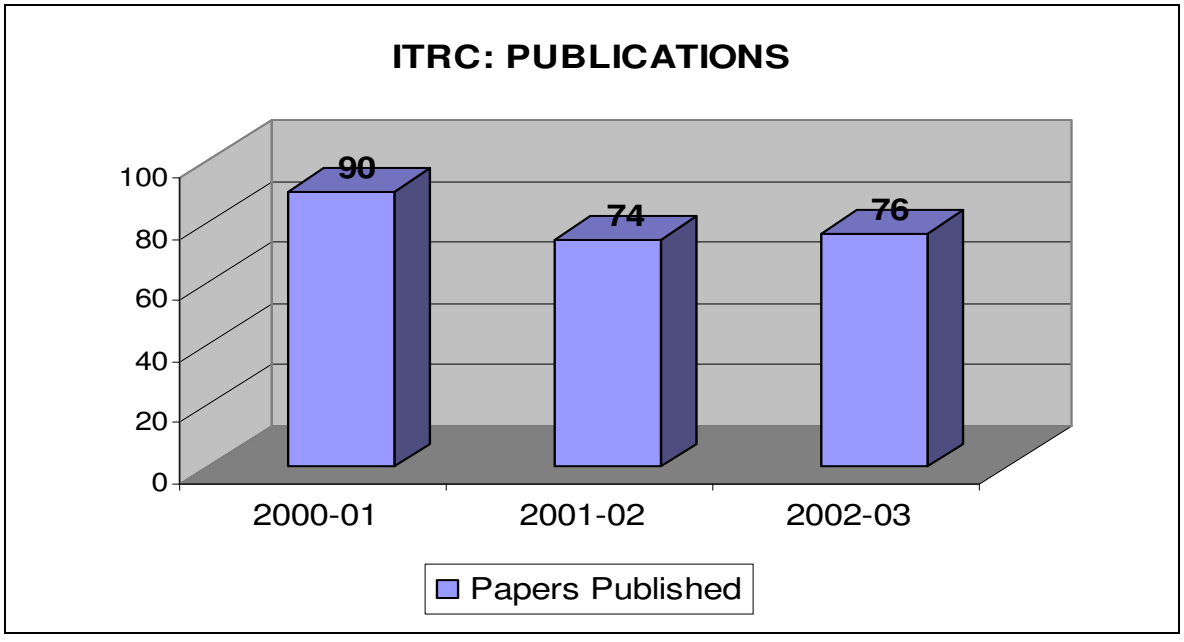
Patents filed by & granted to ITRC during 2000-01 to 2004-05

Year	Patents Filed		Patents Granted	
	In India	Abroad	In India	Nil Abroad
2000-01	3	Nil	2	Nil
2001-02	2	Nil	3	Nil
2002-03	2	Nil	Nil	Nil
2003-04	1	Nil	2	Nil
2004-05	2	Nil	Nil	Nil
Total	**10**	**Nil**	**7**	**Nil**

3.2.10.4 Papers

The following figure 3-24 gives the details of the number of papers published by ITRC during 2000-01 to 2002-03.

Figure 3-24



(For details about the publications of ITRC, refer to the website www.itrcindia.org)

3.2.10.5 Potential exportable R&D services

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

5. Health and environmental monitoring
    a. Epidemiological surveys / studies on occupational diseases in industrial workers with remedial measures
    b. Survey for adulteration and contamination of food material
    c. Environmental & air monitoring studies
    d. Monitoring of noise level in industrial environmental and residential areas
    e. Environmental and ecotoxicological impact assessment studies
6. Analysis of pollutants
    a. Quality assurance studies for purity of herbal raw drugs and presence of contaminants
    b. Analysis of residues of pesticides and metals in biological and environmental samples
    c. Waste water analysis from industries
    d. Analysis of serum samples of protein malnourished children for their anti-oxidant status i.e. SOD, glutathione peroxide total thiol content and TBARS levels
7. Safety evaluation
    a. Safety evaluation of drinking water and packaged water
    b. Safety evaluation of agrochemicals dyes, food additives, plastics and polymers, petrochemicals, detergents, fibres and particulate matter
    c. Long term toxicity studies for neurological, reproductive, tetratogenic, mutagenic, carcinogenic and phototoxic evaluation
    d. Safety evaluation of herbal products
8. Disposal of wastes

    a. Microbial conversion of liquid wastes to useful commodities
    b. Biodegradation of persistent pesticide
    c. Bioremediation of contaminated sites

ITRC has identified testing and evaluation services, consultancy services, surveys and studies and contract research as their areas of interest, as is indicated from the exportable R&D services listed above.

3.2.10.6 Target markets

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

1. Other developing countries
2. SAARC countries

3.2.10.7 Constraints and Suggestions

ITRC highlighted lack of market Information as the constraint that they faced in the export of R&D services.

3.2.11 Central Food Technology Research Institute

The Central Food Technological Research Institute (CFTRI) was declared open by Mr. C.Rajagopalachari, the then Home Minister in the Government of India on the 21st of October, 1950, and Dr. V. Subrahmanyan became the first Director of the institute.

CFTRI thus became a reality (as a constituent institute of CSIR and its third national laboratory) thanks to the vision and endeavours of its founders and a network of dedicated scientists who had a passion to pursue in-depth scientific research into one of the most fundamental aspects of human life. With over 75% of the population occupied in food raising, and no facilities to benefit from post-harvest technology till then, India hailed the birth of CFTRI and started to look at it with great expectations.

By the time the institute formally began functioning, the partition of India had taken place which together with the separation of Burma had precipitated a real food crisis in India. The institute, therefore, rightly set its sights on food conservation, food protection and enhancement of the nutritious status of food products, to help the nation overcome the critical shortage of food and its dire health consequences. The outcome of this was the development of many breakthrough technologies that created waves on India's food scenario, and made the world sit up and take notice.

The institute has come a long way not only chronologically, but even in terms of its perception of its own role as well as its perspectives, in tune with the radical changes taking place on India's economic, social and technological fronts. The food crisis that inspired the birth of the institute is far behind us now, and so are the fetters to India's global economic growth.

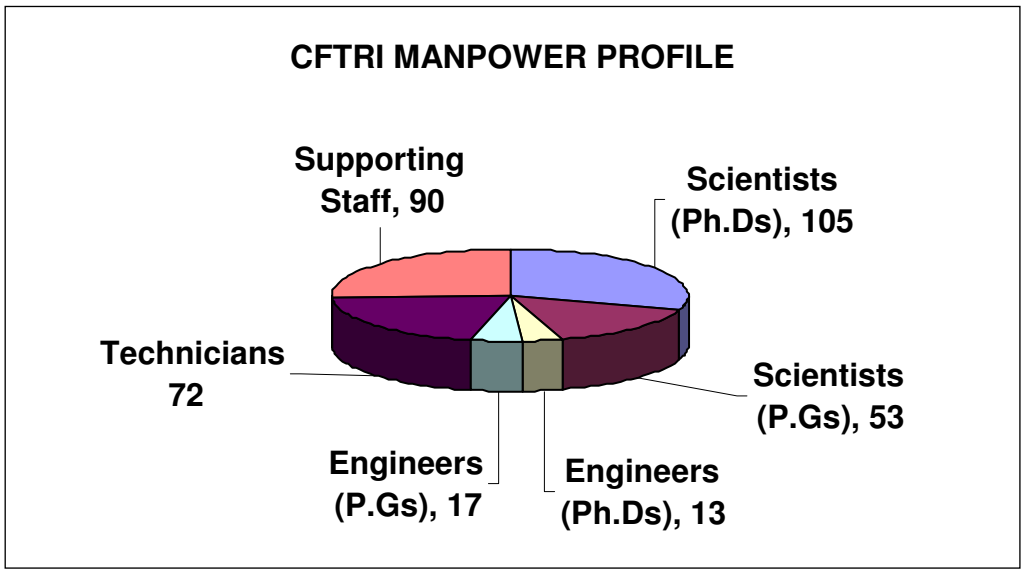
Today India is the second largest food producer in the world and can make a difference to itself and to the world with its advancements in food technology which automatically brings CFTRI to the fore. In every category of our food crop—grains, pulses, oilseeds, spices, plantation produce, fruits & vegetables— and even in meat, fish & poultry, there is now a remarkable uptrend in production, and CFTRI is obviously playing a valuable role

in developing and transferring technologies to derive the optimal processed value from this favourable situation for the benefit of farmers, processors and consumers.

3.2.11.1 Manpower Profile

The following figure 3-25depicts the manpower profile of CFTRI:

Figure 3-25



3.2.11.2 Core Competencies

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

1. Post – harvest technology
2. Food biotechnology
3. Traditional foods
4. Natural food additives
5. Food safety
6. Food microbiology
7. Genetically modified foods and nutrigenomics

Table 3-26 depicts the available manpower in each one of these areas of core competency:

Table 3-26

Sr.No.	Area of Competence	Manpower
1.	Post – harvest technology	85
2.	Food biotechnologys	18
3.	Traditional foods	20
4.	Natural food additives	10
5.	Food safety	28
6.	Food Microbiology	10
7.	Genetically modified foods and nutrigenomics	11

3.2.11.3 Main R&D Facilities

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

1. Nodal CODEX laboratory
2. National Information centre for food science
3. Modern food engineering centre
4. Pilot plant facility
5. National food database resource centre
6. Sophisticated instrumentation facility
7. Animal and plant cell culture facility
8. Computerised wheat mill of 20 tons/day
9. Automated solid state fermentation unit
10. Evaporative cool storage facility

3.2.11.4 Patents

The following table 3-27 gives the details of the number of patents filed by and granted to CFTRI during 2000-01 to 2004-05.

Table 3-27

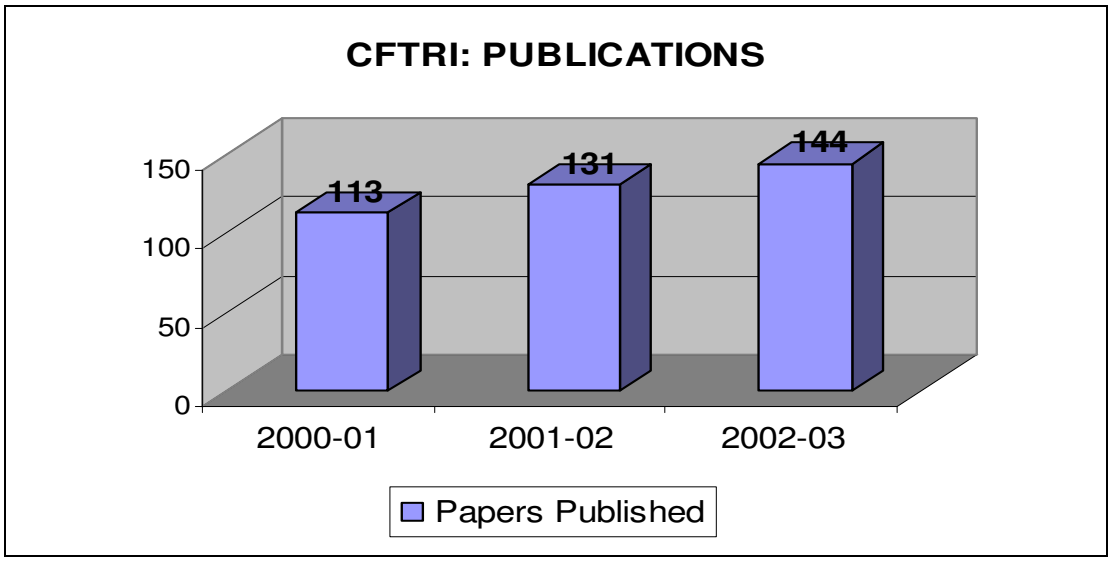
Patents filed by & granted to CFTRI during 2000-01 to 2004-05

Year	Patents Filed		Patents Granted	
	In India	Abroad	In India	Abroad
2000-01	61	26	2	1
2001-02	100	60	8	2
2002-03	122	105	5	7
2003-04	104	66	29	15
2004-05	59	41	31	19
Total	**446**	**298**	**75**	**44**

3.2.11.5 Papers

The following figure 3-26 gives the details of the number of papers published by CFTRI during 2000-01 to 2002-03.

Figure 3-26



(For details about the publications of CFTRI, refer to the website www.cftri.com)

3.2.11.6 Potential exportable R&D services

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

1. Technology transfer in the field of food technology
2. Training and human resource development in the field of food technology
3. Analysis of food samples

CFTRI has identified testing and evaluation services, training, and technology transfer as their areas of interest, as is indicated from the exportable R&D services listed above.

3.2.11.7 Target Markets

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

1. SAARC
2. ASEAN
3. AFRICAN countries
4. EEC

3.2.11.8 Constraints & Suggestions

CFTRI highlighted 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 to overcome the constraints in enhancing the exports of R&D services, the following should be undertaken:

- Projection of R&D services to potential clients abroad
- Project all kinds of R&D services through a state-of-art web site
- Provide thrust through various administrative support in clearance, interaction and joint collaboration etc.