Final Report on

"Pilot Study on the Career Profile and Professional Achievement of the Ph.D.s in Science from Selected Universities / Institutes of India"

[Grant no. 94741: Sanction L No. DST / NSTMIS / 05/49 / 2004, Dated 22/03/04]

Commissioned by

National Science and Technology Management Information System (NSTMIS) Division,

Department of Science & Technology (DST),

Govt. of India,

Technology Bhawan, New Mehrauli Road, New Delhi-110016

Prepared and Submitted By

Natural Resources India Foundation (NRIF)

(A not-for-profit NGO for research, consultancy & turnkey jobs and, operating in More than 11 States Viz.: Andhra Pradesh; Gujarat; Haryana; J & K; Karnataka; Maharashtra; Punjab; Rajasthan; Uttranchal; Uttar Pradesh; Web: <http://nrif.tripod.com/>;

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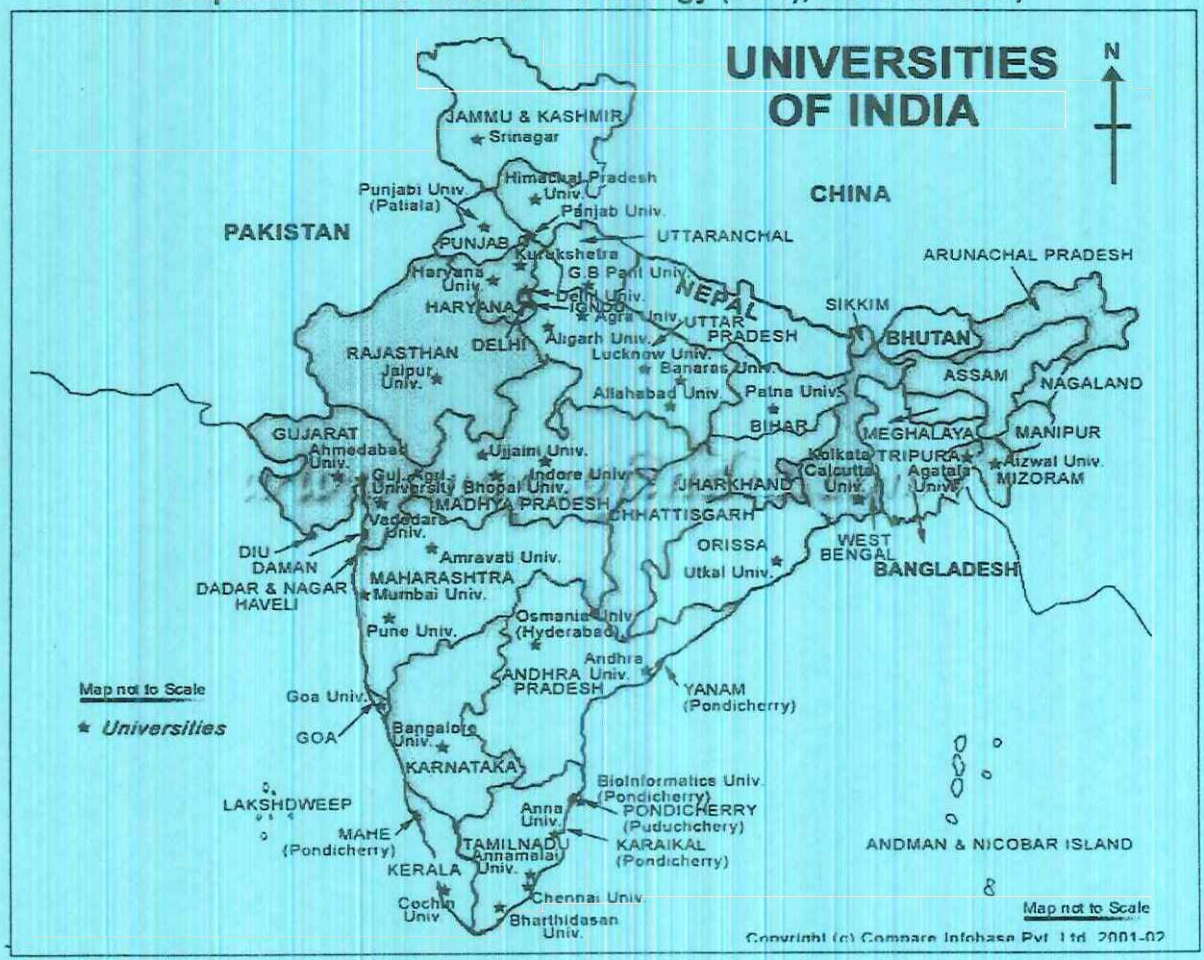

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Decemvber 2005

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Preface

National Science and Technology Management Information System (NSTMIS) Division, Department of Science & Technology (DST), Govt. of India, assigned this pilot study to NRIF during last week of March 2004 to be completed in about 15 months. The work on the assignment was initiated in Mid June 2004, after formal communication was issued to all the 25 selected Central, State, Deemed Universities / Institutes[1] in the country. These comprised of: Nine (9) central universities; ten (10) institutes of national importance; two (2) institutes deemed to be universities; and, four (4) state universities. These 25 Universities / Institutions covered 12 institutes in the Northern region; 5 in the Eastern region; 5 in Southern region and 3 in the Western region.

The study attempted to profile the out-turn characteristics of doctorates through comprehensive case studies from selected institutions covering the reference period from 1999-2000 to 2001-2002. The study was conducted in two phases under the overall guidance of Local Project Advisory Committee LPAC[2] constituted for the study by the NSTMIS. For these phases, separate specially designed questionnaires, approved by LPAC, were used.

Under Phase-I, NRIF created the benchmark of the characteristics of these institutions and generated the information about: a) type of Science faculties; b) their research activities; c) support they received through NET / GATE or sponsorship for PhDs; d) year-wise enrollment of the students having completed the doctorate; and e) information about pattern of professional / career activity of the PhD degree and, f) addresses (permanent / present) of the passed out PhD students for contacting during the second phase;

Under the Phase-2: attempt was made to established contact with all the passed out PhD scholars who had completed PhD during the period from 1999-2000 to 2001-2002, based on the particulars collected during the first phase. Detailed questionnaire was

1 The 25 selected Central, State, Deemed Universities, Institutes were approved by the Programme Advisory Committee (PAC) of NSTMIS on 13th January 2004.

2 The LPAC, held two meetings during the period on 13th August 2004, after completion of the Phase-I and second on 13th June 2005, after completion of the Phase-II.

then sent through post / e-mail to get the responses from the respondents. The survey questionnaire was also placed on the NRIF-Website, which was designed to facilitate the respondents in providing their direct response through it. Further, interactions with faculty members of selected institutions and experts was also undertaken to get their perceptions about the quality of research. Constrains faced by the PhD scholars in the process and factors that required special attention. The number of total scholars who had completed PhD degrees from these 24 universities / institutes[3] during the reference period was 3053. However, based on the addresses available with these institutes, primary questionnaires (under Phase-II) were sent to all these PhD scholars, of which approx. 1,000 questionnaires came back because the scholars had shifted elsewhere. Further, out of the remaining 2,043 scholars, only 1,221, i.e. 60% responded to the questionnaire. The placement of these PhD respondents has mainly been in the Govt. institutions (76%), about 16% have gone abroad, either for doing Post- doctoral studied or have taken up jobs over there and, the balance 8% are serving in the private sector.

The study has contributed to a better understanding of out-turn characteristics of doctorates from the selected institutions. The study also provides details on the share of research done in different disciplines / sub-disciplines, funding support available, the research environment, motivation levels and benefits being derived from the PhD work. The reaction from them has been mixed giving an impression of great satisfaction as well as dissatisfaction.

The study has also attempted to provide important insights to the policy makers and other connected to S&T system with analysis of strengths and weaknesses of the doctoral research program in selected educational institutions.

This Report has been organized into seven chapters, followed by Appendices.

- Chapter-I: Introduction: provides an overview of PhDs in Science faculty in India and a brief comparison at international scenario, besides listing the limitations of the Study, which may have bearing on the interpretations and conclusions.
- Chapter-II: Objectives and Methodology;
- Chapter-III: Characteristics of PhD Scholars;

3 IGNOU does not award PhDs. However, its "School of Sciences" offers few Certificate Courses which form part of BPP, PPC, BA, B. Com., BCA, BTS programmes.

- Chapter-IV: PhD Research Process, Facilities and Output;
- Chapter-V: Career Profile of PhDs in Science & Technology;
- Chapter-VI: Summary of Findings and Conclusions;
- Chapter-VII: Suggestions & Recommendations

Subsequent to the submission of our Draft Report on 31st October 2005, the findings of the study were also presented by Advisor & Head, NSTMIS (Dr. Laxman Prasad), DST, MoS&T, GoI, at the UNESCO conference held in New Delhi in the last week of November 2005. The Final Report is now being submitted after incorporating all the suggestions from NTSMIS, LPAC Members and others.

We hope that the NSTMIS Division, Department of Science & Technology, Govt. of India, as also UGC, the policy planners of higher education, Universities / Institutes running the PhD programme would find the study report useful.

Place: New Delhi For *NATURAL RESOURCES INDIA FOUNDATION (NRIF)*

Dated: 31st December 2005

R P MATTOO
PRESIDENT

Acknowledgement

The NRIF expresses its gratitude to NSTMIS, DST, MoS&T,GoI, for funding this study. Our special thanks are due to Dr. Laxman Prasad, Advisor & Head, NSTMIS, DST, MoS&T, GoI, Mr. Rakesh Chetal, Director and, Mr. Praveen Arora, Director, for their useful technical input since inception of the study. Our thanks are due to other concerned officials of the NSTMIS, DS, GoI, for their invaluable cooperation and necessary assistance while undertaking this study.

We are thankful to all the Vice chancellors, Registrar's, HoD's and members of the Faculty of Sciences of selected 25 Universities / Institutes for providing all the basic information about the PhD scholars, who had been awarded PhD by these institutes during the reference period.

The study would not have taken the present shape without the intellectual guidance and support of Local Project Advisory Committee (LPAC), from time to time.

The NRIF gratefully acknowledges the technical input provided by the cross-section of PhDs which included academicians, some retired and some still involved in research, research scientists in government laboratories, opinion-makers, policy-makers and others.

We are thankful to all the individual PhD scholars / respondents for returning to us filled in Questionnaires by post and e-mail with answers to specific questions as well as with their frank views and perception to some of the issues. The information provided by them has been kept confidential and used only for the purpose of the project study. Some of individuals whom we contacted were good enough to send us the present address of their batch mates to facilitate contact.

Mr. Vijay Kumar Monga, LPAC, Member read through the draft of this report and provided comments and useful suggestions.

We are also greatly honoured and thankful to Dr. Laxman Prasad, Advisor & Head, NSTMIS, DST, MoS&T, GoI, for having presented, among other things, the findings of this study at the UNESCO conference held at New Delhi in the last week of November 2005. We feel proud to have been informed that the findings have been well received at the said conference.

Last but not the least, the study would not have been possible to complete, without the cooperation of our technical team and, experts spread over in different parts of the country. NRIF thanks them all for their unstinted support at all times of the study.

For NATURAL RESOURCES INDIA FOUNDATION (NRIF)

R P MATTOO,
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Local Project Advisory Committee (LPAC)

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2.	Dr. A K Srivastava, Former Jt. Director, IASRI, R/o B-25, GF, Dilshad Garden, Delhi-110095;	Member,
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15.	Mrs. Namita Gupta, Sc D, NSTMIS, DST, MoS&T, GoI;	Special Invitee
16.	Dr. A.N.Rai Sc D, NSTMIS, DST, MoS&T, GoI;	Special Invitee

Study Team

- R P Mattoo, Project Director and, Team Leader

Data Processing & Analysis

- Ms Sheetal Garg, S Bandyopadhyay and Arbind Kumar

Core Team for Field Survey who covered different Universities / Institutions

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- D P Pande & Dr. Pramod Kumar Singh (*Allahabad; Banaras; Lucknow University & IIT Kanpur)*
- D V Jhagirdhar; M R Katti & G B Karweer (*II Sciences, Bangalore*) & *SCTIMST - Medical College, Tirunathapuram*
- K Shankar (*IIT Madras & Madras University*)
- K Krishna Murti *(TIFR, Mumbai)*
- Dr. Santosh Gurtu, V Shravan Kumar & D Dharma Reddy (*Hyderabad University*)
- Dr. A Sarma, Mr. Naba Kumar Bagabati & Jayanta Kumar Chakraborty *(Assam University & IIT Guwahati),*
- Gramin Vikas Seva Sansthan (*Jadhavpur University & ISI, Kolkatta and, IIT Kharagpur*)
- Preveen Kaul *(NIPER, Mohali, Punjab)*
- Progressive Research Aids Pvt. Ltd. (*Pune University*)
- Ms Shama Parween [*AMU, Jami Milia Islamia, AIIMS (Phase-1) & IIT Bombay*]
- Mr. R L Raina *(AIIMS) (Phase-2)*

ABBREVIATIONS USED

AIIMS	All India Institute of Medical Science
ASEAN	Advanced of South East Asian Nations
AICTE	All India Council for Technical Education
AMU	Aligarh Muslim University
AP	Andhra Pradesh
BA	Bachelor of Arts
B.Com	Bachelor of commerce
BCA	Bachelor of Computer Applications
B.Tech	Bachelor of Technology
BCI	Bar Council of India
BHU	Banaras Hindu University
BTIS	Bio- Technology Information System
CDAC	Centre for the Development of Advanced Computing
CSIR	Council of Scientific & Industrial Research
CU	Central University
CABE	Central Advisory Board of Education
CCH	Central Council of Homeopathy
CCIM	Central Council of Indian Medicine
CDC	Consultancy Development Centre
CII	Confederation of Indian Industry
DEA	Data Envelopment Analysis
Dmd U	Deemed University
DEC	Distance Education Council
DSIR	Department of Scientific & Industrial Research
DST	Department of Science and Technology/ Dynamic Stochastic Transfer
ENVIS	Environmental Information System
FC	Foreign Collaborations
FICCI	Federation of Indian Chambers of Commerce & Industry
FIST	Fund for the Improvement of Science & Technology Infrastructure
GATE	Graduate Aptitude test in Engg
GOI	Government of India
HoD	Head of Department
HRD	Human Resource Development
ICAR	Indian Council of Agricultural Research
ICAS	Indian Council of Ayurveda & Siddha
ICMR	Indian Council of Medical Research
ICSTI	International Centre for Science & Technology Information
IDAMS	Internationally Developed Data Management System
IGNOU	Indira Gandhi National Open University
IISc	Indian Institute of Sciences
IIM	Indian Institute of Management
IIT	Indian Institute of Technology
IITM	Indian Institute of Tropical Meteorology
IJHS	Indian Journal of History Of Science
IJPAM	Indian Journal of Pure & Applied Mathematics
ILAC	International Laboratory Accreditation Conference
ILD	Institute For Labour Development
ILTP	Integrated Long Term Programme
IMD	India Meteorological Department
IMDPS	Insat Meteorological Data Processing System
IMR	Indian Monsoon Rainfall
IMS	Indian Meteorological Society
INAE	Indian National Academy of Engineering
INSA	Indian National Science Academy

INSAT	Indian National Satellite
IoNI	Institutes of National Importance
ISCA	Indian Science Congress Association
ISI	Indian Statistical Institute
JRF	Junior Research Fellowship
JNU	Jawaharlal Nehru University
LPAC	Local Project Advisory Committee
MHRD	Ministry of Human Resource Development
MNC	Multinational company
M.Phil	Master of Philosophy
MCI	Medical Council of India
MBA	Masters of Business Administration
MD	Doctor of Medicines
NSF	National Science Federation
NET	
NCSTC	National Council for Science & Technology Communication
NDC	National Data Centre
NGO	Non Government Organization
NSTMIS	National S&T Management Information System
NIPER	National Institute of Pharmaceuticals Education & Research
NAAC	National Assessment & Accreditation Council
NCTE	National Council for Teacher Education
NRI	Non Resident Indian
OECD	Organization for Economic Cooperation & Development
PAC	Programme Advisory Committee
PAMC	Programme Advisory Monitoring Committee
PGI	Post Graduate Institute of Medical Education & Research
PoE	Potential of Excellence
PCI	Pharmacy Council of India
RAE	Research Assessment Exercise
RCI	Rehabilitation Council of India
S&T	Science and Technology
SU	State University
SCI	Science Citation Index
TIFR	Tata Institute of Fundamental Research
UGC	University Grants Commission
UwPoE	University with Potential of Excellence

EXECUTIVE SUMMARY

- ST classification stand at 4% (45). Their distribution between rural is 27% and urban 73% respectively.
- SC classification stands at 3% (37). Their distribution between rural is 32% and urban 71% respectively.
- All above classification clearly indicate that urban residents have a better access to the universities / institutes, perhaps because of their placement-situation in the urban areas i.e. almost all institutions which support PhDs are located in urban areas.

9) The family income had been classified into 5 main occupations viz. Service, Teaching, Agriculture, business and others, in the descending order. Services top the list with 31% (379) out of the total respondents. It is seen that about 10% of the families to whom PhD scholars belong, were from the business class; 12% of such families have an income exceeding Rs.2 lakhs a year. That points out that 26% of the families coming from teaching background is not surprising, but it is heartening that 25% actually come from an agricultural background. Service and business family backgrounds are concentrated in the third income bracket, i.e. Rs.1-2 lakh. There is a reverse relation in the income and Ph.D. holders for all occupation categories. Only the service background shows some symmetric relation.

10) The analysis shows that it is not the prerogative of the wards of the highly qualified parents to pursue PhD studies, the opportunities of higher education and research are now being pursued by scholars of even matriculate parents. Again this augurs well for a developing country like India.

11) Around 1050 respondents had less than 60% aggregate marks in PG, at the time of enrollment and approx. 61 respondents had more than 60% aggregate marks at the time of admission. Rest of the 110 respondents besides PG had qualifications with other professional degrees, whereas none of the respondents had M Phil degree.

12) Around 75% of respondents (915) had taken up enrollment for PhD, on the basis of interview, whereas only 25% (306) had been qualified for admission after giving an entrance test.

13) Individual topics for the PhD had grouped into 4 broad types viz. a) Lab work; b) course work; c) Field work and, d) others. The %age response had been in the same descending order a) Lab work (44% respondents); b) course work (32% respondents); c) Field work (18% respondents) and, d) others (6% respondents).

14) Only 77% respondents had taken membership from the different professional bodies. The remaining 23% thought it either useless or perhaps they could not afford it. However, relative unsatisfactory level of membership of professional bodies by scholars of various kinds of institutions indicates a need for better support in this context by the authorities concerned.

15) Interestingly, academic interest was the motivating factor for 87%) of the PhD scholars. The next response had been for who wanted to improve their career prospectus (30%). No better option, family and peer pressure were of low significance. Sponsorship was too limited a phenomena. Therefore, pursuit of excellence reflected in the academic interest as the prime motivating factor, though a good indicator of march forward, would need further probing on the underlying factor.

16) The placement %age of the respondents has expectedly been in the order of: a) Government (76%); b) Foreign (16%); and, c) Private (8%). The placement with private institutions–either independent or corporate–are few and far between. Even though about 50% of PhDs scholars felt that their work was relevant to industry. But they have neither had enough opportunity to interact with the industry nor industries have so far been attracted toward their topics.

17) Among the 16% of the respondents having moved abroad in 21 countries of different continents. Majority of them are in different institutes in USA: 131 (67.18%); followed by France: 13 (6.67%); Bangladesh: 10 (5.13%); Germany and, Japan: 9 each (4.26%); Canada: 7 (3.59%); Palestine: 2 (1.33%) and, one each in countries like: Australia; Iraq (Baghdad); Egypt; Holland; Hong Kong; Iran; Nepal; New Zealand; South Korea; Sudan; Taiwan; UK and Zurich.

18) Though perception about benefits after PhD degree had varied from either sex but aspect like: "Respect from society" has ranked highest with 73% between the male and female. Approx. 51% feel that they have been given more important responsibilities after completing PhD. Around 49% feel they will get an opportunity to take up post-doctoral fellow-ship and 46% have got higher position after completing PhD. Around 42% have got job after completing PhD. Around 49% (598 out of 1221) of the respondents are fully satisfied after completing PhD, whereas 41% respondents (501) are partially satisfied.

19) About 35% respondents (427) are still pursuing the research activities depending upon the facilities available within their institutions wherever they are serving. Approx. 65% respondents (794) have either no opportunity or they are not interested.

20) Predominantly and expectedly 42% (513) respondents are from the Teaching profession. Next 26% PhDs (317) are from R & D sector followed by 18% (220) from S & T Research: 12% Academician, 2% from Management sector. Approx. 13% PhD respondents (159) are over qualified for their jobs, when their minimum requirement of qualification had been only graduate degree. Next 43% PhD respondents (537) needed only Post Graduate degree for their jobs, whereas they were with doctorate degree.

21) Around 38% of the respondents (463) have got jobs pertaining to their specialization they have had during their PhD programme. One can infers that the PhD programmes in Indian universities / institutes will have to fully train the candidates for obtaining the right kind of jobs. Besides, PhD candidates will also have to get fully aware about the available job opportunities at the right places at the right time.

22) Only 29% of the respondents are having opportunity to apply their research capabilities to the present job. This infers that 71% are over qualified for their present job and /or they grabbed whatever they got even after 5-6 years of hard labour they have put-in while completing their PhD programme.

23) Around 77% of the respondents (940 out of 1221) indicate they are able to apply the knowledge acquired from the PhD to their present jobs. Remaining 23% either did not responded to this question or they were unemployed or their nature of job has been different.

24) Only 33% of the respondents have got special incentive in their jobs after completing PhD. Considering the fact that the Central Government gives 2 pay increments for a PhD, though it is not exactly a huge encouragement despite one spends a minimum 3 and typically 5-6 years for doing a PhD. That calls for change in Govt. policy on incentives!

25) We got about 84% responses on the overall impact of the PhD degree and, the suggestions they provided. Among them about 56% suggested improving the infrastructure in the form of better laboratory facilities, more journals (international), books, instruments etc. Next comes better course work (17%), evaluation of research work (13%), collaboration with industry / institutions (6%).

26) Reacting on the professional degree other than PhD approx. 29% of the respondents felt they would be in a better position elsewhere with professional degree other than PhD.

27) The plus factor for doing PhD helped the scholars to develop: a) analytical thinking (78%); b) applying new skills (67%); and c) more focused (58%). Other advantages are: a) better prospects for moving abroad (67%); b) invitation to different academic professional courses (67%); c) prospects for getting more lucrative jobs (50%); and d) enhanced prestige in the society. 6.47 Interestingly, a) around 26% of the respondents had the job before taking up enrolment for PhD with the ratio of male: female being 66:34; b) 39% got job during their PhD programme with the ratio of male: female being 80:20; and c) around 35% got job after completion of their PhD, under the ratio of male: female being 62:38.

28) The Chapters-IV and V also covers the issues on "Odyssey[6] of PhDs: During the course of doing PhD and after completing PhDs" based on open-ended opinion and interaction at various levels. The findings would provide a lot of insight to the policy makers about the problems being faced by the PhD holders after completing their degree. Suitable policy modification on job strategy and whether any norms can be envisaged for the intervention of private / industrial sectors respectively for the funding of HRD, need active consideration.

29) The next analysis covered job prospects in three stages; a) before enrolment; b) during PhD programme; c) after completing PhD. The results of these three aspects have been: a) around 26% of the respondents had the secured job before taking up enrolment for PhD. The ratio of male: female was 66:34; b) 39% got job during their PhD programme and the ratio of male: female was 80:20; c) around 35% respondents got job after the completion of their PhD. Under this stage the ratio of male: female was 62:38. However, around 28% of the respondents got job within first year of the completion of PhD and, the ratio of male: female was 52:48.

30) The NRIF stretched its inquiry wider in order to elicit views from a cross-section of PhDs. The more insight has been provided after included views from the field of academics, some retired and some still involved in research, research scientists in government laboratories, opinion-makers, policy-makers and others.

Summing up

31) The encouraging features were that approx.60%, students at doctoral level and PhD holders admitted that their curriculum content had satisfactory intellectual depth, wide applicability and allowed the opportunity of developing high order cognitive skills. They were satisfied that their course-work units matched their objectives (32%)and were flexible enough to link theory with professional practice (44%). The course-work units were responsive to inputs and evaluations from the relevant professional and industrial bodies (51%). These were also comparable favorably to courses elsewhere. These researchers (35%) were satisfied that the feedback provided to them was frequent and constructive. They were happy to find up-to-date information about the course easily available. For them research work was both interesting and stimulating (33%). Their guides were supportive and always acted as mentors (80%). They felt that the assessment of their work was fair and transparent (45%). They finished their research in time (36%). They also found library facilities satisfactory for the course-work (33%). Relevant industry and professional activities were integrated with the course (11%). Networking with professionals in the field was promoted and information was provided to them about post-doctoral employment. They also felt that they had the possibility of good employment and high approval in the workplace. They thought that life-long learning is a boon, an opening to new horizons for exploration.

32) Few discouraging responses revealed the downside of the PhD studies and the factors that affected their attitude towards this discipline. This segment found PhD studies a long-drawn sentence and, at the end of it, simply not lucrative enough (23%). Their journey was hard: it

[6] Odyssey ~~ Long adventurous journey, series of wanderings

was difficult to work with an uncooperative or a mediocre guide with not enough research facilities (33%), and all the while was plagued with financial and family problems (35%). Some revealed that they did not have any inclination towards doing a PhD (23%), but ambitious family members with a view to keep up with the Joneses foisted it on them. The same families later nagged them constantly for taking long years to get doctorate. Many (30%) admitted that they found different pressures on them frustrating. Thus their half-hearted approach predictably resulted in mediocre output.

33) The Mixed reactions gave a break-up that 43% respondents found lack of infrastructure facilities that hampered their work at every stage; 20% attributed their ordeal to non-cooperation from their guides; 13% had financial problems (data from the NRIF study). They came from a background of Rs.1 Lakh per year income – a low income bracket; 3% found lack of funds in the university/institution; 10% had to take up part-time jobs because of financial constraints, often they got nagging from both ends- the boss for whom they worked, and the institution head of their research institution – because of divided attention. They said their objections were valid: 3% of the respondents said that family problems hampered new research work; 7% had problems of their PhD taking too long. Many had tried various funding agencies but were largely unsuccessful. Hence they had to drop out of research work, and go in for alternatives like IAS, or join an industry. The refrain in practically all cases was: financial constraints, poor infrastructure facilities, sour researcher-guide relationship, lure of big money in corporate sector without a PhD and with less arduous studies.

- Chapter-VII: Suggestions and Recommendations also includes broad views on: **Second Phase of this study,** under reference, for the kind consideration of NSTMIS, DST, MoS&T,GoI.

CHAPTER-I: INTRODUCTION

1.1 Preamble

1.2 Scenario Analysis

1.3 Rationale of the Study

1.4 Present Study

1.5 Limitations of the study:

CHAPTER-I:
INTRODUCTION

1.1 Preamble

1.1.1 Key technologies of the 21st century are driven by science-based innovations. The development of these technologies require high degree of knowledge intensity and are emerging mainly from industries having large R&D base besides high degree of qualified manpower having close links with research institutions/universities. Some of these science-based industries are *biotechnology, pharmaceuticals, nano-technology, bio-informatics, information* and *communication technologies*. Application of tools and techniques of basic and applied research are helping solve complex technological challenges in these industries. The tacit scientific / engineering knowledge of the highly qualified manpower plays a key role in the whole process. The highly qualified manpower comprise of doctorates or post-doctorates in science and or engineering from reputed institutions. For a country on the march, it is important to have this type of qualified manpower. It has been shown in many research studies and reports (Like NSF reports, World Science Report, European Science Report....) that this type of qualified manpower has played a key role in changing the shape and character of industries (USA, OECD countries are prominently cited in this regard). Their high technology industries cannot survive if this type of qualified manpower is not available. Many of this qualified manpower are coming from countries like India and China. In developing countries and some successful industries in India too, investment in R&D has helped the firms to make their presence felt in domestic and international market.

1.1.2 Therefore, the National Science and Technology Management Information System (NSTMIS) Division, Department of Science & Technology (DST), Govt. of India, felt it important to make an assessment of the out-turn of the doctorates in science faculty in the country and their absorption in the national and international stream. The DST assigned this responsibility to NRIF. Accordingly, NRIF made an attempt to obtain the details of out-turn in terms of quantity and quality of doctorates and attempted to establish benchmarks to compile their characteristics through generation of data from the selected institutions of repute. Before attempting that a "Scenario Analysis" and, "Rationale of the study" are given below for information: -

1.2 Scenario Analysis

1.2.1 India has one of the largest 'Higher Education System' in the world. It has 18 Central Universities (CUs); 195 State Universities (SUs); 89 Institutes Deemed to be Universities

(Dmd Us); 05, Institutes established under State Legislative Act ; 13, Institutes of National Importance (IoNI) and, 16,885 colleges. Main players in the higher education system in the country are:

- University Grants Commission (UGC): UGC is responsible for coordination, determination and maintenance of standards and for release of grants etc. to the universities.
- The statutory Professional Councils, which are responsible for recognition of courses, promotion of professional institutions and providing grants to undergraduate programmes and various awards.
- Central Government responsible for major policy relating to higher education in the country. It provides grants to the UGC and establishes central universities in the country. The Central Government is also responsible for declaration of Educational Institutions as 'Deemed to be University' on the recommendation of the UGC, as per the UGC Act 1956.
- State Governments who are responsible for establishment of State Universities and colleges and providing them plan funds for their development and non-plan grants for their maintenance.
- The coordination and cooperation between the Union and the States is brought about in the field of education through the Central Advisory Board of Education (CABE).

1.2.2 Special Constitutional responsibility of the Central Government: Education is on the Concurrent list' subject to Entry 66 in the Union List of the Constitution. This gives exclusive Legislative Power to the Central Govt. for co-ordination and determination of standards in Institutions of higher education, research as also scientific and technical institutions.

1.2.3 **Academic Qualification Framework - Degree Structure**: There are three principal levels of qualifications within the higher education system in the country. These are

- Bachelor / Undergraduate level
- Master's / Post-graduate level
- Doctoral / Pre-doctoral level
- Diploma courses are also available at the undergraduate and postgraduate level
- A pre-doctoral programme - Master of Philosophy (M.Phil.) is taken after completion of the Master's Degree. This can either be completely research based or can include course work as well.
- Ph.D. is awarded two year after the M.Phil Or three years after the Master's degree. Students are expected to write a substantial thesis based on original research.

1.2.4 The total doctorate / PhD out-turn in Science faculty vis-à-vis other faculties has been fluctuating in India since 1991-92. It went down to 3498 during 1996-97 from 3861 during 1995-96. The same trend was also seen from 1999-00 to 2000-01. However, a brief glimpse is given for the period from 1991-92 to 2002-03 for information in the table below: -

Table-1.1 : Outturn of Doctorate Degrees awarded for the period: 1991-'92 to 2002-'03

Item	'91-'92	'92-'93	'93-'94	'94-'95	'95-'96	'96-'97	'97-'98	'98-'99	'99-'00	'00-'01	'01-'02	'02-'03	Total
PhDs out-turn in Faculty of Science	3226	3666	3467	3657	3861	3498	3894	3896	3885	3727	(4012) - 3955	4497	(45286) - 45229
Total doctorate degrees awarded under all Faculties	8743	10136	9923	9891	10397	10408	11063	11107	11296	(11544) - 11534	(11899) - 11974	13733	130140 - 130215

Note: Figure within brackets ( ) indicates: provisional which; has later been updated by the UGC

1.2.5 Out of the total doctorate degrees awarded, the Faculty of Science has more-or-less been the second highest after the Faculty of Arts, amongst the total doctorates awarded during all these years. The Table-1.2 given below for illustration confirming this.

Table-1.2: Faculty-wise No. of doctorate Degrees awarded during three years

Faculties	No. of Doctorate degrees awarded		
	2000-2001	2001-2002	2002-2003
1. Arts	4,398	4,524	5,034
2. Science	3,727	3,955	4,497
3. Commerce / Managements	621	728	857
4. Education	399	420	554
5. Engineering / Technology	778	734	779
6. Medicine	221	219	243
7. Agriculture	889	838	1,042
8. Veterinary Science	110	110	153
9. Law	105	110	138
10. Others *	296	336	436
11. Total	11,534	11,974	13,733
* Others (*includes: Music / Fine arts, Library Science, Physical Education, Journalism, Social Work, etc.....*)			

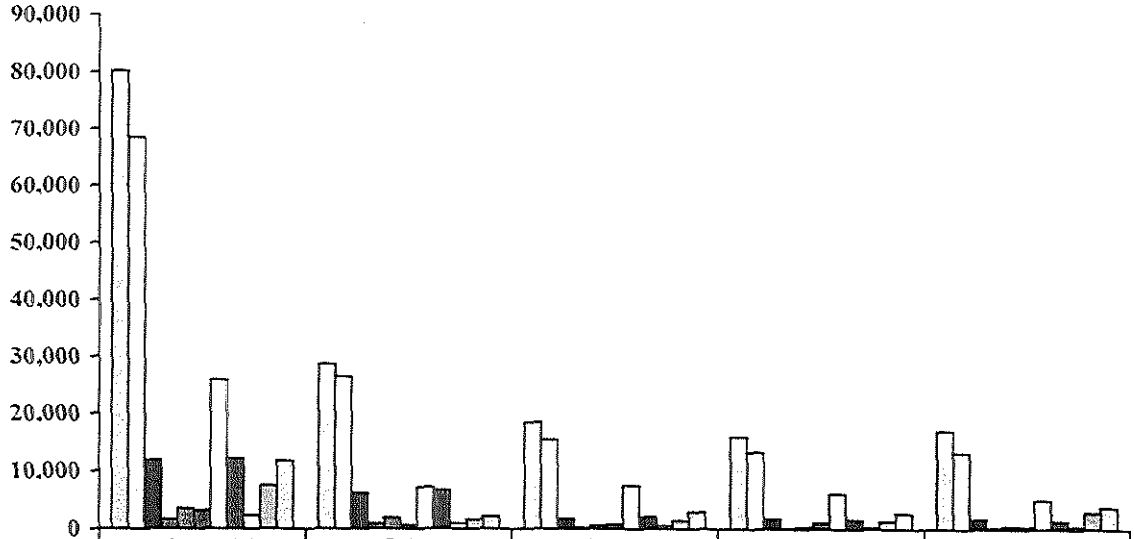
Source: UGC Annual Report: 2003-2004

1.2.6 The period 1991-92 to 2002-2003 further indicates that out of the total 1,30,140 (or 1, 30, 215) doctorate degree holders, 35% (i.e. 45,286) PhDs come from the faculty of sciences.

1.2.7 On the other hand, a comparison of the Asian PhD recipients in USA by field and country / economy of origin during the period 1985 to 2000, more-or-less reflects the disadvantageous position for Science stream for India. The trend can be seen among the

Asian Recipients of doctorates' in Science & Engineering by field and country/economy of origin at USA during the period 1985–2000. (Figure-1.1).

Figure-1.1: ***Asian: Recipients of doctorates' in USA under S&E by field and country/economy of origin: during the period 1985–2000***



	All Asian recipients	China	Taiwan	India	South Korea
All fields	80,310	28,698	18,508	16,029	17,075
S&E	68,550	26,534	15,487	13,274	13,255
Physical sciences	11,987	6,356	1,923	1,856	1,852
Earth, atmospheric, and ocean sciences	1,731	972	327	180	252
Mathematics	3,585	1,954	614	438	579
Computer/information sciences	3,221	673	839	1,178	531
Engineering	25,923	7,207	7,518	6,146	5,052
Biological sciences	12,251	6,790	2,175	1,766	1,520
Agricultural sciences	2,333	901	601	316	515
Psychology/social sciences	7,519	1,681	1,490	1,394	2,954
Non-S&Ea	11,760	2,164	3,021	2,755	3,820

1.2.8 The number of Science & Engineering (S&E) PhDs was 68,550 in the US during 1985-2000 period. The proportion of S&E of the total number of PhDs in the US was 85.3%, while it is higher for students of Chinese origin (92.5%), slightly lower for those of Indian origin (82.8%), and further lower for S. Koreans (77.6%).

1.2.9 A time series analysis of the number of science PhDs as opposed to the total number of PhDs shows a gradual decline from ~37% from 1991-1996 to about 32-33% in the period 2000-2002.

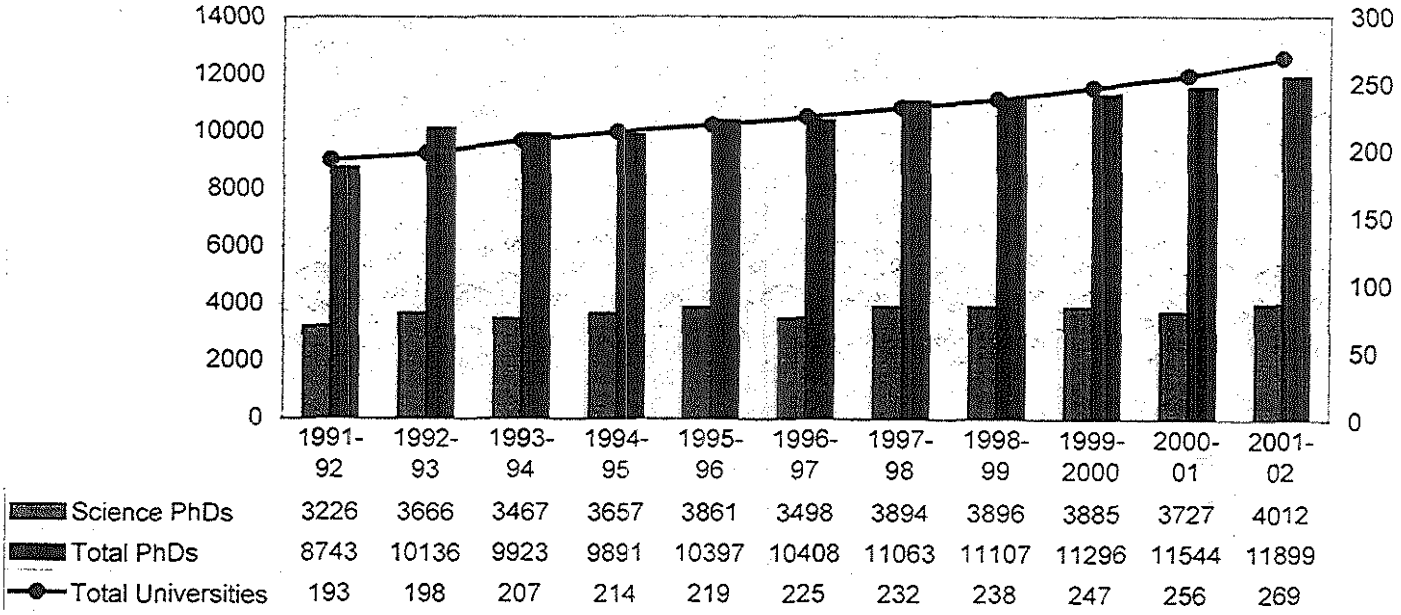
1.2.10 The thesis examination system in some institutions does not pose a significant academic hurdle; friendly examiners can be found for almost any dissertation. It is therefore not surprising to find that a large fraction of doctoral theses do not result in any

significant research publications, in journals of consequence." [1] This does not imply that overall the quality is not up to the mark. In many educational institutions only high quality research work leads to awarding of doctorate degree. There are lots of checks to ensure high degree of quality and timely finishing of the research. Refer *DST sponsored Pilot study on R&D output at post graduate/research leveling engineering & technology disciplines of selected northern India institutes.*

1.3 Rationale of the Study

1.3.1 Statistics of PhD out-turn in Science for the period from 1991-92 to 2001-2002, reveals that academic institutions in the country have awarded PhD degrees numbering between 3,226 to 4,012 in the various disciplines of science against the total number of doctorates under all faculties that vary from 8,743 to 11,899 during the corresponding period.

Figure 1.2: ***Out-turn of PhD's over the years in India (UGC / DST)***



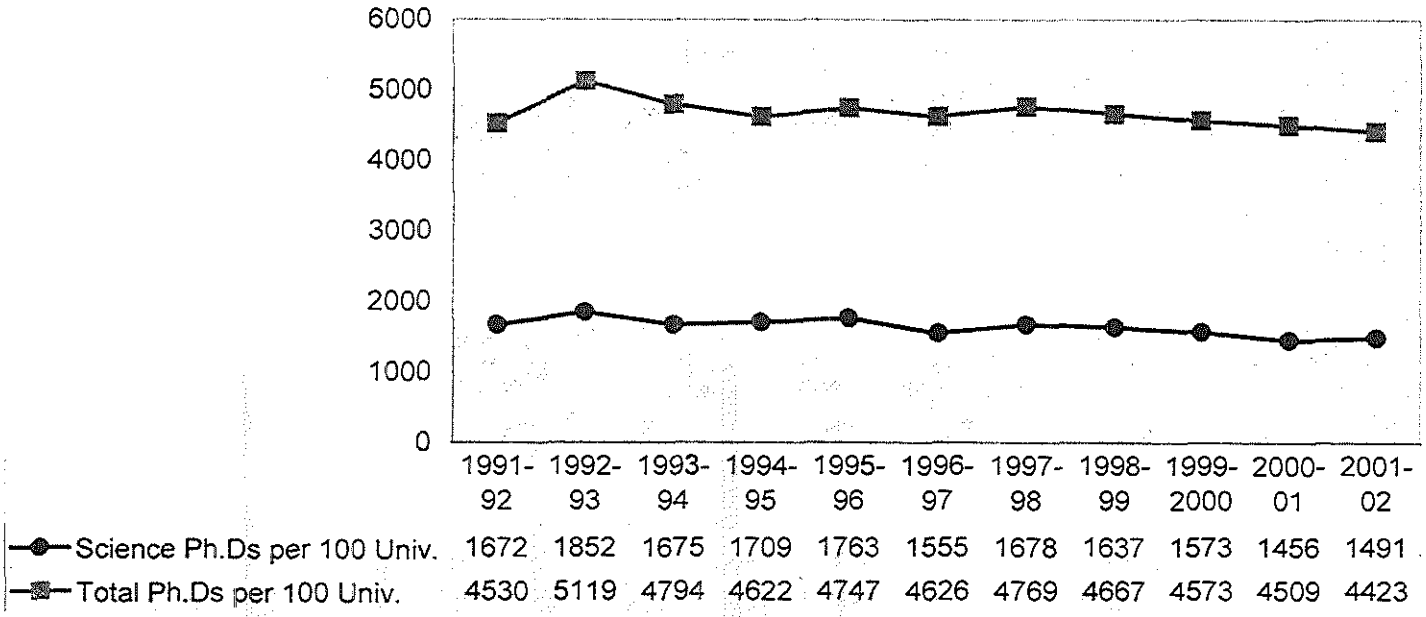
	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-2000	2000-01	2001-02
Science PhDs	3226	3666	3467	3657	3861	3498	3894	3896	3885	3727	4012
Total PhDs	8743	10136	9923	9891	10397	10408	11063	11107	11296	11544	11899
Total Universities	193	198	207	214	219	225	232	238	247	256	269

1.3.2 The figure above shows that PhDs grew by 2.89% (annual compounded growth rate). India produces thousands of Ph.D.s. in different faculties, but out of them around 49% only are in the Science & Technology Group consisting of Natural Sciences, Engineering & Technology, Medicine, Agricultural Sciences, and Veterinary Sciences. The number of Ph.D. manpower is one of the important indicators of growth in Science & Technology. The number of PhDs produced might be useful as an indicator to assess the highly qualified manpower availability in the science faculty. But through this benchmark study, it has not

[1] P. Balaram, Current Science, Vol. 84, No.6, March 2003

been directly possible to know: "*Is India producing Ph Ds of an acceptable quality to withstand the global competition? And, whether our academic standards are improving or declining in our university system* "? and, so on. But what has certainly come to light that there has been a declining trend in the number of PhDs from 1997-98 onwards as compared to other sciences as can be viewed in the graph above Figure 1.2. Again if we take into account percentage change over the years it shows that Science group has predominance over the other groups (*Other groups consists of*: arts, Commerce, Education, Law Music, Fine Arts, Library Science, Journalism and Social Work).

Figure 1. 3: ***Change of Science Ph.D. holders over the years in India***



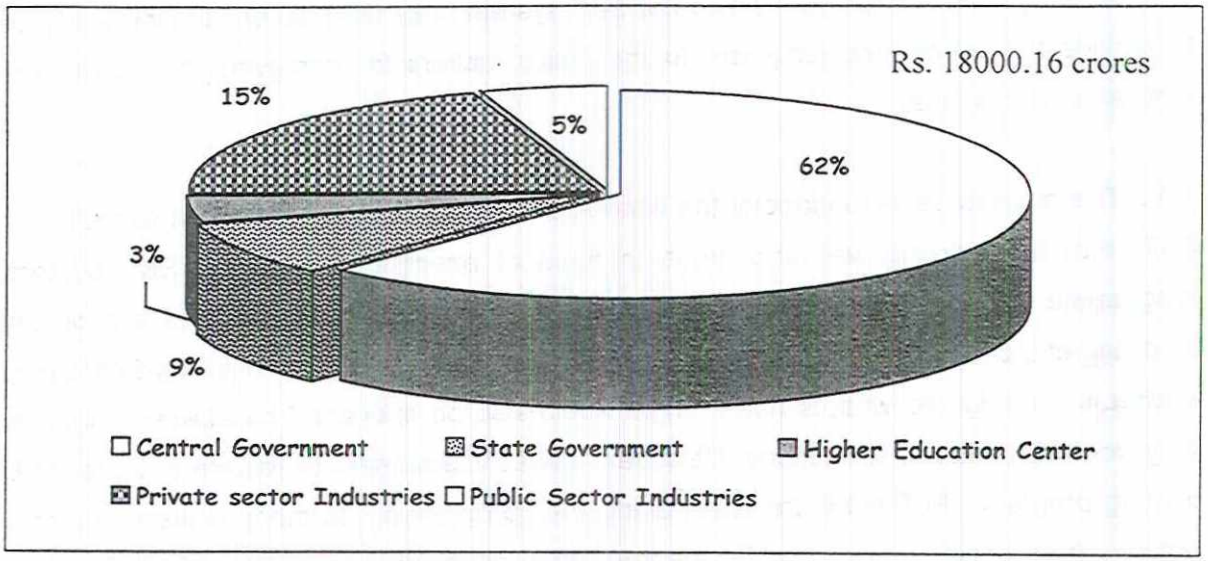
	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-2000	2000-01	2001-02
Science Ph.Ds per 100 Univ.	1672	1852	1675	1709	1763	1555	1678	1637	1573	1456	1491
Total Ph.Ds per 100 Univ.	4530	5119	4794	4622	4747	4626	4769	4667	4573	4509	4423

1.3.3 The total number of doctorate degree awarded e.g. per 100 universities over the years has been more or less constant or declining in recent years, as is revealed from the figure above. The case of science faculty group has been notable in this regard. It showed that this decline continues and, it may persist for a long time. The only exception in the recent years was during the year 1997-98, which showed an increase in growth over the preceding year.

1.3.4 But why is this happening? Are the day-to-day processes of doctoral programmes sufficiently comprehendible so that students can concentrate on developing knowledge and skills? One of the main reasons could be that science is no longer an important subject in the field of job opportunities. Ph.D.s are mostly appointed in the academic sector. A smaller academic job market cannot absorb the new PhDs. For instance after completing Ph.D. degree in science, the scholar does not get jobs easily in industry or business. The training

received by the PhD students is neither what they want nor does it prepare them for the jobs they wish to take-up. Whereas due to globalization, a fresh graduate obtaining some management or computer degree / diploma gets a lucerative job in various industries or MNCs. These days business, industry, non-government organization and even government need well-informed and skilled employees. Another reason for the malady is government investment in higher education has remained more or less constant at approx. 3% over the years, as can be seen in the Figure-1.4 below.

Figure-1.4: National Investments on R&D activities during 2002-03



The national investment on R&D activities has attained a level of Rs.18000.16 crores in 2002-03. The same is estimated to be Rs.19726.99 crores in 2003-04 and Rs.21639.58 crores in 2004-05. Around 0.80% of gross national product (GNP) was devoted to R&D during the year 2002-03.

The sector wise percentage share of national R&D expenditure during 2002-03 was from Central Govt. 62%, State Govt. 8.5%, Higher Education 4.2%, Public sector industries 5% and Private Sector Industries 20.3%. It is reported that as on 1st April 2001 nearly 2.96 lakhs personnel were employed in the R&D establishments in the country including in-house R&D units of public and private sector industries. 31.7% were performing R&D activities, 30.4% were performing auxiliary activities and rest 37.9% was providing administrative and non-technical support.

1.4 Present Study

1.4.1 The present study attempts to profile the out-turn characteristics about doctorates from selected institutions for the years 1999-2000 to 2001-2002. The support system for their research work leading to completion, disciplinary / sub-disciplinary details, influencing factors that played major role and factors that constrained their research were investigated.

The study also attempted to explore the career profile and the activities (thus cover only those who are in the R&D system) of the doctorates as covered by the period of study. The study also reflects the proportion of highly qualified manpower that has remained within the R&D and related careers, besides, what they are contributing and how many of them are moving out to separate domains. Further the researchers who have moved abroad and nature of their activities have also been uncovered. The study provides a glimpse of the contribution, timely completion-the quality, type, motivating and, de-motivating factors that have played a role in completing their PhDs. These researchers are among the most coveted entry-level researchers within our S&T system, thus detailed profile would help us to provide better-informed judgment to the policy makers for improving the quality and motivation at this level.

1.4.2 The other issue is to pinpoint the various aspects of doctoral education especially in S&T, that are working well and those in need of attention. Looking at S&T doctoral programme through the eyes of a PhD student, it would appear that they are on the receiving end of doctoral education. Their experience of how the system is truly functioning – what is working and what is not, in India would also be relevant. The academic models vary from institution to institutions. Relatively few scholars seem to require any pre-Ph D training program / M Phil before undertaking PhD programme. In many universities there are no standardized procedures for the admission or registration of PhD scholars. Many researchers take admission in the PhD program only to obtain financial support in the form of scholarships after they pass out the national level examinations JRF / Gate or MSc. As the number of Ph D degrees awarded by diverse institutions increases it may be necessary to reflect on the quality of our Ph D programme and the doctoral thesis that are produced. An aspiring scientist usually learns the tools of the trade, during the period of a Ph D program, generally serving as an apprentice to a master. This type of PhD work may require a significantly greater length of time, for completing all the requirements for a Ph D. Some PhD degrees however are associated with greater specialization and involve researchers from reputed institutions. Most of these PhD candidates are sponsored from their institutes and work on problems that they may be required to tackle in their workplace. These are generally completed in shorter time periods and are often more applied in nature.

1.4.3 This report is based on the responses of the PhD scholars who passed out the doctorates during the period from 1999-2000 to 2001-2002 from 25 Universities comprising: Central, State, Deemed Universities and, institutes of national importance, which were selected as per the advice of Programme Advisory Committee (PAC). The list of the 25 institutions is provided in the Chapter-II on Methodology.

1.4.4 The Report is based on the detailed field investigation and, interaction taken-up in two phases: Phase-I covered all the Science faculty departments from every selected institute and, Phase-II covered the PhD scholars who were approached through specially structured questionnaires covering all the broad issues related to the terms of reference (ToR) of the study.

1.5 Limitations of the study:

15.1 The study is, no doubt, constrained by the limited number of institutions selected and thus the results and conclusions drawn cannot be extrapolated to overall PhD research in the country. The future research / study could, however, try to include a wider set of institutions so that it is possible to draw more generalized conclusions. The various constraints faced and limitations are given below: -

- The survey got delayed by over 3-4 months due to the new academic sessions starting in July / August 2004. Our investigation team had to make frequent visits to the officials for obtaining the year-wise, department-wise, contact addresses of the PhD scholars from all the selected universities / institutions;
- Unfortunately, most of the Universities / institutes did not have manpower information system readily available. The records were either in shambles or at the mercy of clerical / subordinate staff. Therefore, obtaining year-wise, department-wise, correct names and addresses have been a Herculean task.
- Only few selected universities / institutions had active student's alumni, who kept an up-to-date records of year-wise, department-wise, correspondence addresses of the students registered with the alumni. IIT Khargpur, being one of the oldest IIT's, had yet to have a student's alumni unlike other IIT's. The greatest hassle faced, so far, had mainly been with AIIMS, for which repeat visits and follow-up with 9 departments had to be done.
- Based on the addressed provided by various Institutions, so far, as many as, around 1000 stamped envelopes of the PhD scholars returned undelivered due to lack of authentic addresses or changes taken place therein subsequently.
- Un-verified and lack of updated of data provided by various agencies created doubts about their authenticity, as no two-data-sets matched with each other. There has been conflicting data pertaining to PhDs produced in different disciplines from different sources besides, their being gaps in data availability. Take e.g. years 1991 and 1999

Table-1.3: PhDs produced during the years 1991 and 1999

Source	PhDs produced in Science		PhDs produced in Engineering	
	1991	1999	1991	1999
UGC	3002	699	260	696
AICTE	2950	N A	629	N A
DST	2950	N A	629	N A
CSIR	3002	N A	260	N A

Source: Current Science Vol. 86, No.7, 10th of April 2004

- And, it is these documents, which form the base for S&T planning and policy-making. This can affect the planning and obliterate the decision-making as also perception of common people.
- This being a pilot study of explanatory nature has mostly confined to the envisaged objectives and, its conclusions are subject to the limitations listed here.

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CHAPTER-II OBJECTIVES AND METHODOLOGY

2.1 Objectives

2.3 Coverage / Scope of the Study

3.3 Approach:

2.4 Data requirement and sources:

2.5 Processing and Analysis of Data

CHAPTER-II

OBJECTIVES AND METHODOLOGY

2.1 Objectives:

2.1.1 The study covered the following objectives as envisaged under the ToR: -

i. Detailed profile of PhD's in terms of discipline / sub- discipline, gender, entry-level qualifications / input requirements, scholarship / funding support, time taken, etc.

ii. To determine the factors that facilitated researchers / thesis supervisors in the PhD research programs and / or the Constraints faced by the scholars during their PhD programme.

iii. Magnitude, career profile, professional achievement of PhDs, their present status in R&D and / or whether the PhDs are having closer linkages with demands of the industry;

iv. Pattern of absorption in India and to identify the number of PhD's who have and /or are moving abroad;

v. Suggestions and recommendation based on conclusions from above.

2.2 Coverage / Scope of the Study

2.2.1 The NRIF had proposed covering up mostly central Universities to meet the objectives of the study. However, Local Project Advisory Committee (LPAC) on 13th January 2004, during presentation at INSA, suggested covering the combination of Universities / Institutes, which comprise of: Central, State, and Deemed Universities and also Institutes of National Importance, for the reference period from 1999-2000 to 2001-2002.

2.2.2 Accordingly, 25 Universities / Institutes with such combination (as given in Box-2.1) were later approved by the NSTMIS. These comprise of: Nine (9) central universities; ten (10) institutes of national importance; two (2) institutes deemed to be universities; and four (4) state universities.

Box-2.1
University/ institute with year of Establishment

Name of the University with year of establishment	Year
A. Central University (CU) [9 out of 19 CUs i.e. 47%]	
1. Aligarh Muslim University	1920
2. Allahabad University @	1887
3. Assam University	1994
4. Banaras Hindu University	1916
5. Delhi University	1922
6. Hyderabad University	1974
7. Indira Gandhi National Open University (INGOU)	1985
8. Jamia Millia Islamia	1988
9. Jawaharlal Nehru University	1970
B. Institutes of National Importance [10 out of 13 IoNI i.e. 77%]	
1. AIIMS	1956
2. IIT, Kharagpur	1951
3. IIT, Bombay	1958
4. IIT, Delhi	1963
5. IIT, Kanpur	1959
6. IIT, Madras	1959
7. IIT, Guwahati	1994
8. ISI, Kolkatta	1931
9. National Institute of Pharmaceuticals Education & Research (NIPER)	1994
10. Sree Citra Tirunal Inst. Of Medical Sciences & Technology (Became IoNI in 1980)	1973 / 1980
C. Deemed University [2 out of 89 Dmd U i.e. 2%]	
1. IISc, Bangalore	1909
2. Tata Institute of Fundamental Research	1945
D. State University [4 out of 195 SUs i.e.2%]	
1. Jadavpur University	1955
2. Lucknow University	1920
3. Madras University	1840
4. Pune University	1948

@ Declared Central University under the Parliament Act. 2004.
{25 Universities / Institutes out of 320 i.e. 8%}

The spread of these 25 Universities / Institutions covered 12 institutes in the Northern States; 5 in the Eastern States; 5 among Southern States and, 3 in the Western region. The approved list is given in the box on the right side.

2.2.3 The replacement of PGI, Chandigarh by NIPER was subsequently approved at the 1st Local Project Advisory Committee (LPAC) meeting held on 13th August 2004.

2.3 Approach:

2.3.1 The approach covered two-phase survey of these institutes: -

(i) Phase-1: NRIF created the benchmark to characterize these institutions and, obtained the information about: a) Type of Science faculties; b) their research activities support they received through NET / GATE or sponsorship for PhDs; d) year-wise enrollment of the students having completed the doctorate; and e) information about pattern of professional / career activity of the PhD degree holders; and f) addresses (permanent / present) of the passed out PhD scholars for contacting during the second phase. For this first phase an especially designed questionnaire (as given in ***Appendix-I***) was administered to all the 25 universities / institutes. Direct interactions with faculty members, experts was also undertaken to get their perceptions about the quality of research, constrains faced and factors that require special attention. Thesis supervisors were also contacted to get response from them in terms of factors they perceive as facilitating their research work or the constraining factors that inhibited them during their research supervision. This entry-level questionnaire acted as initial reference material in defining the population that formed the basis of further analysis, under the phase-II.

(ii) Phase-2: At the second stage, specially designed questionnaire (as given in ***Appendix-II***) was sent to PhD awardees (covering the period from 1999-2000 to 2001-2002) after verifying their addresses. The questionnaire was sent through post / e-mail to get the responses from the respondents who had responded to the entry-level questionnaire. This questionnaire was also placed on the NRIF-Website and designed to facilitate the respondents in providing their direct response through it. Direct interactions with faculty members and experts was also undertaken to get their perceptions about the quality of research, constrains faced and factors that require special attention.

2.3.2 Consultations:

(i) Brain storming sessions were held with LPAC and other experts before finalizing the detailed questionnaire for the Phase-II. The meetings of the LPAC held on 13th August 2004,

and 6th June 2005, among other things, also reviewed an updated position of data generation for Phase-I and Phase-II respectively.

(ii) Some eminent educational experts were also contacted to get inputs regarding their perception about the factors that require urgent attention to improve the quality of research.

2.4 Data requirement and sources:

2.4.1 The background data

(i) It covered the information about the individual university / institute / department / discipline with an average intake of PhD scholars in each year during the reference period: (a) whether full time, part time, sponsored; (b) whether encouraged to take up industrial problems; (c) involvement of external guides / experts in the governing / academic / research–evaluation committees from the government / research laboratories and other universities and (d) whether university / institute / department / received special grants / incentives for infrastructure or other development works. For this purpose 25 University / Institutes were contacted. The visit revealed that these 25 Universities / Institutes, as given in **Box-2.1**, consist of:

- Central Universities: 9;
- Institutes of National Importance: 10;
- Deemed Universities: 2;
- State Universities: 4;
- The total population, sample population and, respondents population is given in **Box-2.2.**
- Likewise, regional distribution of these universities / institutes is given in **Box-2.3**, below.

(ii) These universities / institutes have approx. 231 Faculties of Sciences. These range from three (3) Faculties of Sciences at IIT Kanpur & IIT Guwahati to 31 faculties at Madras University and maximum 37 Faculties of Sciences at Sree Chitra Tirunal Institute for Medical Sciences & Technology (SCTIMST), Thiruvanathpuram. The University / Institute-wise names of the departments are given at ***Annex-2.1***.

(iii) Classification of Science Faculties: With a huge list of departments, the NRIF, for operational convenience, has classified all the science faculties into 5 broad categories, viz. a) Life / Biological Sciences; b) Physical Sciences; c) Chemical Sciences; d) Mathematics & Statistics; and, e) Inter-disciplinary sciences. These classifications have been given in detail at ***Annex-2.2*** and has been used for analysis purposes wherever possible in various Chapters.

2.4.2 Target population and sample size covered:

(i) During the reference period 1999-2000 to 2001-2002, the number of total PhD scholars who completed PhD from these 25 universities / institutes were tentatively 3053 scholars. However, approx. 1,000 questionnaires came back because the scholars had shifted elsewhere. Further out of the remaining 2,043, scholars, only 1,221, i.e. 60% responded to the questionnaire. Details of these are given at a glance in **Box-2.2**, below. These formed as the ultimate sampling units for the study.

(ii) Target population and sample size covered and Regional distribution is given below:

Box-2.2:
Year-wise Sample coverage at a Glance of 25 Universities / Institutes during the Reference period: 1999-2000 to 2001-2002 was:

Year	Sample	% of
'99-'00	1,099	36
'00-'01	1,039	34
'01-'02	0,915	30
Total P	**3,053**	**100**
Returned	1,000	#
Net Sample	**2,043**	40 of TP
Response	1,221	60 of NS

% Age response of Total population;
% Age response of NS= Net sample
# = Due to changed addresses

Box-2.3
Region-wise Coverage of Universities / Institutions

Northern States (No)		Southern States (No)	
Delhi	6	A P	1
Punjab	1	TN	2
UP	5	KTK	1
Total	**12**	KER	1
Eastern States (No)		**Total**	**5**
Assam	2	**Western States (No)**	
Bihar	1	MAH	3
W.B	2	**G. Total**	**25**
Total	**5**	**States**	**11**
		Cities	**17**

2.4.3 Some of the selected Universities / institutes have been selected by the University Grants commission (UGC) as the Institutes with Potential of Excellence (PoE) and awarded accreditation by National Assessment & Accreditation Council (NAAC), brief details of which are given below.

Selected Universities with Potential of Excellence (PoE) by University Grants Commission (UGC) and Accreditation by National Assessment & Accreditation Council (NAAC)

Box-2.4

Selected Universities with PoE on Subjects and / or Area of specialization

- **Madras University**: Herbal Sciences;
- **JNU**: Genetics, Genomics & Biotechnology;
- **Hyderabad University**: Interface studies & Research;
- **Jadhavpur University**: Mobil Computing & Communication;
- **Pune University**: Bio-informatics & Biotechnology;
- **Allahabad University**: Behavioral & Cognitive Sciences

Box-2.5

NAAC: Grading System allotted to our selected Institutes as per the old system

- **Central University:**
  - Hyderabad.....Five Star;
  - Lucknow.....Four Star;
- **State university:**
  - Madras.....Five star;
  - Jadhavpur.....Five Star;
  - Pune.....Five Star;
- Other institutes have either applied or not cared to apply

Brief write-up on PoE and NAAC is given the ***Annex-2.3*** for information and reference.

2.4.4 During the field visit direct interactions were also held with the respective University registrars, alumni associations, departments, library, present researchers and PhD scholars who had completed PhD during the earlier years.

2.5 Processing and Analysis of Data

Statistical analysis based on different categories of responses has been done to bring out the main issues in focus as perceived by the respondents. The background study of the primary literature, institutions involved, interactions with faculty members, research scholars and experts also helped to clarify the aspects that were not possible to be addressed by the questionnaire approach. Thus the study has covered both quantitative as well as qualitative data to draw conclusions.

Whereas data has been organized in single and multivariate cross-tables, the same has been illustrated with graphs, histograms / bar charts, wherever relevant. The findings have mainly been drawn on the basis of analysis of the responses of the ultimate respondents to the questionnaires (1221 in number).

In certain cases, where the overall position based on the total number of PhDs is available, the same too has been presented; e.g. the analysis of sample characteristics for 'total', 'net' and 'respondents' population was attempted to establish representation character of the 'respondents', which is fairly evident from the analysis given in Chapter-III.

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CHAPTER-III: CHARACTERISTICS OF PHD SCHOLARS

3.1 Sample Characteristics;

3.2 Annual family income of PhD scholars at the time of joining PhD program

3.3 Family's main occupation at the time of PhDs scholars joining PhD program

3.4: Income Group wise Analysis-Occupation-wise

3.5 Parental Educational profile of PhD respondents

3.6 Educational Qualification of respondents at the time of admission-Category-wise

3.7 Enrolment with Test / Interviews: Discipline-wise

3.8 Type of thesis vis-à-vis topic / work handled

3.9 Respondents Membership or Non-Membership of professional bodies

3.10 Motivating Factors:

3.11 Conclusions

Table-3.1: Univ./ Institute wise: Total population of PhD Scholars vis-à-vis Net Sample & Respondents *(Ref. Period: 1999-00 to 2001-02)

S.No.	Univ/Institute	Total Population (No.)	% to Total Population	Net Sample Population (No.)	% to Net Sample Population	Respondents (No.)	% to Respondents	% of Respondents over Net Sample Population within each Univ /Inst.	
1	AMU	99	3%	97	5%	96	8%	99%	CU: Central Universities
2	Allahabad University	67	2%	60	3%	11	1%	18%	
3	Assam University	21	1%	18	1%	13	1%	72%	
4	BHU	118	4%	117	6%	110	9%	94%	
5	DU	131	4%	97	5%	59	5%	61%	
6	Hyderabad University	77	3%	73	4%	10	1%	14%	
7	IGNOU	0	0%	0	0%	0	0%	0%	
8	Jamia Milia Islamia	109	4%	99	5%	49	4%	49%	
9	JNU University	67	2%	63	3%	50	4%	79%	
10	AIIMS	116	4%	87	4%	23	2%	26%	IoNI: Institutes of National Importance
11	IIT, Kharagpur	64	2%	54	3%	11	1%	20%	
12	IIT, Bombay	72	2%	62	3%	36	3%	58%	
13	IIT, Kanpur	84	3%	64	3%	22	2%	34%	
14	IIT, Delhi	55	2%	15	1%	12	1%	80%	
15	IIT, Madras	175	6%	70	3%	24	2%	34%	
16	IIT, Guwahati	24	1%	19	1%	5	0%	26%	
17	ISI, Kolkata	31	1%	23	1%	5	0%	22%	
18	NIPER	15	0%	15	1%	14	1%	93%	
19	SCTI	11	0%	9	0%	2	0%	22%	
20	IISc, Bangalore	279	9%	256	13%	243	20%	95%	Dmd U: Deemed
21	TIFR	175	6%	52	3%	12	1%	23%	
22	Lucknow University	248	8%	149	7%	49	4%	33%	SU State Universities
23	Madras University	121	4%	93	5%	24	2%	26%	
24	Jadhavpur University	633	21%	348	17%	243	20%	70%	
25	Pune University	261	9%	103	5%	98	8%	95%	
	Total	**3053#**	**100%**	**2043**	**100%**	**1221**	**100%**	**60%**	

 # Note: Approx. 1,000 questionnaires returned undelivered because of old addresses provided by the respective Univ./Inst. Therefore, overall **Net Sample** has been taken as **2043.** The analysis, however, is based mostly on the **1221** (Respondent population).

*** Reference period of this study is 1999-00 to 2001-02; all-subsequent tables / graphs cover this period.**

CHAPTER-III:
CHARACTERISTICS OF PHD SCHOLARS

PERLUDE

Picking the thread from the Chapter-II, we are analyzing here population of PhD scholars 'total' (3053), 'net' (2043[1]) and 'respondents' (1221) to establish the characteristics of sample / respondents, who had completed doctorates in faculty of sciences during the period from 1999-2000 to 2001-2002, from the 24 selected universities and institutes.

3.1 Sample Characteristics:

The sample characteristics have been elaborated through the various table's graphs - charts as given below.

3.1.1 University / Institute-wise population: 'Total population' of PhD scholars vis-à-vis 'Net sample' and 'Respondents' has been highlighted in the **Table-3.1**: the table gives the university / institute-wise details of the total population, net sample population and, the number of respondents who forwarded the filled questionnaire, by post and / or e-mail.

(i) The Table-3.1: indicates that among the 9 central universities (CU), except IGNOU [2], the percentage of respondents over the net sample population with-in each university varied from 14% in Hyderabad University to 99% in Aligarh Muslim University during 1999-2000 to 2001 to 2002.

Likewise, among the institutes of national importance (IoNI) the percentage varied from 20% in IIT Kharagpur to 93% in Indian Statistical Institute, Kolkatta.

On the other hand among the deemed universities (Dmd U) the %age varied from 23% in TIFR, Mumbai to 95% in IISc, Bangalore.

The percentage variation for the same among the state universities (SUs) was from 26% in Madras University to 95% in Pune University.

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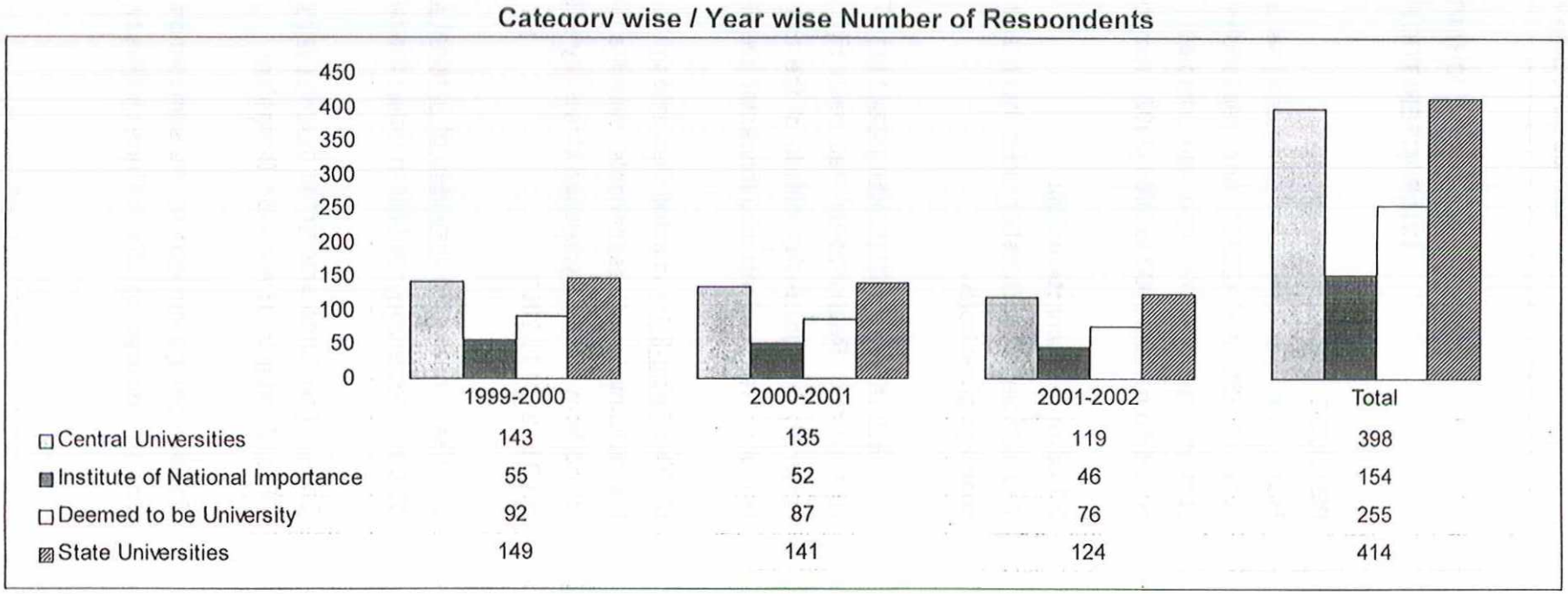
[1] After approx. 1000 questionnaires returned undelivered because the PhD scholars had moved to the new places without informing their base-university / institute (*alma mater*).

[2] IGNOU: Does not award PhDs. Whereas "School of Sciences" offers and, prepares Few Certificate Courses, which form part of BPP, PPC, BA, B. Com., BCA, BTS programmes etc.

Table-3.2: Category-wise/ Year wise: Total population of PhD Scholars vis-à-vis Net Sample & Respondents

		1999-2000			2000-2001			2001-2002			Category-wise Glance						
S.No.	Category -Wise	Total Population	Net Sample Population	Respondents	Total Population	Net Sample Population	Respondents	Total Population	Net Sample Population	Respondents	Total Population	% of Total Population	Net Sample Population	% of Net Sample Population	Respondents	% of Respondents	Category-wise % of Respondents over Net Sample Population
1	CU	248	225	143	234	212	135	206	187	119	689	23%	624	31%	398	33%	64%
2	IoNI	233	150	55	220	142	52	194	125	46	647	21%	418	20%	154	13%	37%
3	DmU	163	111	92	154	105	87	136	92	76	454	15%	308	15%	255	21%	83%
4	SU	455	249	149	430	236	141	379	208	124	1263	41%	693	34%	414	34%	60%
	Total	**1099**	**735**	**440**	**1039**	**695**	**416**	**915**	**612**	**366**	**3053**	**100%**	**2043**	**100%**	**1221**	**100%**	**60%**

CU: Central University; **IoNI**: Institute of National Importance; **DmU**: Deemed University ; **SU**: State University .



It can further be interpreted from the Table-3.1 that the percentage of respondents across the universities / institutes ranged from 16% combined among (IoNI) through 21% among Dmd Us; 29% among CUs to 34% among SUs for an overall respondent sample of 1221.

(ii) Category-wise / year-wise: Total population of PhD scholars vis-à-vis net sample and respondents has been highlighted in **Table-3.2.**

The table reflects that outturn has been more during 1999-2000 (total: 1099; net sample: 735 and, respondents: 440) and, least during the year 2001-2002 (total: 915; net sample: 612 and, respondents: 366). That shows there has been a declining trend in the out-turn.

(iii) Regional Representation: The region-wise analysis has been indicated in **Table-3.3 & Graph.** The analysis reflects a uniform trend from 57% to 67% of respondents over the net sample population across regions from Northern universities / institutes to the ones western region. The Table and the histogram depict the Region-wise position of the respondents.

(iv) Top Ten Universities / Institutes on the basis of maximum number of respondents have been shown in the Bar Diagram and, **Table-3.4 & Graph.**

Among the respondents, larger number of responses came from IISc, Bangalore, Jadhavpur University and, BHU (above 100). From other universities / institutes the response was less than 100. In declining order were Pune university (98); AMU (96); Delhi University (59); JNU (50); JMI (49); Lucknow University (49); and IIT Mumbai (36).

The above-constitute the top 10 respondents among the 25 Institutes selected for the study.

(v) Gender-wise pattern of PhD Scholars: This has been projected in the **Table-3.5 & Graph**.

The overall gender distribution between the total and sample population more-or-less goes at the same level in that order with male-67% and female-33%, for total 70% male and 30% female in the sample.

(vi) The university-wise and gender-wise distribution of PhD Scholars from total Vs sample and the respondents has been given in **Table-3.6.**

The table provides the gender ratio within each university for all the three types viz. total, net sample and the respondent's population, which varies from institute to institute. However, with-in the institute the highest female percentage out-turns comes from JNU (at

Table-3.3: Regional representation: Total Population of PhD Scholars vis-à-vis Sample and Respondents

Region	Total Population within each Region (%.)	Sample Population within each Region (%)	Respondents within each Region (%)	% OF RESPONDENTS OVER NET SAMPLE POPULATION ACROSS REGIONS
NORTH	1109(36%)	863(42%)	495(41%)	57%
EAST	773(25%)	462(23%)	277(23%)	60%
WEST	508(17%)	217(11%)	146(12%)	67%
SOUTH	663(22%)	501(25%)	303(25%)	60%
OVERALL	**3053(100%)**	**2043(100%)**	**1221(100%)**	**60%**

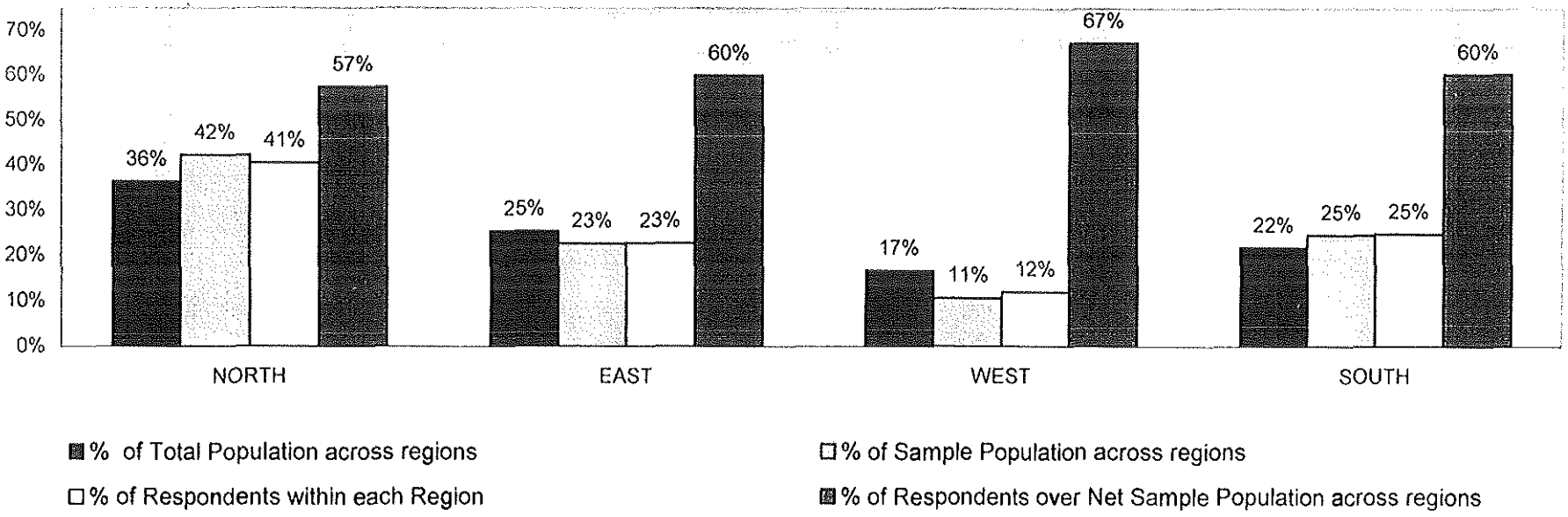
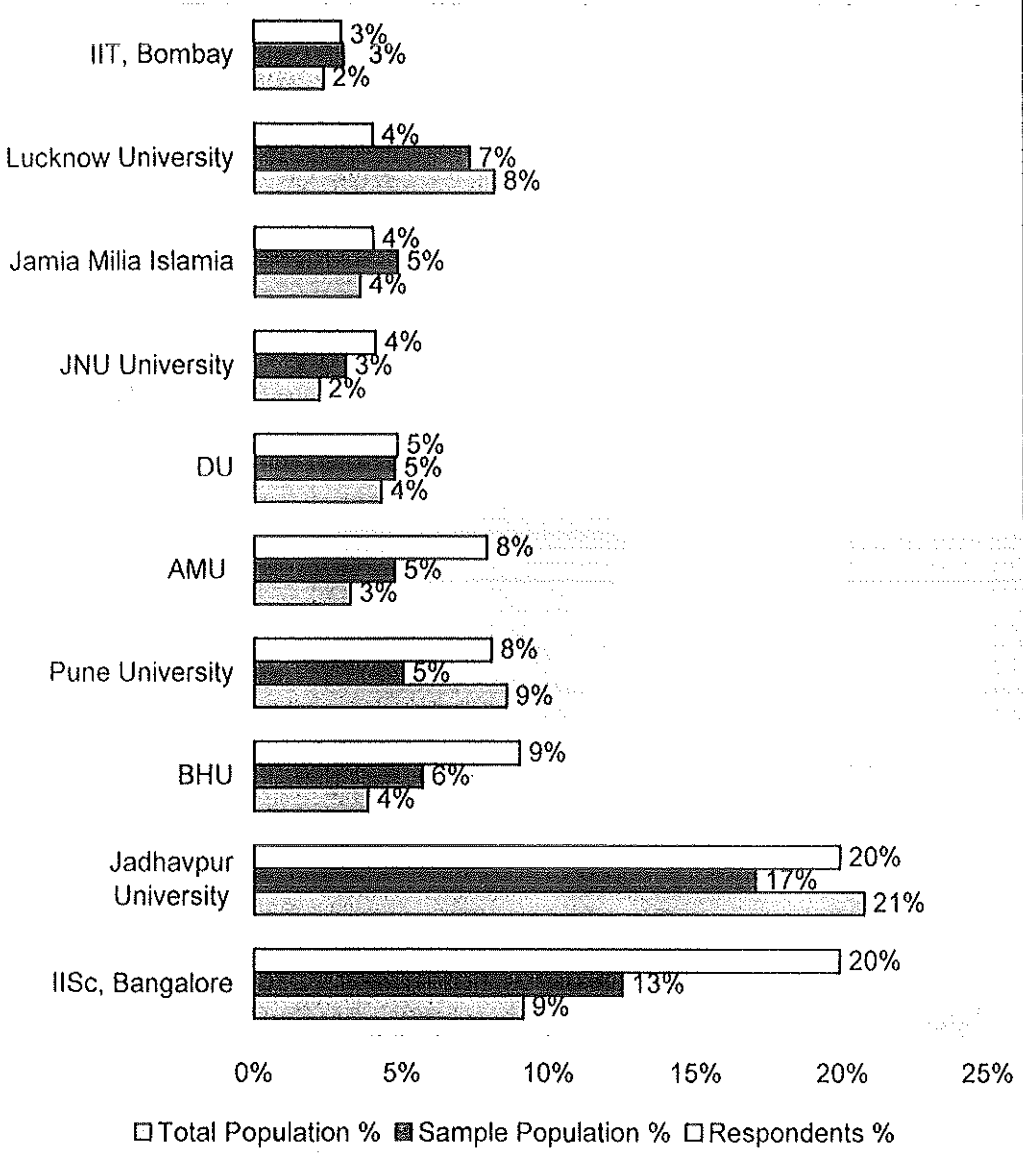
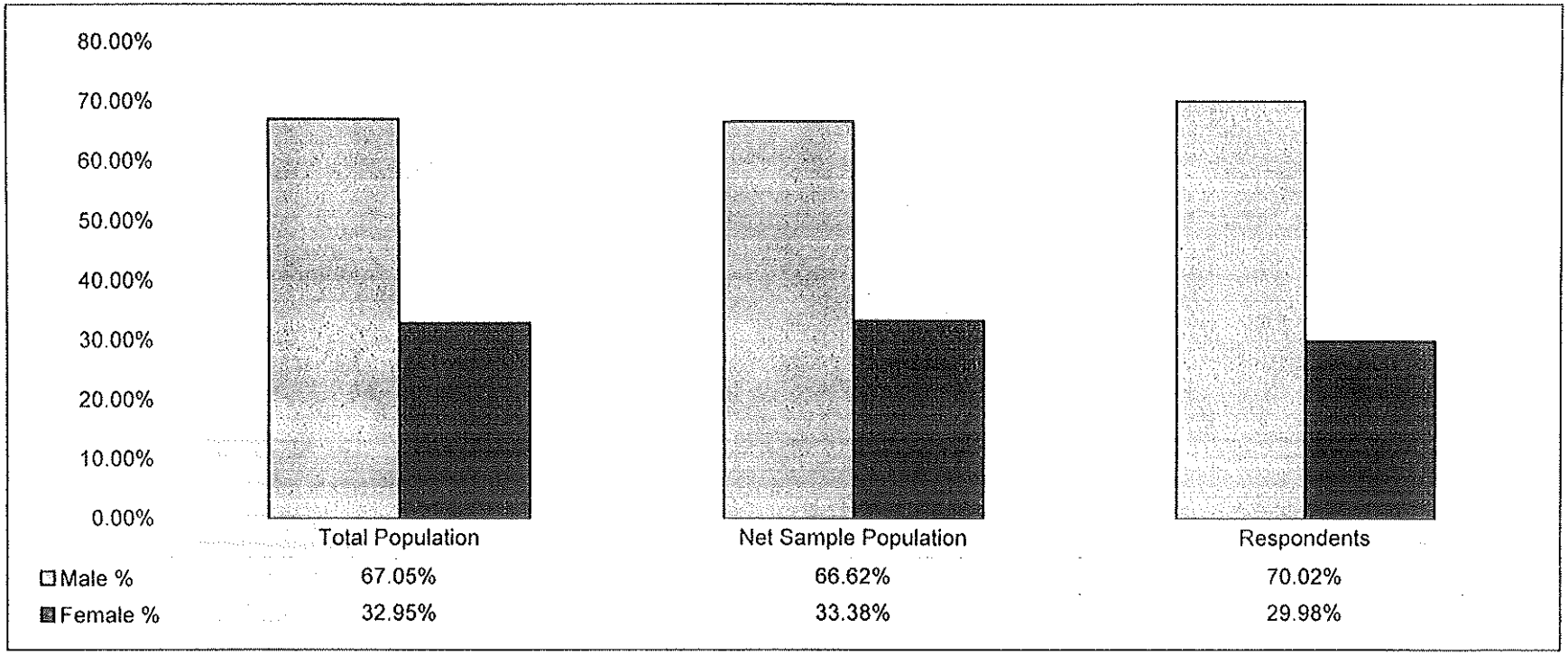


Table-3.4: Top Ten Institutes on the basis of maximum no. of respondents



S.No.	Univ-wise	Total Population	Sample Population	Respondents
1	IISc, Bangalore	279	256	243
2	Jadhavpur University	633	348	243
3	BHU	118	117	110
4	Pune University	261	103	98
5	AMU	99	97	96
6	DU	131	97	59
7	JNU University	67	63	50
8	Jamia Milia Islamia	109	99	49
9	Lucknow University	248	149	49
10	IIT, Bombay	72	62	36

Table-3.5: Gender wise delineation of PhD Scholars

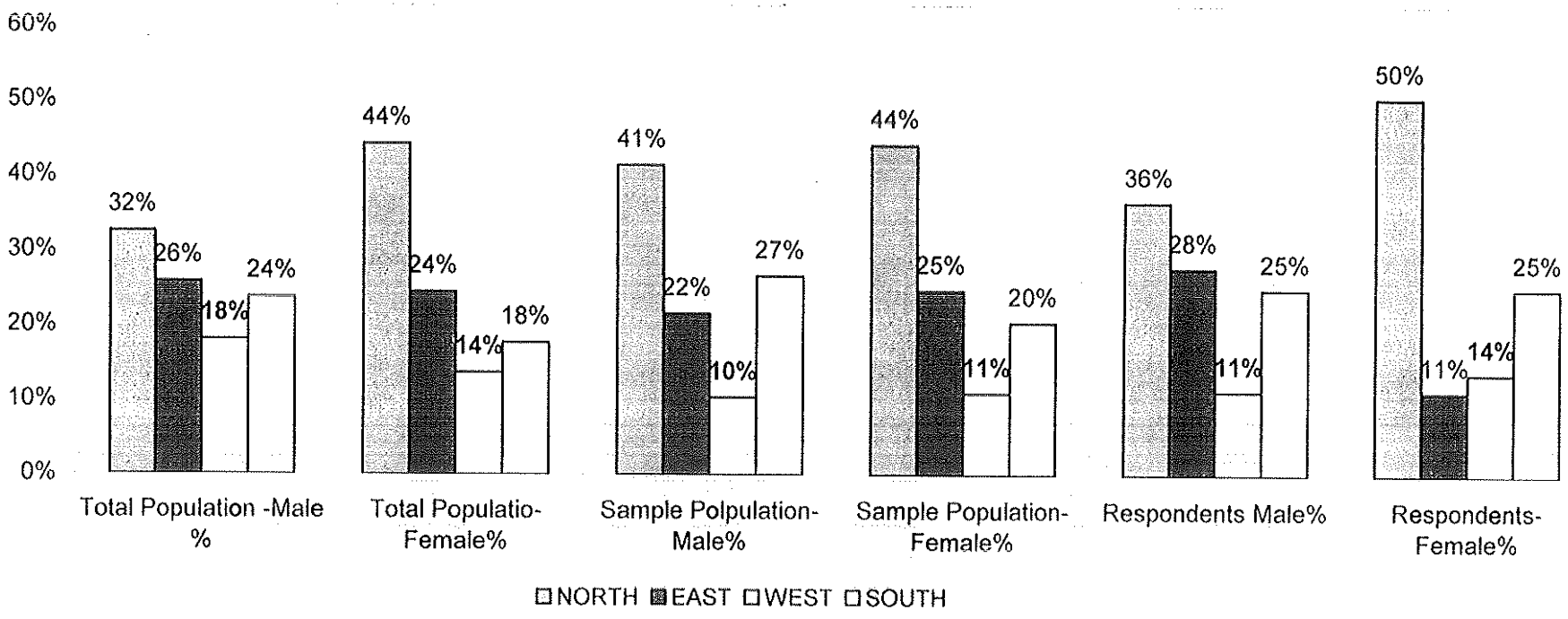


	Total Population	Net Sample Population	Respondents
Male	2047	1361	855
Female	1006	682	366
Total	**3053**	**2043**	**1221**

Table-3.6: University Wise: Gender wise distribution of PhD scholars Total Vs Net Sample and Respondents (Ref. Period: 1999-2002)

		Total Population			Sample Population			Total Respondents		
S.No.	UNV-wise	TP-Male (%)	TP-Female (%)	Total (I%)	Sample - Male (%)	Sample - Female (%)	Total (%)	Respondents-Male (%)	Respondents-Female (%)	Total
1	AMU	37(37%)	62(63%)	99(3%)	37(38%)	60(62%)	97(5%)	36(38%)	60(63%)	96(8%)
2	Allahabad University	43(64%)	24(36%)	67(2%)	38(63%)	22(37%)	60(3%)	11(100%)	0(0%)	11(1%)
3	Assam University	13(62%)	8(38%)	21(1%)	11(61%)	7(39%)	18(1%)	10(77%)	3(23%)	13(1%)
4	BHU	75(64%)	43(36%)	11(4%)	75(64%)	42(36%)	11(6%)	73(66%)	37(34%)	110(9%)
5	DU	55(42%)	76(58%)	131(4%)	53(55%)	44(45%)	97(5%)	36(61%)	23(39%)	59(5%)
6	Hyderabad University	54(70%)	23(30%)	77(3%)	53(73%)	20(27%)	73(4%)	10(100%)	0(0%)	10(1%)
7	IGNOU	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
8	Jamia Millia Islamia	94(86%)	15(14%)	109(4%)	85(86%)	14(14%)	99(5%)	37(76%)	12(24%)	49(4%)
9	JNU University	26(39%)	41(61%)	67(2%)	23(37%)	40(63%)	63(3%)	13(26%)	37(74%)	50(4%)
10	AIIMS	61(53%)	55(47%)	116(4%)	45(52%)	42(48%)	87(4%)	23(100%)	0(0%)	23(2%)
11	IIT, Kharagpur	45(70%)	19(30%)	64(2%)	35(65%)	19(35%)	54(3%)	11(100%)	0(0%)	11(1%)
12	IIT, Bombay	58(81%)	14(19%)	72(2%)	50(81%)	12(19%)	62(3%)	24(67%)	12(33%)	36(3%)
13	IIT, Kanpur	80(95%)	4(5%)	84(3%)	60(94%)	4(6%)	64(3%)	22(100%)	0(0%)	22(2%)
14	IIT, Delhi	46(84%)	9(16%)	55(2%)	12(80%)	3(20%)	15(1%)	12(100%)	0(0%)	12(1%)
15	IIT, Madras	122(70%)	53(30%)	175(6%)	39(56%)	31(44%)	70(3%)	11(46%)	13(54%)	24(2%)
16	IIT, Guwahati	16(67%)	8(33%)	24(1%)	14(74%)	5(26%)	19(1%)	3(60%)	2(40%)	5(0.4%)
17	ISI, Kolkata	29(94%)	2(6%)	31(1%)	21(91%)	2(9%)	23(1%)	4(80%)	1(20%)	5(0.4%)
18	NIPER	12(80%)	3(20%)	15(0.5%)	12(80%)	3(20%)	15(1%)	11(79%)	3(21%)	14(1.1%)
19	SCTI	8(73%)	3(27%)	11(0.4%)	7(78%	2(22%)	9(0.4%)	0(0%)	2(100%)	2(0.2%)
20	IISc, Bangalore	195(70%)	84(30%)	279(9%)	183(71%)	73(29%)	256(13%)	180(74%)	63(26%)	243(20%)
21	TIFR	122(70%)	53(30%)	175(6%)	27(52%)	25(48%)	52(3%)	11(92%)	1(8%)	12(1%)
22	Lucknow University	136(55%)	112(45%)	248(8%)	123(83%)	26(17%)	149(7%)	37(76%)	12(24%)	49(4%)
23	Madras University	106(88%)	15(12%)	121(4%)	80(86%)	13(14%)	93(5%)	11(46%)	13(54%)	24(2%)
24	Jadhavpur University	424(67%)	209(33%)	633(21%)	213(61%)	135(39%)	348(17%)	208(86%)	35(14%)	243(20%)
25	Pune University	190(73%)	71(27%)	261(9%)	65(63%)	38(37%)	103(5%)	61(62%)	37(38%)	98(8%)
Total		2047 67%	1006(33%)	3053(100%)	1361(67%)	682(33%)	2043(100%)	855(70%)	366(30%)	1221(100%)

Table-3-7: Region Wise: Gender wise distribution of PhD scholars Total Vs. Net Sample and Respondents



Region	Total Population - Male	Total Population-Female	Sample Population-Male	Sample Population-Female	Respondents Male	Respondents-Female
NORTH	665	444	563	300	311	184
EAST	527	246	294	168	236	41
WEST	370	138	142	75	96	50
SOUTH	485	178	362	139	212	91
OVERALL	**2047**	**1006**	**1361**	**682**	**855**	**366**

74%) followed by AMU (at 62%), IIT, Madras (at 54%) and, Madras university (at 54%) respectively.

(vii) The region-wise and Gender-wise distribution of PhD scholars Vs Net sample and respondents; is highlighted in **Table-3.7 & Graph**. It is clearly evident that the highest number of female respondents comes from the northern region (at 184) followed by Southern region (at 91), western region (at 50) and, Eastern region (at 41) in that order out of the overall 366 females across the institutions.

(viii) On the other hand the category-wise and gender-wise distribution of PhD scholars: Total Vs Net Sample and respondents population has been reflected in the **Table-3.8 & Graph**. The highest number of female out-turn has been from CUs (at 172), followed by SUs (at 97); Dmd Us (at 64) and, IoNI (at 33) out of the total respondents population of 366.

(ix) Area-wise and Social category-wise position among the respondents also reveals an interesting feature, as can be seen in **Table-3.9 & Graph**.

Around 72% of the respondents come from the general category. The distribution of respondents between rural is 29% (258) and, urban 71% (with number at 623) respectively.

- OBC classification is the next highest with 21% (258). Their distribution between rural and urban is 42% and 58% respectively.

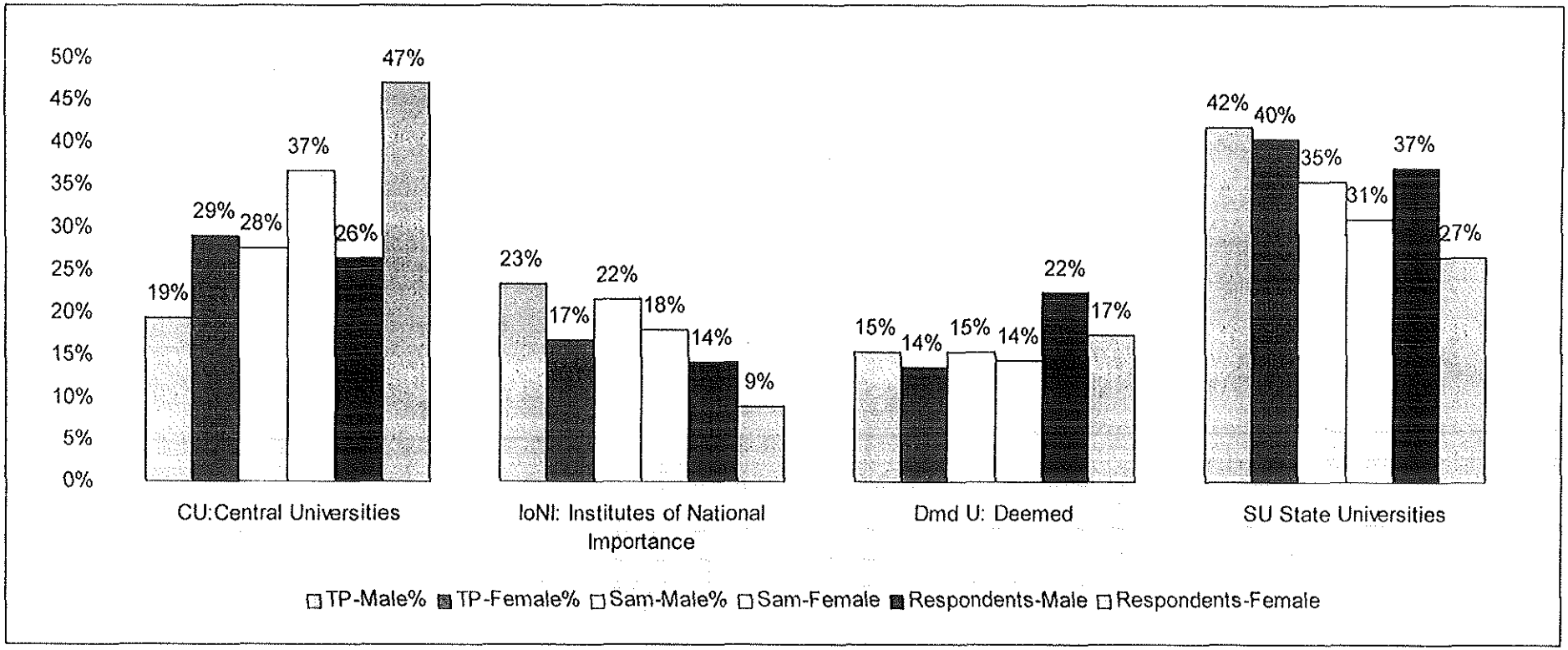
- ST classification stand at 4% (45). Their distribution between rural and urban is 27% and 73% respectively.

- SC classification stands at 3% (37). Their distribution between rural and urban is 32% and 71% respectively.

- All above classification clearly indicate that urban residents have a better access to the universities / institutes, perhaps because of better awareness and study facilities in the urban areas;

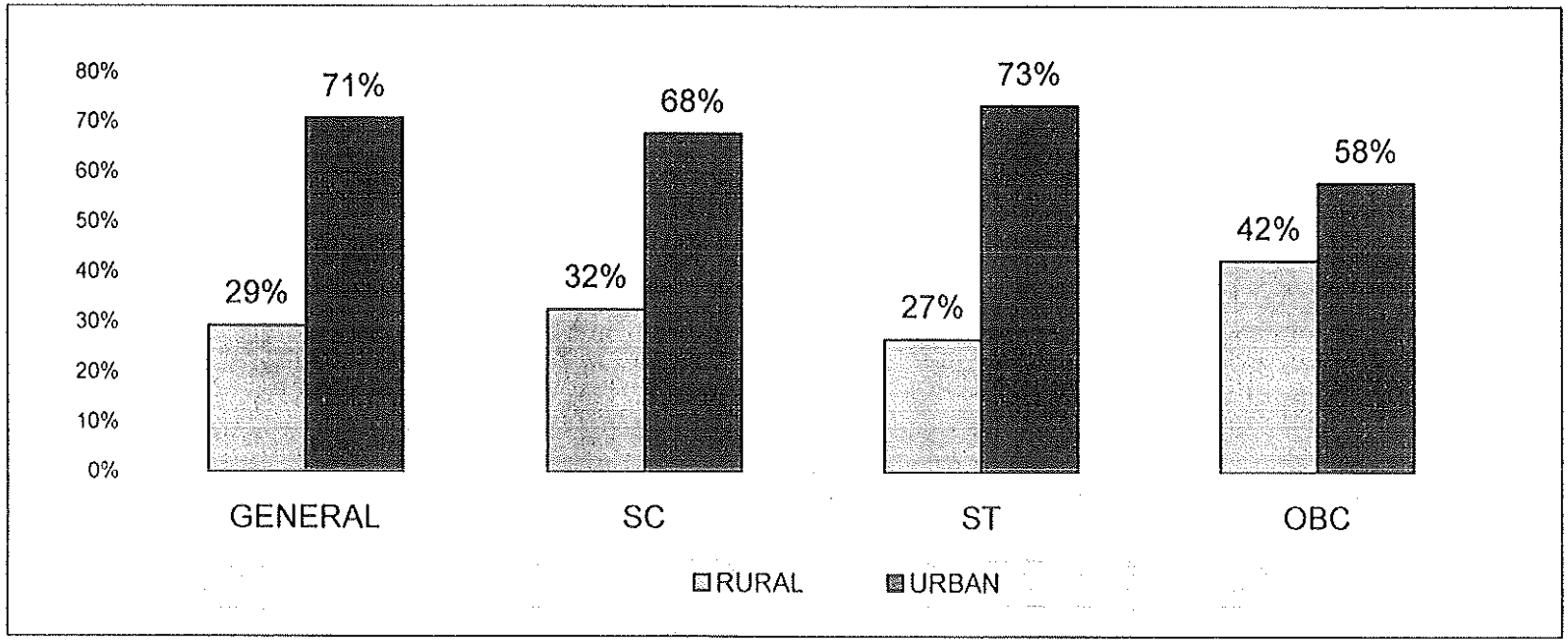
3.1.2 This calls for another relevant question here about the number of institutions that provide hostel accommodation to those that need it and whether the cost of the lodging and boarding has discounted rates for the lower income groups, these questions missed attention both on the part of the interviewers and the respondents did not volunteer to provide suggestions on the issue.

Table-3.8: Category Wise: Gender wise distribution of PhD scholars Total Vs Net Sample and Respondents



UNV-wise	Total Population-Male	Total Population-Female	Sample population-Male	Sample Population-Female	Respondents-Male	Respondents-Female
CU:Central Universities	397	292	375	249	226	172
IoNI: Institutes of National Importance	477	170	295	123	121	33
Dmd U: Deemed	317	137	210	98	191	64
SU State Universities	856	407	481	212	317	97
Total	**2047**	**1006**	**1361**	**682**	**855**	**366**

Table – 3.9: Area Wise / Social Category wise: Population of Respondents.



PLACE	GENERAL	SC	ST	OBC	Overall
RURAL	258	12	12	109	**391**
URBAN	623	25	33	149	**830**
OVERALL	**881**	**37**	**45**	**258**	**1221**

3.2 Annual family income of PhD scholars at the time of joining PhD program: The **Table-3.10 & Graph**

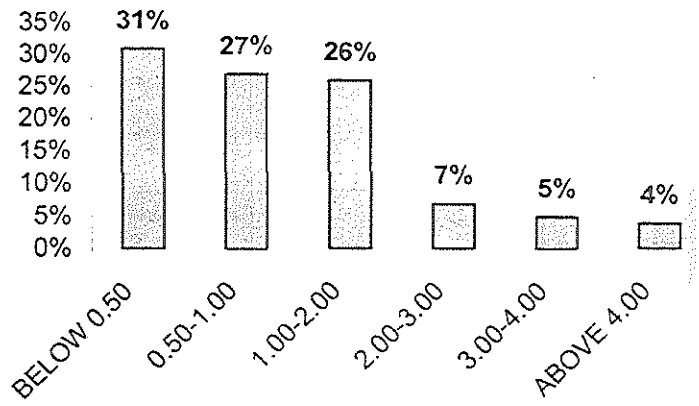


Table-3.10: Annual Family Income (In Re. lakhs)	
Family Income	**Total**
Below Rs.0.50	379
0.50-1.00	330
1.00-2.00	317
2.00-3.00	85
3.00-4.00	61
Above 4.00	49
Total	**1221**

- **Annual family income of PhD scholars at the time of joining PhD program:**
- Graph / Table clearly indicates that 31% of the respondents (379) had the family income less than Rs.50, 000 p. a at the time of joining PhD programme;
- Around 26% had annual income up to Rs.1.00 lakh p.a. and, 26% had between Rs.1 to 2 lakh p.a.;
- The income bracket of less than Rs.4.00 lakhs and above has been inversely proportional to the number and percentage of respondents in that group, as can be seen in the table and graph above.
- One can accordingly see that few of the PhDs are from the high-income groups: only 12% come from families with an annual income of more than 2 lakhs.

3.3 Family's main occupation at the time of PhDs scholars joining PhD program

Table -3.11:

- The family income has been classified into 5 main occupations and, services tops the list with 31% (379) out of the total respondents

Table-3.11: Family's main Occupation	
Main occupation	**Total**
Services	379(31%)
Teaching	319(26%)
Agriculture	307(25%)
Business	107(9%)
Others	107(9%)
Total	**1221(25%)**

- The table shows that about 10% of the families to whom PhD scholars belong, were from the business class: this is consistent with Table-3.10, which shows that 12% of

such families have an income exceeding Rs.2 lakhs a year. That means 26% of the families have a teaching background is not surprising, but it is heartening that 25% actually come from an agricultural background.

- Incidentally, the Table-3.9 indicates 391 families are from a rural area, while in Table-3.11: 307 families are with agriculture background. This implies that 86 of these families are rural-based, but not agricultural.

3.4: Income and Occupation- wise Analysis

Table-3.12: Income and Occupation-wise Analysis

Income Group	Agricultural Background	Teaching Background	Business Background	Service Background	Others	Total
BELOW - 0.50	182	38	34	87	38	379
0.50-1.00	63	122	23	99	23	330
1.00-2.00	13	98	38	120	48	317
2.00-3.00	24	37	0	24	0	85
3.00-4.00	12	12	0	37	0	61
ABOVE 4.00	13	12	12	12	0	49
OVERALL	307	319	107	379	109	1221

- Majority of the respondents families i.e. 84% fall under the income group of upto Rs.2 lakhs;
- Only 16% families fall under the bracket of Rs.2.00 to Rs.4.00 lakhs & above;
- The data clearly indicates that agriculture family background of Ph.D. holders are mainly concentrated in the lowest income bracket below 0.50 lakhs while for teaching the same is i.e. Rs.0.50 to 1 lakh.
- Service and business family backgrounds are of these in the third income bracket, i.e. Rs.1-2 lakh. There is a reverse relation in the income and Ph.D. holders for all occupation categories. Only the service background shows some symmetric relation.

3.5 Parental Educational profile of PhD respondents:

Table-3.13: Parental Education

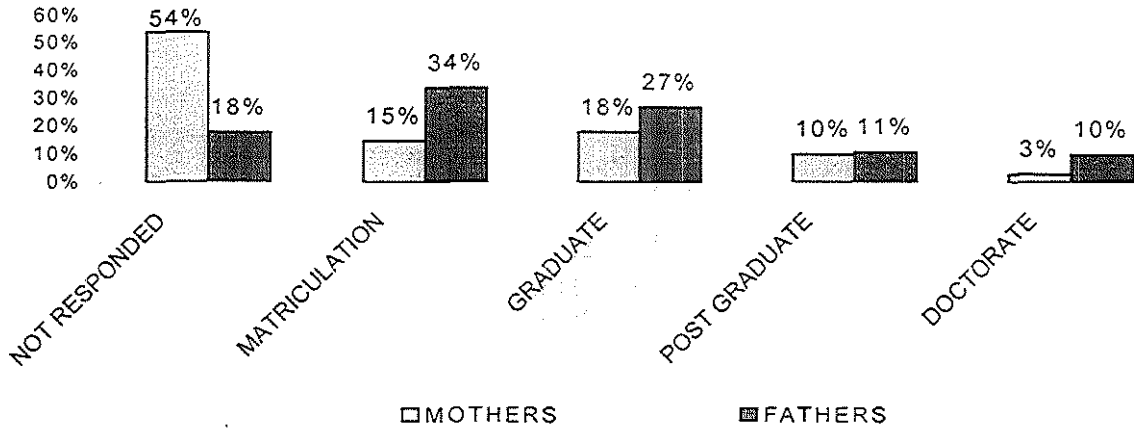
The table & graph below clearly highlight the parental educational of the respondents.

There is consistent distribution for both parents at the graduate level in the ratio of 27:18 between fathers and, mothers, as can be seen in the table;

Educational Profile	Mothers	Fathers
Not responded	659	220
Matriculation	183	415
Graduate	220	330
Post graduation	122	134
Doctorate	37	122
Total	1221	1221

- The table / graph also indicates that majority of respondents have 'not responded' to the question;
- At the postgraduate level mother's and father's are almost neck-to-neck at 11:10;
- Under the Doctorate level fathers out number the mothers at 10:3 ratio

Parental Educational profile of PhD respondents:



3.6 Educational Qualification of respondents at the time of admission-Category-wise

The **Table-3.14**, below gives category-wise enrollment criteria and the minimum qualification of the respondents at the time of taking admission to the PhD courses in the different categories of universities, viz. CU, IoNI, DmD U, and SUs.

Table-3.14: Educational Qualification of respondents at the time of admission-Category-wise,

Discipline	Master Degree with less than 60%	Master Degree with more than 60%	M.Phil.	Net/ Gate	Others	Total
Central Unv.	381(31.2%)	6 (0.49%)	0	0	11 (0.90%)	**398 (32.5%)**
IoNI	114 (9.3%)	16 (1.31%)	0	0	24 (1.96%)	**154 (12.6%)**
Deemed Unv.	192 (15.72%)	24 (1.96%)	0	0	39 (3.19%)	**255 (20.88%)**
State Unv.	363 (29.72%)	15 (1.22%)	0	0	36 (2.94%)	**414 (33.9%)**
Total	**1050 (85.99%)**	**61 (4.99%)**	**0**	**0**	**110 (9%)**	**1221**

CU=Central University; IoNI= Institute of National Importance; DmU=Deemed university; SU= State University

Out of the total respondents, around 1050 scholars had the minimum qualification with the Masters degree (having aggregate marks less than 60%) in sciences. Their distribution varied from 36% in the CUs to 11% in IoNI, whereas respondents from the SUs covered 35% and, the DmDU 18%. Around 61 respondents had qualification PG with more than 60% marks. Around 110 respondents had PG degree besides the different merit certificates at the time of getting admission to the PhD courses. Their percentage varied from 13% in IoNI to 34% in SUs. On the other hand the 34%age were in CUs and, 21% in the DmD Us. However, none of the respondents had taken up M. Phil before seeking admission to the PhD work.

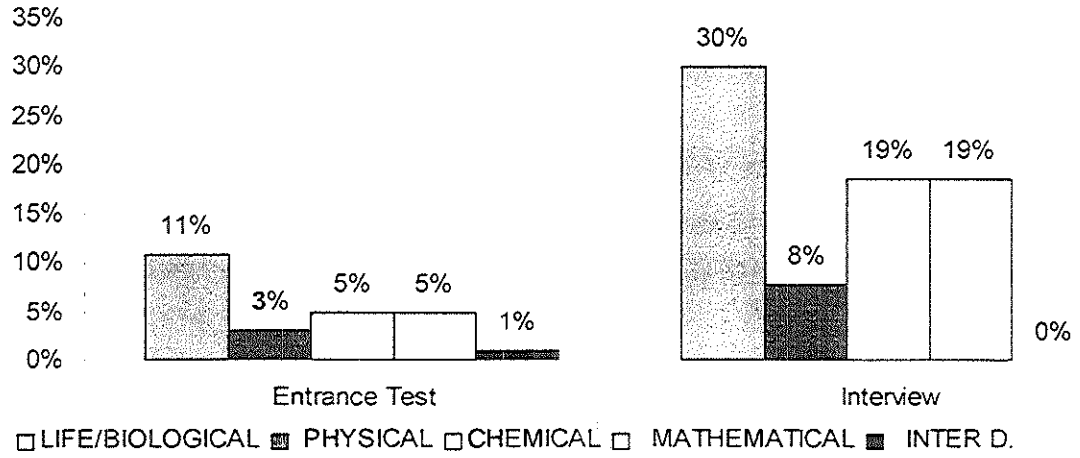
3.7 Enrolment with Test / Interviews: Discipline-wise

The **Table-3.15:** indicates the response about Enrolment through Test / Interviews discipline-wise

Table-3.15: Enrolment through Test / Interviews: discipline-wise			
Discipline	**Entrance Test**	**Interview**	**Total**
Life /Biological sciences	134 (10.97%)	368 (30.13%)	502 (41.11%)
Physical sciences	37 (3.03%)	95 (7.78%)	132 (10.81%)
Chemical sciences	61 (4.99%)	226 (18.5%)	287 (23.5%)
Mathematical sciences	61 (4.99%)	226 (18.50%)	287 (23.5%)
Inter disciplinary	13 (1.06%)	0	13 (1.06%)
Total	**306 (25.06%)**	**915 (74.93%)**	**1221**

- The situation is almost identical with 306 respondents having taken up enrollment for PhD after being interviewed either by the HoD / faculty / the guide. The percentage over the disciplines varies from 30% in the case of Life / Biological sciences to 19% each in the case of Chemical and Mathematical / Computer sciences, whereas it is 8% in the case of Physical sciences

  - Similarly, about 306 respondents had been enrolled for PhD through entrance test in the various disciplines. Their percentage varied from 11% to 1% between Life / Biological sciences to I% (with the number a1 13) respondents who were enrolled under the Inter-disciplinary subjects.
  - For better clarity and, representation, Enrolment through Test / Interviews: discipline-wise has been depicted in the graph below:



3.8 Type of thesis vis-à-vis topic / work handled

The **Table-3.16 &** Graph on Type of Thesis vis-à-vis topic / work (with multiple answers) is given below:

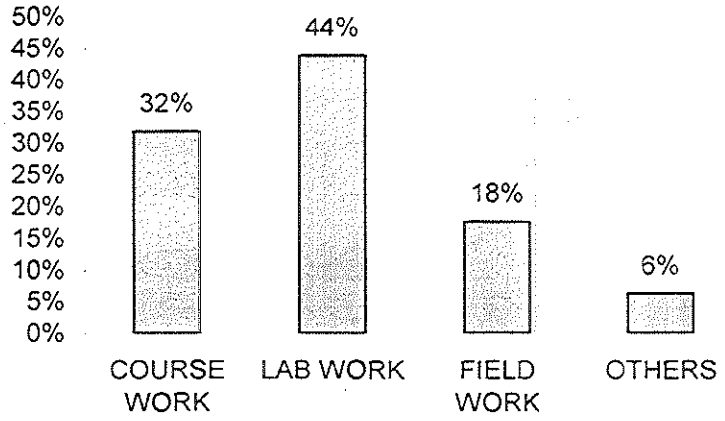


Table-3.16: Type of Thesis vis-à-vis topic / work	
Type of Work/Thesis	**No. of answers**
Course Work	549
Lab Work	757
Field Work	305
Others	110
Total	**1721**

- The table and graph gives a brief analysis of the multiple answers on the selection topics. Though individual topics have not been analyzed but these have been grouped them into 4 broad types viz. a) Lab work; b) course work; c) Field work and, d) others;
- The percentage response has also been in the same order a) Lab work (44% of respondents); b) course work (32% of respondents); c) Field work (18% of respondents) and, d) others (6% of respondents);

3.9 Respondents Membership or Non-Membership of professional bodies

- The Table, below shows that maximum respondents who had taken membership from the professional bodies has been 77% (i.e. with number at 317) from the SUs;

Table-3.17: Respondents Membership or Non-Membership of professional bodies
(No. & percentage relate to total respondents)

MEMBERSHIP STATUS	CU	IoNI	DmU	SU
➢ NON MEMBERSHIP	179 (45%)	61 (40%)	169 (66%)	97 (23%)
➢ MEMBERSHIP	219 (55%)	93 (60%)	86 (34%)	317 (77%)
➢ TOTAL	**398**	**154**	**255**	**414**

CU=Central University; **IoNI**= Institute of National Importance; **DmU**=Deemed university; **SU**= State University

- This is followed by 60% (i.e. with number at 93) from the IoNI;
- The CUs had 55% (i.e. with number at 219) out of the total of 398 who completed PhD from the CUs;
- Around 23% of the PhD respondents have not been members of the various professional bodies. Either they thought it to be not very useful or could not afford it.

3.10 Motivating Factors:

- Table-3.18, below, indicates the motivational factors / reasons with **multiple answers** (total responses at 1697) that have lead the respondents to take up PhD

programme. Their rank in the descending order as per the response has been given in the table below.

- Interestingly, academic interest was the motivating factor for most of the PhD scholars (87%). Then next came those who wanted to improve their career prospectus (30%). No better option, family and peer pressure were of low significance. Sponsorship was too limited a phenomena.

Table-3.18: Motivational Factors of Respondents

Factors that Motivated	Respondents
Purely academic interest	1062 (87%)
To obtain a particular kind of job	366 (30%)
No better option	85 (7%)
Others (Qualify)	61 (5%)
Family pressure	49 (4%)
To meet minimum requirement	37 (3%)
Sponsored by the organizations	24 (2%)
Peer pressure	12(1%)
Overall	**1697**

3.11 Conclusions:

- The sample selected is quite comprehensive in terms of type and category of institutions covered, regional representation, gender-wise coverage, social category coverage as also rural & urban representations.

- The number (1221) and percentage of 60% responses from the PhD scholars with whom contact could be established gives a fairly valid base for statistical interpretation of data and drawing conclusion, subject to the limitations mentioned in Chapter-II.

- The study de-mystifies the perception that only scholars with higher family incomes go for PhD. A good number of scholars (84%) from lower income brackets (annual income below Rs.2.00 Lakhs) reflect a healthy development for a nation promoting equality of opportunity under "Directive Principles of State Policy" under the constitution.

- Services followed by Teaching and agriculture was the principal family occupations of the scholars (82%). The share of 25% of scholars from Agricultural background reflects the emerging awareness of the rural elite to pursue higher education. The overall trend though encouraging does show that business class is as yet more inclined to go for education that pays more in return.

- The analysis also shows that it is not the prerogative of the wards of the highly qualified parents to pursue PhD studies, the opportunities of higher education and research are now being pursued by scholars of even matriculate parents. Again this augurs well for a developing country like India.

- However, relatively unsatisfactory level of membership of professional bodies by scholars of various kinds of institutions indicates a need for better support in this context by the authorities concerned.

- Pursuit of excellence reflected in the academic interest as the prime motivating factor, though a good indicator of march forward, would need further probing on the underlying factors.

CHAPTER-IV:
PHD RESEARCH PROCESS, FACILITIES AND OUTPUT

Prelude:

4.1 Enrolment and Selection Criteria for PhD through entrance test / interviews

4.2 Quality of Research topics / work: Category-wise

4.3 Choice of Research Topics

4.4 Choice of Guide for PhD: Category-wise for taking research guide from different agencies

4.5 Choice of guide from various agencies under different Disciplines

4.6 Facilities- Fellowship / Scholars / Laboratories etc.

4.7 Completion of PhD with Age-wise analysis

4.8 Completion of PhDs response category-wise

4.9 Time Duration taken in completing the PhD program by respondents

4.10 Enrolment of Respondents Year-wise and their year of award / out-turn of PhD

4.11 Completing PhD programme by the Respondents: Gender-wise analysis.

4.12 Constraints faced during PhD Programme:

4.13 Aspects / constraints that affected research work during the PhD programme

LINKAGE / OUTPUT

4.13 Publication wise analysis (apart from PhD Thesis)

4.14 PhD Output whether published in International / National Journals: discipline-wise

4.15 Odyssey of PhD Research- During the process

4.16 Conclusions

CHAPTER-IV:

RESEARCH PROCESS, FACILITIES AND OUTPUT

Prelude:

This pilot study brings to light all the facets of Doctorate-from the day of researcher's selection, passing out and entering the job market. The impressions were a mixed bag: positive and not so positive. This Chapter accordingly, deals with the responses of approx. 1221 PhD scholars, who completed their PhD in the faculty of sciences from 24 out of 25 Universities / institutes (except for IGNOU, which does not award PhD) selected for this study. NRIF had devised an elaborate questionnaire with more than 37 questions for canvassing to seek the opinions of scholars holding doctorates in faculty of sciences. The major aspects covered basically were as per the objectives of the study from the stage of their enrollment / registration for PhD, background academic information, requirement for admissions, category, linkages & output in PhD programme, motivation and, constraints. The questionnaire mostly had closed ended questions (with probable answers mostly having been responded). However, among other open questions, responses have been either limited or no responses. But most useful input came in the form of comments and suggestions.

4.1 Enrolment and Selection Criteria for PhD through entrance test / interviews

- The Category-wise enrollment and selection criteria, as given in **Table-4.1 and Graph**, gives an interesting picture and the variation between the different category of universities / institutes.

Table-4.1: Enrolment & Selection criteria

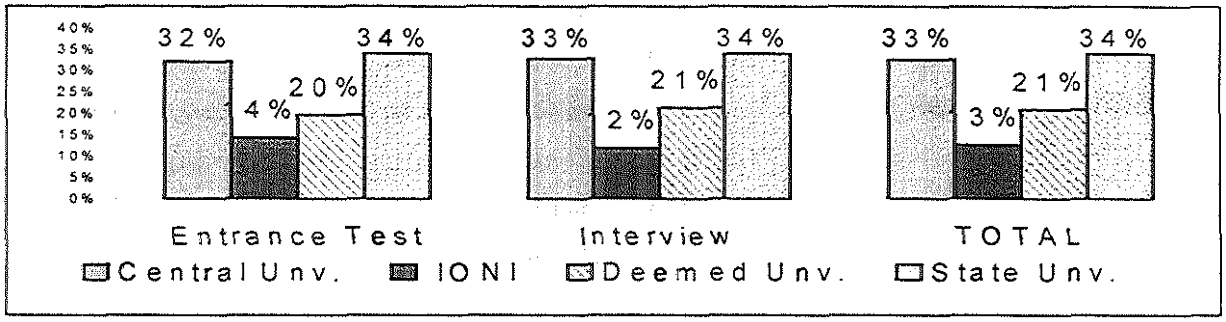
Category-Wise	Entrance Test	Interview	TOTAL
➢ Central Unv.	98	300	**398**
➢ IONI	44	110	**154**
➢ Deemed Unv.	60	195	**255**
➢ State Unv.	104	310	**414**
➢ Total	**306**	**915**	**1221**

CU=Central University; IoNI= Institute of National Importance; DmU=Deemed university; SU= State University

- Out of the total 1221-PhD scholars, maximum number of respondents (75%) had been enrolled for admission in the faculty of sciences on the basis of an interview.

They were interviewed either by the HoD / faculty members / guides of the concerned departments. Their number was around 915, their percentage varied from 34% in SUs to 14% in IoNI; whereas this for DmdUs has been 20% and CUs 32% respectively.

- On the other hand, around 306, i.e.25% of the total respondents, had to qualify in the entrance test before getting enrollment in the respective departments of the science faculty. Their percentage trend almost has been identical with that of the ones who had been enrolled simply on the basis of interview. The percentage ranged from 34 in SUs to 12 in IoNI and that for the DmDUs had been 21 and, CUs 33 respectively.
- The graph below depicts the comparative position Category-wise enrollment and selection criteria



4.2 Quality of Research topics / work: Category-wise

Category-Wise (Quality of Research Work) has been given in the **Table 4.2** below:

Table 4.2: Quality of Research topics / work: Category-wise

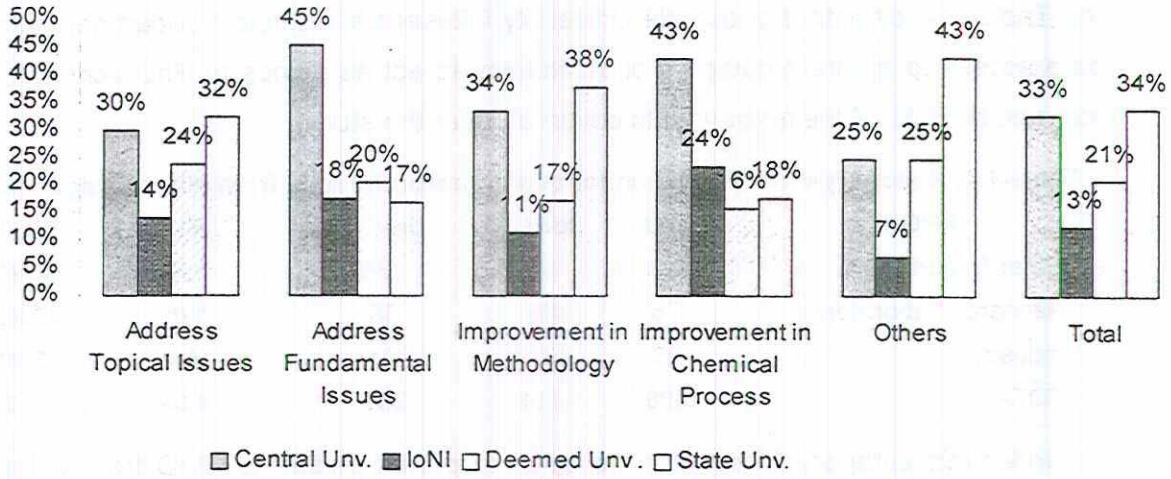
Category	Address Topical Issues	Address Fundamental Issues	Improvement in Methodology	Improvement in Chemical Process	Others	Total
Central Unv.	75	62	123	51	87	**398**
IoNI	35	24	42	28	25	**154**
Deemed Unv	59	28	63	19	86	**255**
State Unv.	81	23	138	21	151	**414**
TOTAL	**250**	**137**	**366**	**119**	**349**	**1221**

CU=Central University; IoNI= Institute of National Importance; DmU=Deemed university; SU= State University

- The question to the respondents on the PhD topic and, quality of research work had been categorized in the 4 broad issues. The responses on them in order covered the following viz.
  - Improvement in Methodology (responses received was from 366 i.e. 30% of the respondents): this varied from 38% in SUs, CUs: 34%, DmD Us: 17% to 11% in IoNI;

- Addressed the Topical Issues (received responses from 250 i.e. 21% of the respondents): this varied from 32% in SUs; 30% from CUs; 24 and 14% from the DmD U and IoNI respectively;
- Addressed Fundamental or Basic Research (covered responses from 137 i.e. 11% of the respondents): this varied from 45% in CUs; 20% from DmD Us; 18 and 17% from the IoNI and SUs respectively;
- Improvement in Chemical Process: (received responses from 119 i.e. 9% of the respondents): this varied from 43% in CUs: 24% in IoNI, 18 and, 16% from SUs to DmD Us, in that order.
- However responses were received from 349 i.e. 29% of the total respondents indicating other category than the ones mentioned above. Its percentage was highest from the SUs at 43% as can be seen form the graph below.

- The graph below illustrates the comparative position of topics addressed by the PhD scholars.



4.3 Choice of Research Topics

- It is clearly evident from **Table-4.3** that 51% of respondents had taken-up research topics with industrial application, whereas the others had taken up other than industries as their topics for their PhD research.

Table-4.3: Research Topics whether with Industrial application

Research oriented with possible industry application	Sample (%age)
➢ Industry application	623(51%)
➢ Non- Industry application	598(49%)

- The respondents having taken up non-industrial topics covered mostly the ones as given in Table 4.2, above. These included: a) Improvement in Methodology; b)

Addressed the Topical Issues; c) Addressed Fundamental or Basic Research; and, d) Improvement in Chemical Process etc.

- However, the other relevant question for which no response were received were:
  a) Whether scholars had applied for any patents?
  b) Was there any plan to apply for a patent?
  c) Whether the work had been published in a journal that emphasizes industrial applications?
  d) The research work that could be evaluated either in terms of a citation index for research publications or in terms of patents applied for (or preferably whether granted).
- Since these issues were not covered in the scope of the study, the next phase of the study could cover them up with more issues and problems.

4.4 Choice of Guide for PhD: Category-wise for taking research guide from different agencies

The Table 4.4 depicts that outside University / Research Institute / departments have more access to different category of institutions to act as guides to PhD scholars, as indicated by 56% of the respondents covered under the study.

Table-4.4: Category-wise: Provision for taking research guide from different agencies

FROM	C U	IoNI	Dmd U	SU	TOTAL
➢ Other Departments	300	55	136	193	**684(56%)**
➢ Research Laboratory	75	68	85	175	**403(33%)**
➢ Industry	23	31	34	46	**134(11%)**
➢ TOTAL	**398**	**154**	**255**	**414**	**1221**

- Under this category CUs are more open to permit guides for PhD from out side departments;
- The SUs have preferred to allow Scientists from the Research Laboratories to act as guides for the PhD scholars;
- Industries are ranked third to take an active role in associating with the SUs to act as guides to the PhD scholars.

4.5 Choice of guide from various agencies under different Disciplines

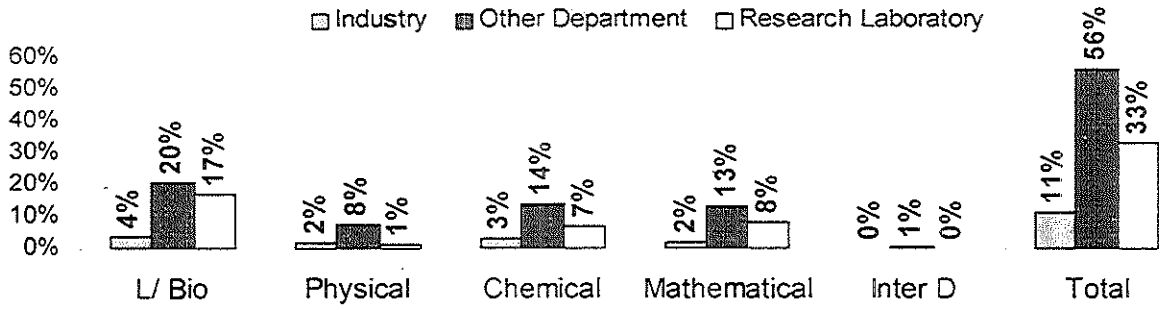
- Provision for taking research guide from various agencies under different Disciplines has been given in Table-4.5:
- The Table indicates that outside / other departments have consistently played major role for all the four disciplines viz. Life / Biological sciences (as indicated by the 20% of the respondents), Chemical sciences (14%), Mathematical / Computer

sciences (13%) and, Physical sciences (8%) in that order, for acting as guide to the PHD students during the period under reference;

Table-4.5: Provision for taking research guide from various agencies under different Disciplines

From	L/ Bio	Physical	Chemical	Mathematical	Inter D	Total
Industry	49	24	37	24	0	**134**
Other Department	250	95	165	164	10	**684**
Research Laboratory	203	13	85	99	3	**403**
Total	**502**	**132**	**287**	**287**	**13**	**1221**

- This is followed by Research Laboratories in three disciplines viz. Biological sciences (as indicated by the 17% of the respondents during the reference year of the study), followed by Mathematical / Computer science (8%) and, Chemical science (7%);
- Whereas Industries have consistently played role in at least all the four disciplines viz. Life / Biological sciences (4% of the respondents), Chemical sciences (3%), Mathematical / Computer sciences and, Physical sciences (at 2%) respectively in that order as indicated by the respondents.
- The comparative position about taking research guide from various agencies under different Disciplines has been reflected in graph below: -



4.6 Facilities- Fellowship / Scholars / Laboratories etc.

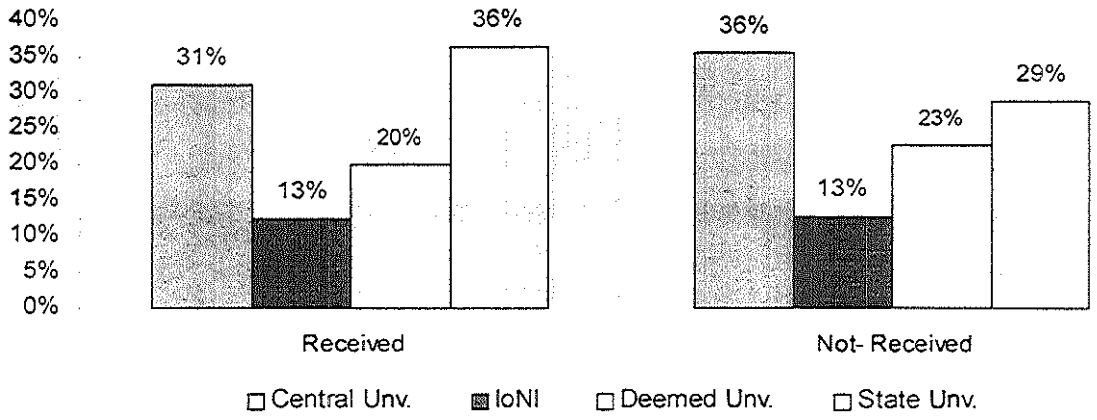
4.6.1 The Category-wise Fellowship receive during PhD are provided in **Table-4.6** below:

- Around 68% of the respondents had fortunately received fellow-ship (either JRF or SRF);

- Table-4.6: Fellowship facility: Category-wise: during PhD received by the respondents

Category-Wise	Received	Not-Received	TOTAL
Central Unv.	258	140	398
IoNI	104	50	154
Deemed Unv.	165	90	255
State Unv.	300	114	414
Total	827	394	1221

- Among the ones who received fellowship, 36% respondents came from SUs, followed by CU (31%), DmD Us (20%) and, IoNI (13%) in that order;
- Other respondent's who did not get any fellowship were viz. around 32% of the total respondents. These were either employed or were financed by their families / any other agencies, as they did not indicate their source of funding. Their % age varied in the descending order from CUs (36%), SUs (29%), DmD Us (23%) and, IoNI (13%).
- However, many respondents / researchers agreed that lack of funded projects or partly funded projects created financial problems for most scholars. The research attention is thus diverted from assiduous research to exploring and imploring funders.
- The institutional / category-wise comparative position of those who received the grants to those who did not is depicted in the graph below: -



4.6.2 Fellowship Analysis: Discipline-wise.

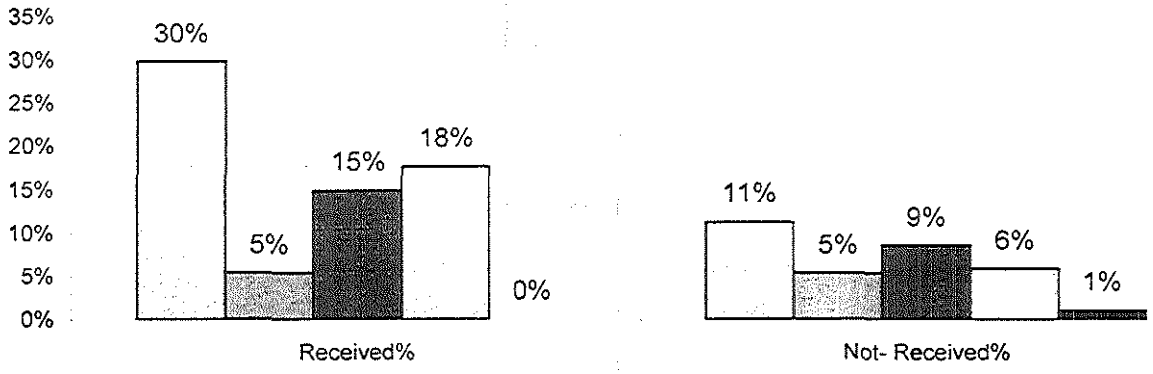
- This Table 4.7 below can be interpreted with the Table-4.6 above, **Table-4.7,** gives discipline-wise situation of fellow ships.
- The situation is almost identical with 827 respondents having received the fellowship for the PhD programme. Their percentage varied from 30% in the case of Life / Biological sciences to 18% in the case of Mathematical / Computer sciences,

15% in the case of Chemical sciences and, 5% in the case of Physical sciences in that order.

Table-4.7: Fellowship Analysis: Discipline-wise.

Discipline	Recd	Not Recd	Total
Life / Biological Sciences	364	138	**502**
Physical Sciences	66	66	**132**
Chemical Sciences	182	105	**287**
Mathematical Sciences	215	72	**287**
Inter-disciplinary	0	13	**13**
Total	**827**	**394**	**1221**

- There is an identical situation as well for the ones who did not get fellowship. Their percentage varied from 11% in the case of Life / Biological sciences to 1% in the case of Inter-disciplinary.
- The comparative position of discipline-wise fellowship received by the ones to those who did not is depicted in the graph below
- **Discipline-wise Fellow-ship received and who did not:**



4.7 Completion of PhD with Age-wise analysis

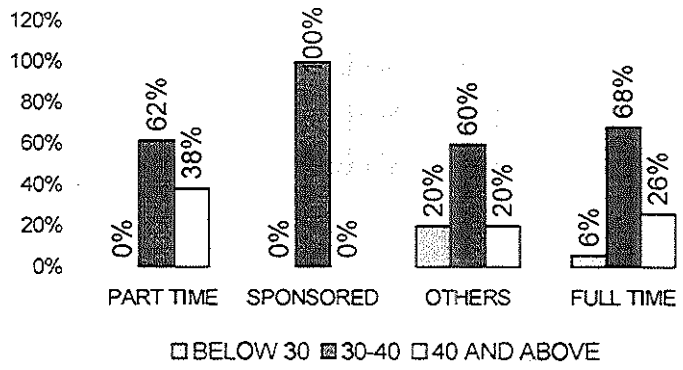
- The **Table-4.8: Age-wise reveals responses by the ones who completed PhD**

Completion Of PhD	BY AGE			Total
	BELOW 30	30-40	40 AND ABOVE	
Part Time	0	201	124	**325**
Sponsored	0	96	0	**96**
Others	20	60	20	**100**
Full Time	41	478	181	**700**
Total	**61**	**835**	**325**	**1221**

- The Table and graph (below) clearly reveals that overall responses have been grouped as per the three stage age-ranges. Accordingly, around 68% of

respondents (i.e. with the number at 835) had been in the age group between 30 to 40 years who completed PhD during the reference period. These respondents with age group between 30 to 40 years were involved in research full time basis were: (68%), part time (62%). Their PhD was fully sponsored by either agencies or parents.

- Around 27% of the respondents (i.e. with the number at 325) were in the age group of 40 years and above. Out of them 38% completed PhD on part time basis, 26% on full time basis and around 20% completed PhD on part-term basis.
- Only 5% of the respondents in the age group of less than 30 years of age received scholarship. Around 20% respondents received scholarship for other purposes; it could be either for books, equipments, stationary, printing or miscellaneous items etc. whereas only 6% received full time scholarship.
- Comparative position is reflecting Age-wise responses by the ones who completed PhD in the graph below: -



4.8 Completion of PhDs response category-wise

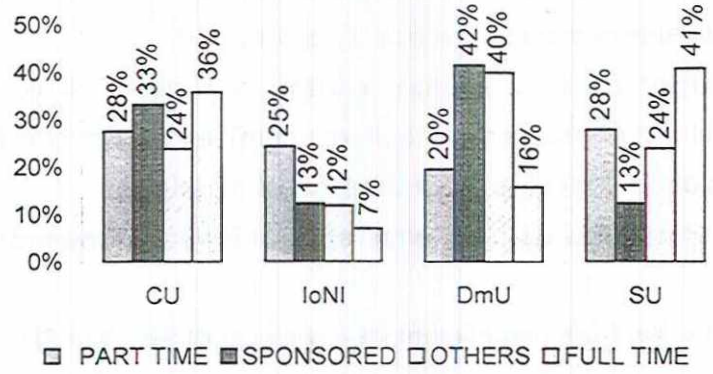
Table-4.9: Completion of PhDs response category-wise

Completion of PhD	CU	IoNI	DmU	SU	Total
Part Time	90	80	64	91	**325**
Sponsored	32	12	40	12	**96**
Others	24	12	40	24	**100**
Full Time	252	50	111	287	**700**
Total	**398**	**154**	**255**	**414**	**1221**

CU=Central University; IoNI= Institute of National Importance; DmU=Deemed university; SU= State University

- Table-4.9 gives Category-wise response. It shows the majority of the respondents i.e. 57% (with number at 700) have completed PhD on full-time, followed by 27% (with number at 325) on part-time basis, whereas around 8% of respondents got sponsorship.

- Further, under category-wise the respondents from CUs have completed PhD on part-time basis (28%), sponsorship (33%), full-time basis (36%), followed by the DmD Us, SUs and, lastly IoNI on similar patter with percentages indicated.
- The graph below depicts the comparative position for various institutes / universities about the completion of PhD by the respondents whether of full-time or part-time basis



4.9 Time Duration taken in completing the PhD program by respondents

- The Table-4.10 / graph depicts the time duration of the respondents

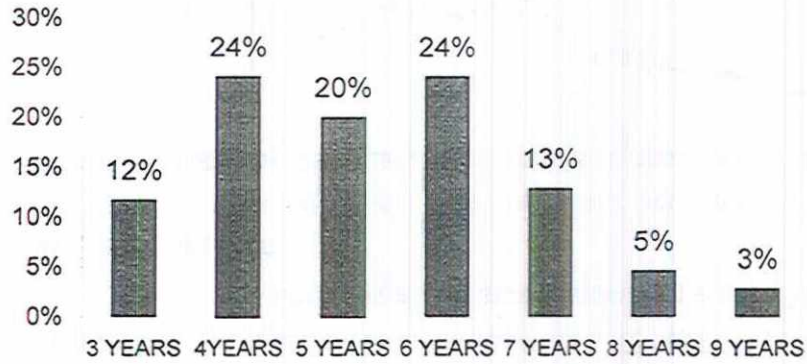


Table-4.10: Time duration in completing PhD

DURATION	TOTAL
3 Years	143
4 Years	294
5 Years	244
6 Years	293
7 Years	157
8 Years	56
9 Years	34
Total	1221

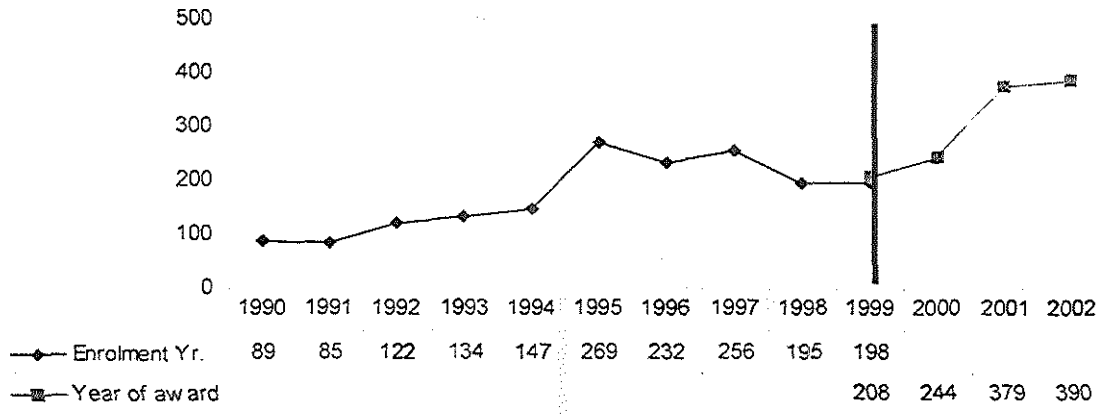
- The Table above gives time duration of the respondents who have completed PhD between 3 years (12% of the respondents) to 9 years (3% of respondents);
- Approx. identical %age of respondents i.e. 24% who have completed PhD within 4 and 6 years respectively;
- Around 20% of the respondents have taken 5 years, 13% ~ 7 years, 5%~8 years and, 3% ~ 9 years;
- From the graph, it is clear that majority of the respondents have completed PhD within 6 years after taking enrollment in their respective institutes;
- The graph also indicates that the time taken to complete a PhD of all the respondents shows a minimum at 5 years, which could be a possibility. However, the list of institutions covered indicates that it covers almost all of India's premier

institutions. Therefore, pooling of all the respondents to look at the trend, instead of analyzing the data in terms of an institutional break-up, looks more appropriate.

- Nevertheless, if we disregard this minimum, we can fit the data - roughly - to a normal distribution with a mean time of 5 years and a standard deviation of 0.7 years.
- Another dimension from the point of view of finance – particularly of PhD students from disadvantaged backgrounds – there is a need to indicate the number of years for which a scholarship is provided, which is not reflected.
- The reason is important as UGC has a cutoff of 5 years, while a significant proportion of PhD students (almost half of them) exceed this cutoff. A more detailed analysis of constraints is given in section 4.12 ahead.

4.10 Enrolment of Respondents Year-wise and their year of award: out-turn of PhD

The Graph / **Table-4.11: Year-wise enrollment vis-à-vis year of award of PhD**



- The above graph / table highlights the two aspects of the situation viz.
  - Left segment of the graph indicates the year-wise trend about the enrollment of research scholars, who had been registered in the various institutes over the years from 1990 onwards till 1999. The number of students also includes respondents, who had taken longer than normal time to complete their PhDs;
  - Right segment of the graph indicates the reference period of the study from 1999-2000 to 2001-2002. The year-wise trend indicates the number of respondents who completed their PhD from 1999 onwards till the end of the reference period by 2002. One can clearly see the relationship with time and completion pf PhD.

4.11 Completing PhD programme by the Respondents: Gender-wise analysis.

- The description gender-wise and year-wise time duration and distribution has been depicted through the bar, as given in the graph / **Table-4.12** below.
- The peak for the male respondents in 6 years (i.e. 17% of the respondents with number standing at 110) to complete the PhD;
- On the other hand, the peak for the female respondents is 4 years (i.e. 9% of the respondents with number standing at 109);
- Evidently male respondents have taken longer period of time in completing their PhDs as against their female counterparts.

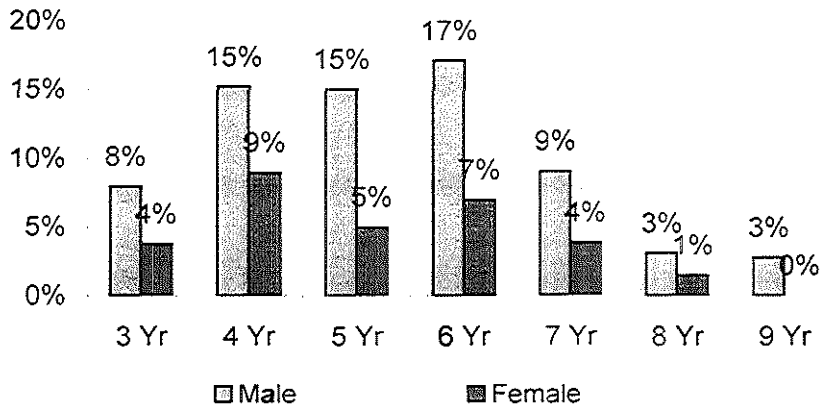


Table-4.12: Gender- wise period of completion of PhD

Year	Male	Female	Total
3 Yr	97	46	**143**
4 Yr	185	109	**294**
5 Yr	183	61	**244**
6 Yr	208	85	**293**
7 Yr	110	47	**157**
8 Yr	38	18	**56**
9 Yr	34	0	**34**
Total	**855**	**366**	**1221**

- This study was an ambitious one in the sense that had all those to whom questionnaires were sent responded, it would have covered a large fraction (~60%, 3053/5000?) of all PhDs in India. In the present study about 20% of all PhDs in India have responded. Further, all 25 of the major institutions in India have responded. Therefore, it would be desirable to indicate the percentages of male and female respondents who have completed in 3 years, or 4, or 5...as fraction of the total male (and female) respondents, which is depicted in the Table-4.12 A below: -

Table-4.12 A: Gender- wise period of completion of PhD

Gender-wise time duration	3 yrs	4 yrs	5 yrs	6 yrs	7 yrs	8 yrs	9 yrs
% of males	11.3	21.6	21.4	24.3	12.9	4.4	4.0
% Of females	12.6	29.8	16.7	23.2	12.8	4.9	0
% Of respondents	11.7	24.1	20	24	12.9	4.6	2.8

- Note that the last two rows show a bimodal behavior (with a minimum at 5 years), but that the 1st row–for males–shows only one peak (at 6 years);
- Also this effect is visible in the total histogram even though females are 30% of the total number of respondents. Also, on an average males take slightly longer than females to complete their PhDs:
  - a) About 54.3% have completed in less than or equal to 5 years, while the figure is 59.1% for females;

- b) The expected time for males is 5.4 years for males versus 5.1 years for females.

4.12 Constraints faced during PhD Programme:

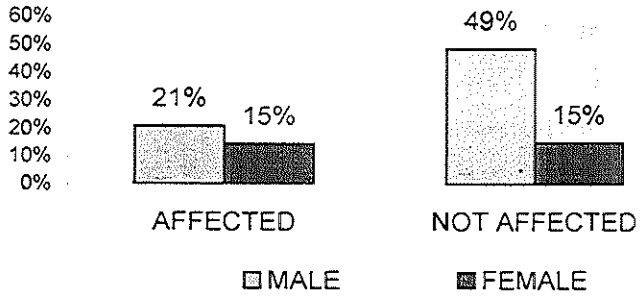


Table-4.13: Constraints faced by either sex			
Aspects that Affected Research	Male	Female	Total
Affected	257	178	435
Not affected	598	188	786
Total	855	366	1221

- This graph and table indicates that about 36% of the respondents faced problems during their programme;
- Their distribution between the male and female has been male (21%) and female (15%);
- On the whole, 48.4% of females felt constraints in their PhDs as opposed to 30% for males.
- These problems can be well understood better by the Table-4.14, that gives the type of the constraints.

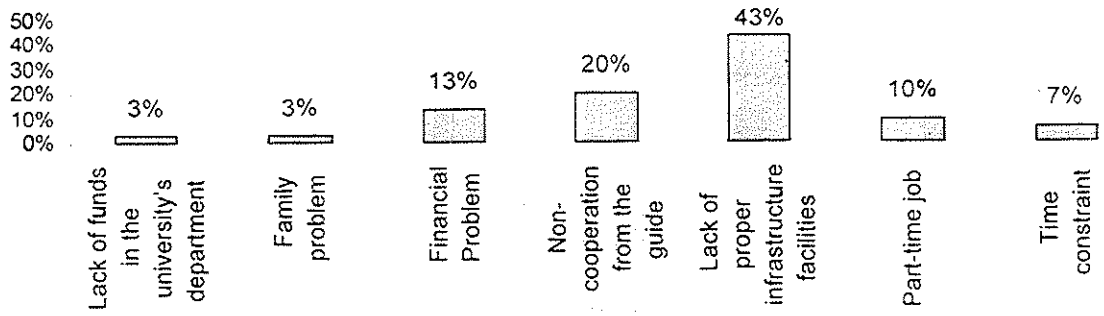
4.13 Aspects / constraints that affected research work during the PhD programme

- This Table-4.14 and graph below mostly bout responses of the 30% who had constraints during completion of PhD programme.

Table-4.14: Aspects that affected research	Respondents
Lack of proper infrastructure facilities	159
Non-cooperation from the guide	73
Financial Problem	49
Part-time job	37
Time constraint	24
Lack of funds in the university's department	12
Family problem	12
Total	**366**

- This graph mostly discusses about responses of the 30% of the problem constraints whereas 70% either did not have any problems or did not care to respond
- The major constraint has been Lack of proper infrastructure facilities (43%);

- The graph below depicts the comparative position for various constraints faced by the respondents in the completion of their PhD.



- Under the constraints, next has been the non-cooperation from the guide (20%). The relationship between the guide and the student is a peculiar one. Often it can degenerate into a very exploitative relation. Cases of incompatible personalities are legion.
- Occasionally one comes across students who have gone through half a dozen guides before completing their PhDs! Cases in which the guide has unfairly used the student's work are also common. However, what is not very common is the right kind of institutional framework in the universities to ensure that a student gets a fair chance and is not unduly exploited by a guide. There are cases in which a student has left one guide after 8 years, and then completed the work in a year with another, more amenable guide.
- Study also highlights the fact that 13% of students have faced financial problems.
- This has definite policy implications since ~50% of PhD students are under a double burden: the requirement of finishing the PhD (while overcoming various obstacles) as well as reduced or zero scholarships. In addition, there is the anxiety regarding job prospects;
- Another major problem in India is lack of teamwork. Who gets the credit is a question, which occupies people's minds even before any actual work is done. Plenty of time to worry about how to cut the cake: make it and bake it first! The requirement of making teams work well is imperative: first-rate science and technology today requires inter-disciplinary skills that are often beyond the talents of one or two individuals.
- Around 10% of those who responded to the NRIF questionnaire mentioned having taken–up part-time jobs. This factor in a sense reflects financial constraints.
- However, another route followed by many researchers is to first get a full-time job in a national or regional institution and then work on a doctorate part-time. This is easier said than done. Often such a student may experience problems with his direct boss or the head of the institution. In some cases the objection is valid: the

PhD student is neglecting his assigned duties. In others the boss is merely jealous. In any event, such PhD's generally take a long time to complete.

LINKAGE / OUTPUT

4.13 Publication wise analysis (apart from PhD Thesis) whether required at the time of admission

- The Table-4.15 reveals 62% of the PhDs have no publications whereas 38% do have.

Table-4.15: Publication Status	
Publication Status	**Respondents**
No publication	**757 (62%)**
Publication	**464 (38%)**
Total	**1221 (100%)**

- Analysis whether publications were required at the time of admission / enrolment
- Many Indian universities and PhD guides do not insist on the publication requirement.
- Further, out of the 38% that have publications roughly half are in national journals. The percentages that have presentations in conferences or seminars are not indicated. This is important because many are not peer-reviewed.
- Nobody is going to dispute that we in India should strengthen our Indian journals. However, the fact remains that most Indian journals are not even listed in the citation indexes – or, if they are, they have impact factors that are much less than 1.0. One should not over-emphasize the importance of impact factors, since many reasonably good international journals also have impact factors less than 1 (because of the fact that they cater only to a specialist audience), but the impact factor is accepted as a reasonable way of quantitatively assessing the importance of research work.

4.14 PhD Output whether published in International / National Journals: discipline-wise

- This aspect has to be read in link with Table-4.15, where only 38% have publications. Further, out of the 38% that have publications roughly half are in national journals.

Table-4.16: Publication in National / International Journals			
Discipline	**International Journals**	**National Journals**	**Total**
L/Bio	346	156	502
Physical Scs.	34	98	132
Chemical Scs.	158	129	287
Mathematical Scs.	121	166	287
Inter Disciplinary	0	13	13
Total	**659**	**562**	1221

Role of Indian Institutes associated with Science and Technology

- Interestingly, there has been a trend recently with Indian biological scientists publishing in several reputed journals, like Nature, Cell, Science, and others, which hitherto was not common. This could well be correlated with the reverse "brain drain" in recent years, and also increasing availability of funds for doing cutting edge research. The day is not far off when India might be leading the way in drug discovery too.
- The number of expatriate Indians returning is still a small flow. It should not be a difficult choice for them after having spent several years in Europe and the United States. There are several things that need to be improved, like a more professional approach, less bureaucracy, and providing better salaries. These scientists bring with them the confidence, talent, and critical thinking much needed in research. We hope there comes a day when we are welcomed back without having to face the rebuke of your fellowmen that you could not succeed in the land of opportunities and when one can say with pride "I am going back to India."
- "Reverse Brain-Drain" effect and the possibilities of India becoming a "global R&D hub." One of the key issues is the role of Indian institutes, which are more likely to play a key role in this transition of becoming a "global R&D hub." E.g. we find 700 young Indian employees working in GE's largest R&D centre at Bangalore. Many of these employees are the alumnus of prestigious institutes like **Indian Institute of Technology (IIT) and Indian Institute of Science (IISc).**
- **IITs have also been rated and ranked as third best technology universities in the world for 2005, according to the Times Higher Education Supplement**. The THES, said, "Peer review of the world's top technology universities had also ranked IIT fourth in 2004"
- The Indian union budget for the year 2005-2006 (2) has allotted 1000 million Indian rupees (approx. 22.73 million US dollars) to IISc. "IISc has enjoyed a high reputation as a centre of excellence in research and development. The government believes that investments in institutions of higher education and R&D organizations are as important as investments in physical capital and physical infrastructure. We are certain by 2020; IISc will be ranked alongside Oxford, Cambridge, Harvard, and Stanford.
- The government believes that investments in institutions of higher education and R&D organizations are as important as investments in physical capital and physical infrastructure. What we need are world-class universities and we must make a beginning with one institution. IISc is really a world-class institute. We are certain that, by 2020, IISc will be ranked alongside Oxford, Cambridge, Harvard, and Stanford.

Use the Knowledge power in the right direction

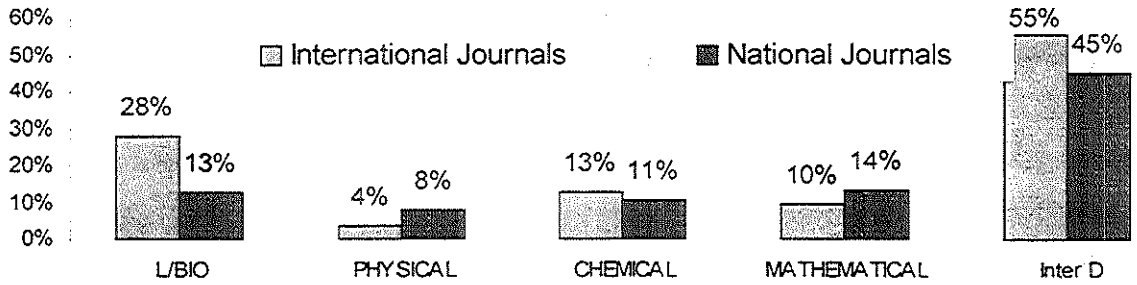
- Indians may lack much hardware and infrastructure facilities, but we have a wealth of software in the form of knowledge. The recent Information Technology boom in India is just one example. The whole world is utilizing the Indian's software knowledge, but not many Indian companies.

- The emerging opportunities in India has also given a potential of brain-gain, as many have come back after upgrading their skills. "Around 25,000 IT professionals have come back in the last two years itself. We now have world-class facilities and work environments", says Union Minister of State for Science & Technology, Govt. of India, while reacting on: "Why don't Indians win the Nobel Prize?

- Let us take the example of Japan. They are very similar to India. Like India, they don't have many natural resources. Japan has also had to face many problems with natural disasters, from earthquakes, volcanic eruptions, typhoons, very cold temperatures at certain places, to tsunamis. Lessons need to be learned from them. Bouncing back is in their culture, it seems. You can't see any trace of World War II now in Hiroshima or Nagasaki. Due to proper utilization of knowledge power, they are again in one of the wealthiest countries.

- Similarly, in India, with proper use of youth power and the help of many renowned Indians working abroad, as DG, CSIR said, "India can become the world's number one knowledge center, provided cards are properly played at the right time toward the right goal". We hope that by putting the science and technology policies it in the right direction, the goals can be achieved.

- The distribution of these publications both in International / national journals when looking at a graph below, give an interesting trend when looked through discipline-wise break-up viz.
  - Life / Biological science's has the ratio of international vs. national 28:13;
  - Mathematical / computer science's in the ratio of international vs. national 10:14;
  - Chemical science's in the ratio of international vs. national 13:11;
  - Physical science's in the ratio of international vs. national 4:8;
  - Inter disciplinary sciences in the ratio of international vs. national 55:45.



- A major problem with a lot of India's science and technology efforts in universities is that it is under-funded. The consequence is that the research effort is largely wasted.
- The bulk of the papers, reports and theses that are created are published in journals with low impact factor or journals that are not even listed in the Science Citation Index.
- A major improvement in Indian PhDs would automatically occur if it were insisted that there must be at least 2-3 peer-reviewed publications in the doctorate – and these should be accepted papers, not merely 'communicated'. This would restrict the PhDs but would enhance their quality.

4.15 Odyssey[1] of PhD Research

It is evident from the analysis presented in this chapter, that marketing PhD work and thereafter landing to get a suitable job / career is a challenging task. A detailed analysis is presented below which has emerged as part of the open-ended opinion and interaction at various levels-university staff, guides, research scholars and other concerned. These can be summed up as follows: -

[1] **Odyssey** ~~ Long adventurous journey, series of wanderings

- **During the process and, After completing the process**
  - **Odyssey of PhDs process -** A dichotomy
  - There have been cases where a PhD scholars' doctoral program is running smoothly. The major success and progress of the program depends on the institute, the environment, research facilities and the 'guide' one chooses to work with;
  - Those who faced the problems, considered PhD programme a long and never ending exile, full of hard work, troubles, tensions, slogging and most importantly the hegemonies guide (research supervisor) or miss-guide.
  - **Odyssey of PhDs process - Guide as Demotivator**
  - The student-supervisor relationship though requires a degree of patience on both sides but in certain cases the relationship had broken down. Reasons for such a break down might have been lack of sincere effort on the part of the student and / or Guide acting as Demotivator
  - In certain cases Guide has been casual in approach and turning a deaf ear to the problem of the scholar;
  - Guide treats the scholar as his personal assistant, who would share his teaching responsibilities; manage the laboratory, be a caretaker for the juniors and in worst cases like a housemaid;
  - Harsh treatment of guide as well as other staff in Dept./ Institute affecting scholar's psychologically is quite common;
  - Group-ism, rivalry, among staff, due to mutual misunderstanding, race, community and other personal reasons also affects the scholars e.g. in weekly seminars / symposiums / such systems, groups of staff harass the scholar's of the opponent group and try to even prevent scholars from submitting thesis etc. Even after thesis is submitted, viva-voce exams held, the reports have not been forwarded by the HoD for a fortnight or more to the university;
  - In few such cases HoD having played lot of politics for the scholar's working under such guide e.g. data stolen from Computer and, used for publishing papers with the support of seniors;
  - Life becoming even more difficult for the PhD student, if the guide is not very influential / effective within the institute or in the scientific community.
  - Experimental / research work
  - The problem for few has become worst when the supervisor attempted to use the laboratory / institute as a political playground for self-promotion and deliberately allowed the core issue to slip out of focus;
  - The problems associated with the experimental work has been classified as follows:

- Failures that have lead to further stretching of the 'exile'.
- Lack of basic facilities and instruments to fulfill the objective of the study has lead to delay in the progress.

- Economic Constraints
- Projects requiring difficult, multi-step procedures or steps that require critical monitoring may eventually drain the entire hard-work due to unavailability of professional expertise;
- Sometimes unavoidable delays have taken place due to sudden breakdown of the instrument, procurement delays, etc.
- The ageing scholar needing more points of constant financial support and fellowship than just research. Pursuing of research work certainly calls for sufficient flow of funds. However, lack of funded projects with the supervisor creating lot of problems for the scholar are also noticed;

- **Reasons when PhD scholars get frustrated:**
- With a boost / steep rise in the wages of IT sector, Corporate 's are not looking beyond Bachelor's or MBAs for mid-run IT, sales or marketing divisions. As a result, numbers of PhDs have started falling with alarming rate to a mere one-third of the capacity of the engineering colleges. As a result bright are being weaned away by the industry;
- PhD scholar's feel depressed and loose the zeal to work by looking at his non-doctoral peers who are well placed professionally, earning handsome salaries and settled with a family of their own.
- Emotional feeling emerging that 'Science is no longer an important subject in the field of job opportunities, as PhDs are mostly appointed in the academic sector'.
- A smaller academic job markets does not nearly employ the new PhDs. For instance after completing PhD degree in science scholar does not get jobs easily in industry or business;
- Reason being that training the PhD students receive is neither able to decide what they want nor does it prepare them for the jobs they take;
- Besides, constant nagging from the family to squeeze in the long time and settle soon adds to the growing frustration.

4.16 Conclusions

- The major aspects covered in this Chapter have been as per objectives of the study from the stage of: a) enrollment / registration for PhD; b) background about academic information; c) requirement for admissions; d) category; d) linkages & output in PhD programme; e) motivation and, f) constraints.

- The interview (75%) followed by entrance test (25%) were the prime methods for enrolment /selection of the PhD scholars. Universities, both central and state, preferred the interview method.
- On the Quality of Research Work, the emphasis in order has been on: a) Improvement in Methodology (30%); b) Addressing the Topical Issues (21%); c) Addressing Fundamental of basic research (11%); and d) Improvement in Chemical Process (10%). And, the balance under others has been 28%. Interestingly, over 50% of scholars had taken-up research topics with industrial application, whereas the others had taken up topic other than industrial under the aspects indicate above.
- There was general preference for having the guide from outside the department. 56% CUs were more open to permit guides for PhD from the out side, whereas SUs preferred Scientists from the Research Laboratories to act as guides. Industries are ranked third to take up an active role in associating with the SUs to act as guides to the PhD scholars.
- Preference of outside guide was on Life / Biological sciences (20%); Chemical sciences (14%); Mathematical / Computer sciences (13%); and, Physical sciences (8%) in that order.
- Majority (68%) of the scholars had, fortunately received fellow-ship (either JRF or SRF). Among the ones who received fellowship, 36% came from SUs, followed by CU (31%), DmD Us (20%) and, IoNI (13%) in that order. About 30% in the case of Life / Biological sciences to 18% in the case of Mathematical / Computer sciences, 15% in the case of Chemical sciences and, 5% in the case of Physical sciences had received fellowships. Remaining 32% of the respondents were either employed or were financed by their families and / or any other agencies. Their percentage varied in the descending order from CUs (36%), SUs (29%), DmD Us (23%) and, IoNI (13%).
- Many respondents / researchers agreed that lack of funded projects or partly funded projects created financial problems for most of the scholars.
- Majority (68%) of scholars were in the age group of 30 to 40 years who completed PhD during the reference period. They were involved in research on full-time-basis (68%) and part time basis (62%). Their PhD was fully sponsored by either some agencies or parents.
- On the whole, majority of the respondents i.e. 57% (700) completed PhD on full-time basis, followed by 27% (325) on part-time basis, whereas around 8% of respondents got sponsorship.
- CUs 28% completed the PhD on part-time basis, 33% had sponsorship and 36% full-time basis. Similar pattern obtained for the DmDUs, SUs and IoNIs

- The period of completion of PhD ranged from 3 years (12% of scholars) to 9 years (3%). Majority of the respondents completed their PhD within 6 years with 24% taking 4-6 years, 20% upto 5-6 years, 21 % over 7 years. Majority of male respondents took 6 years while females had taken approx. 4 years to complete their PhD.
- A substantial (36%) of the scholars had faced problems during their PhD programme - males (21%) and females (15%). On the whole, larger proportion of (48.4%) females felt constraints in their PhDs as opposed to 30% males. Non-cooperation from the guide had been a peculiar problem and exploitative types of relationship were the main reasons of delay in completion of PhD.
- Some (13%) of scholars faced financial problems. It would be interesting to correlate this with the family economic status of the PhD student – and also with the expected time for the research to be completed. Over 50% of PhD scholars had faced multiple problems e.g. the requirement of finishing the PhD in time (while overcoming various obstacles), reduced or zero scholarships, and the anxiety regarding job prospects. Around 10% had to take–up part-time jobs.
- Many Indian universities and PhD guides did not insist on the requirement of publishing papers. As a result out of the 38% that had publications roughly half were in national journals. Yet the publication of Life / Biological science's scholars had the ratio of 28:13 in international vs. national journal. The corresponding ratio for Mathematical / computer science's in the ratio of international vs. national 10:14; Chemical science's 13:11; Physical science's 4:8; Inter disciplinary science's 55:45.
- Detailed analysis of the open-ended opinion and interaction at various levels-university staff, guides, research scholars and other concerned have been brought out in the form of odyssey of PhD scholars during the process, highlighting the scholar guide relationship and problem of scholars in undertaking and completing the PhD research.

CHAPTER-V:
CAREER PROFILE OF PHDS IN SCIENCE

5.1 Prelude

5.2 Placement wise analysis

5.3 Placement: Gender-wise Analysis

5.4 Benefits PhD scholars obtained after attaining PhD degree

5.5 Gender-wise response on type of help PhD degree provided

5.6 Level of satisfaction about jobs expressed by PhD respondents

5.7 Whether perusing further research in the subject Domain / specialization of their thesis

5.8 Minimum qualification required for the present post

5.9 Desirable qualification required for the present post

5.10 Present Job work pertains / not pertain to specialization

5.11 Application of Knowledge gained in Research Work to present job

5.12 Correlation of present job with doctorate degree

5.13 Getting special incentives in present job after obtaining PhD degree

5.14 Would the benefits have been better, if having a professional degree other than PhD?

5.15 Benefits / Outcome after obtaining the Doctoral degree

5.16 Suggestions to change doctoral research program and major changes suggested by the PhD Scholars- Major suggestions

5. 17 Odyssey of PhD Research

5.18 Conclusions

CHAPTER-V:

CAREER PROFILE OF PhD's IN Science

5.1 Prelude

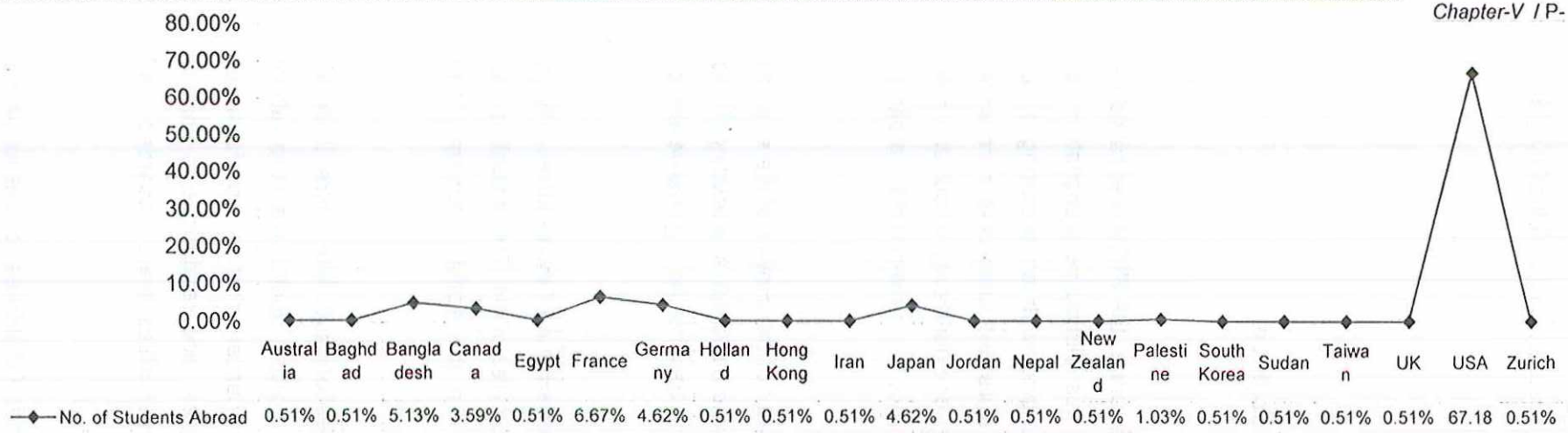
Right from time immemorial in India, as per the popular parlance, the PhDs are called as 'Brahmins' of the Academic Community. They achieve this distinctive appellation for working on original pieces of work. They approach any subject with an enquiring mind, mole wide study, apply critical judgment as also analytical skills and undertake hard work. At no stage are they ready or inclined to accept ambiguity or uncertainty about any new find. They are interested in tangible outcomes and not in unverifiable, arbitrary propositions.

The number of Ph Ds produced might be useful as an indicator of the growth of the science and technology sector. However, lot of debate is going on whether India is producing PhDs of an acceptable quality or has falling academic standards despite the highest levels of university system in the country.

Any country owes its success to original ideas and in the execution of those ideas. These are given by highly educated specialists and well-trained professionals. The scientific and technological inputs combined together play a vital role in the social, economic and physical development of a country- India as well.

With this backdrop, the NRIF devised an elaborate questionnaire with more than 37 questions for canvassing to seek the opinions of scholars holding doctorates in faculty of sciences. Broadly the emphasis was to study their career profiles, professional achievements, their trials and tribulations, their experiences, and responses to various situations at different levels while researching. The responses were recorded and analyzed.

In all 1221 scholars responded from 24 selected Universities / institutes for the reference period 1999-2000 to 2001-02.



Country	No. of Students Abroad
1. Australia	1
2. Baghdad	1
3. Bangladesh	10
4. Canada	7
5. Egypt	1
6. France	13
7. Germany	9
8. Holland	1
9. Hong Kong	1
10. Iran	1
11. Japan	9
12. Jordan	1
13. Nepal	1
14. New Zealand	1
15. Palestine	2
16. South Korea	1
17. Sudan	1
18. Taiwan	1
19. UK	1
20. USA	131
21. Zurich	1
Total	195

Graph / Table-5.1 A: PhD Respondents serving abroad

- With reference Graph / Table-5.1, approx. 196 (16%) of the respondents are serving abroad in 21 countries of different continents. The name of the countries is clearly evident in the table on the left. They are either doing Post Doctoral or have taken up job in some organization as per their merit and / or on availing the job opportunity.
- Majority of the respondents are in different institutes in USA: 131 (67.18%); followed by France: 13 (6.67%); Bangladesh: 10 (5.13%); Germany and, Japan: 9 each (4.26%); Canada: 7 (3.59%); Palestine: 2 (1.33%) and, one each in countries like: Australia; Iraq (Baghdad); Egypt; Holland; Hong Kong; Iran; Nepal; New Zealand; South Korea; Sudan; Taiwan; UK and Zurich.
- However, that reminds us about Craig Mundie of Microsoft Corp. as reported by the Hindu on 8th October 2005 (p.9) as having said that India produces less than 50 PhDs in computer science – which is about the output of one medium university in the US. This concept gradually needs to change.

5.2 Placement wise analysis:

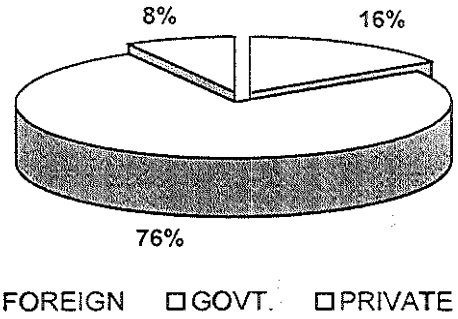


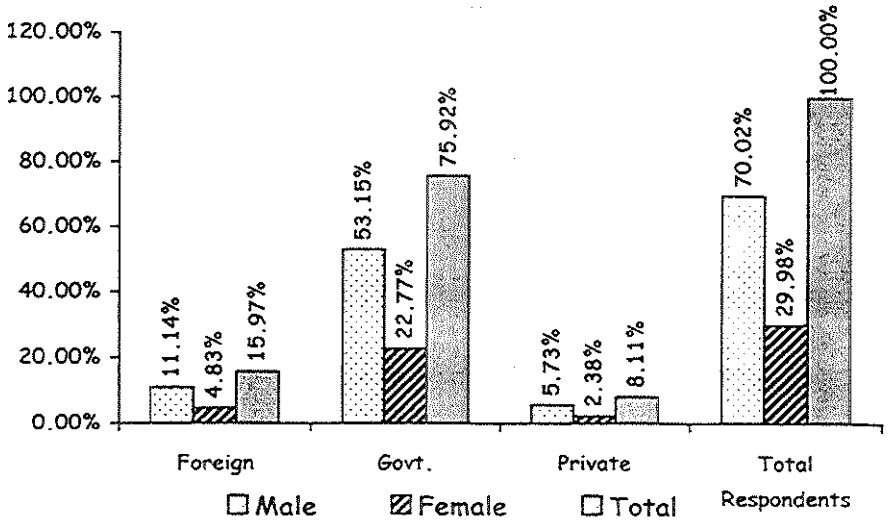
Table-5.1: Placements Analysis	
Placements	**Respondents**
o Foreign	195
o Govt.	927
o Private	99
o Total	1221

- **Placement wise analysis**
- The placement percentage is expectedly in this order viz.
  - Government (76%);
  - Foreign (16%);
  - Private (8%);
- The placement with private institutions – either independent or corporate – are few and far between. Although about 50% of PhDs scholars (Table-4.3: Research Topics with Industrial application) felt that their work was relevant to industry.
- PhD respondents serving abroad have been dealt at in Table-5.1 A
- The graph on the opposite page illustrates the position vividly.

5.3 Placement: Gender-wise Analysis

Gender-wise analysis reveals that proportionately large no. of male PhDs have gone to Govt. jobs. The same trend is reflected even for the ones who have either gone abroad or are serving in the private sector. The graph below depicts the position clearly for both genders that are either in govt., foreign or private.

Table-5.2: Gender-wise Placement			
Placements	**Male**	**Female**	**Total Respondents**
Foreign	136	59	195
Govt.	649	278	927
Private	70	29	99
Total	**855**	**366**	**1221**



Gender-wise nature of present job work

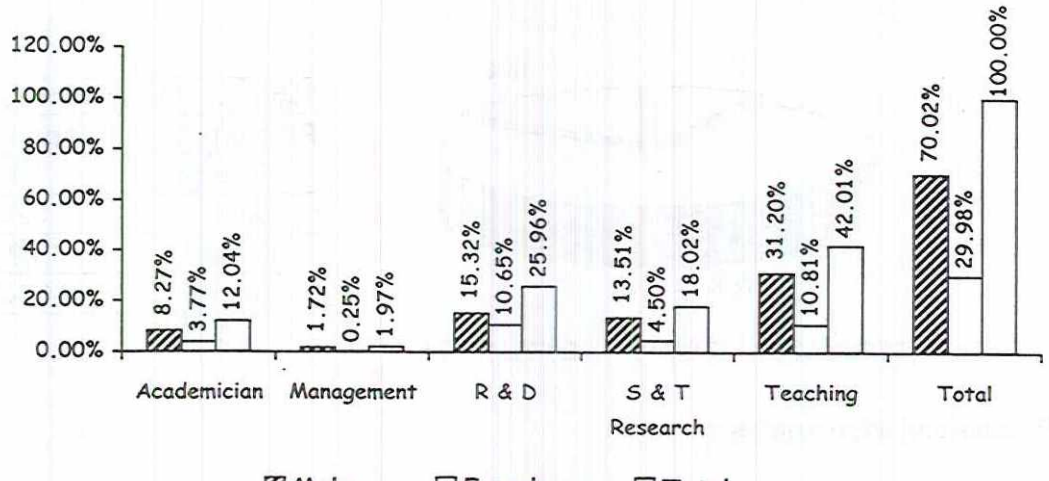


Table-5.3: Gender-wise nature of Placement

Nature of placement	Male	Female	Total	%Age
Academician	101	46	147	12%
Management	21	3	24	2%
R & D	187	130	317	26%
S & T Research	165	55	220	18%
Teaching	381	132	513	42%
Total	**855**	**366**	**1221**	**100%**

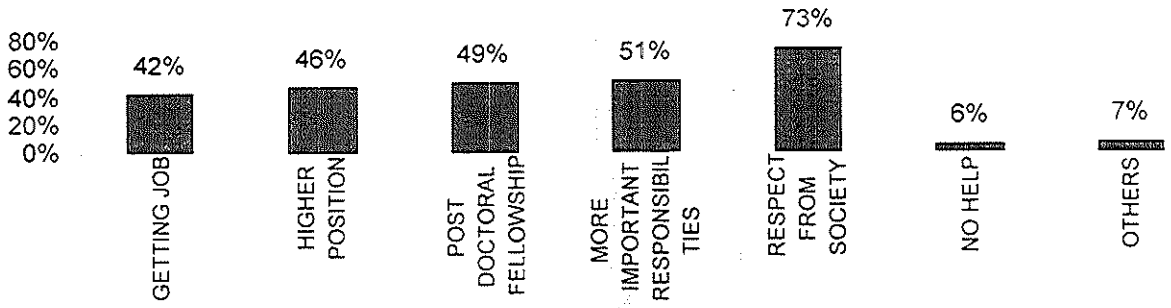
Gender-wise analysis reveals that proportionately large numbers of scholars are serving in teaching profession (viz. 42 percent), which includes male (31.20 percent of the total population) and females (10.81 percent). This is followed by R&D covering male (15.32 percent) and female (10.65 percent). The third category is S&T Research male (13.51 percent) and female (4.50%).

5.4 Benefits PhD scholars obtained after attaining PhD degree

- This bar graph below highlights the benefits the respondents perceived after being awarded the PhD degree. This perception has been ranked in the descending order of their percentage response as indicated below:
  - Respect from society: 891 (73%) respondents;
  - More important responsibility assigned after completing PhD: 622 (51%) respondents;
  - Got an opportunity to take up post-doctoral fellow-ship 598 (49%);
  - Getting higher position 562 (46%);
  - Getting job 513 (42%);

Benefits PhD scholars obtained after attaining PhD degree

- The graph giving comparative perceptions of the respondents is depicted below:



5.5 Gender-wise response on type of help PhD degree provided

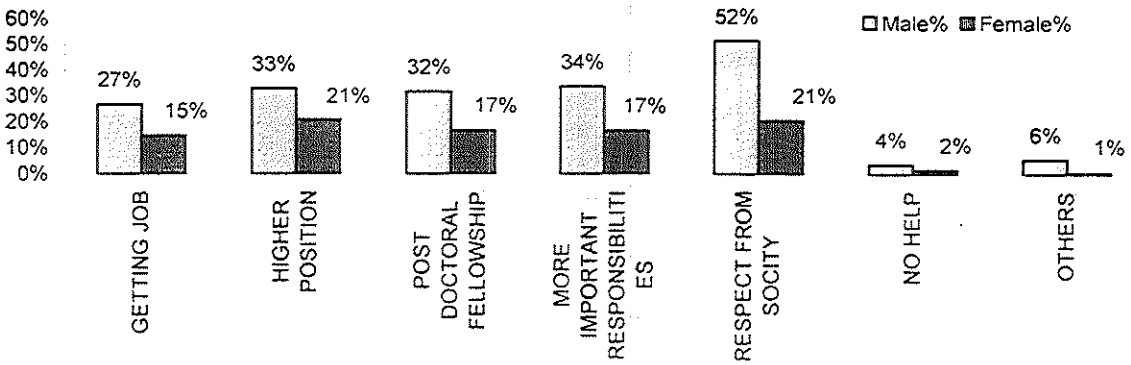
- Though perception varied from either sex but aspect like: "Respect from society" has ranked highest between the male and female. The comparative position is reflected in the Table-5.4 and, histogram given below. This also goes in line with the issues highlighted at Para 5.1 above.

Table-5.4: Gender-wise response on type of help PhD degree provided

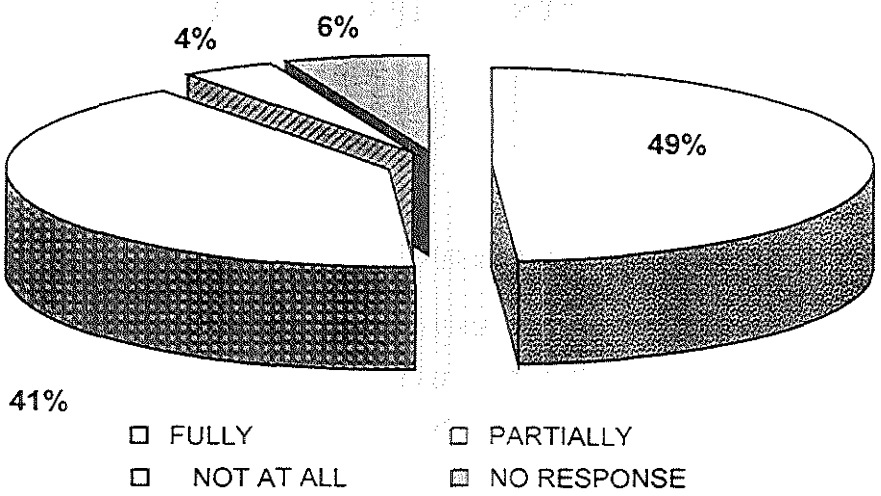
Help in job	Male	Help in job	Female
Respect from Society	635	Respect from Society	259
More Important Responsibilities	415	Higher Position	256
Higher Position	403	Post Doctoral Fellowship	208
Post Doctoral Fellowship	415	More Important Responsibilities	208
Getting Job	330	Getting Job	183
Other's	73	No help	24
No help	49	Other's	12
Total	**2295**	**Total**	**1150**

- The Table-5.4 gives the number of multiple responses, whereas the histogram gives the %age distribution among the various factors, which are self-explanatory.
- The graph below gives a comparative picture about the type of help PhD degree provided to the respondents after completing PhD

Type of help PhD degree provided to the respondents

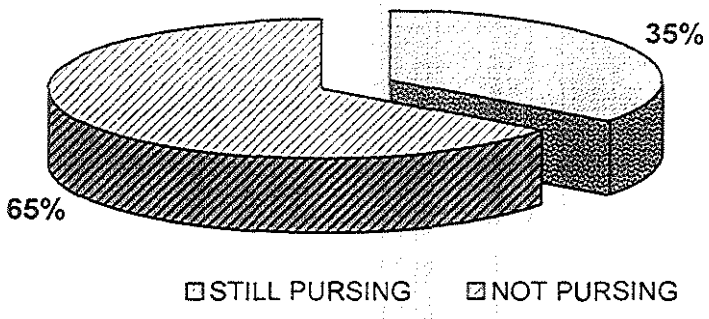


5.6 Level of satisfaction about jobs expressed by PhD respondents



- The pie-diagram is self-explanatory where, 49% (598 out of 1221) of the respondents are fully satisfied;
  - 41% respondents (501) are partially satisfied;
  - 6% respondents (73) have given no response;
  - 4% respondents (49) are not at all satisfied.

5.7 Whether perusing further research in the subject Domain / specialization of their thesis

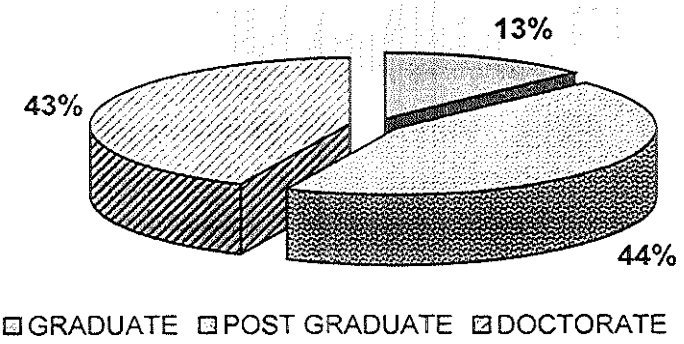


- The graph is self-explanatory, where only 35% of the respondents (427) are still pursuing the research activities depending upon the facilities available within those institutions were they are serving. Whereas 65% respondents (794) either do not have opportunity or they are not interested.

5.8 Minimum qualification required for the present post

- The pie diagram below depicts the unique position that 159 PhD respondents (i.e. 13%) are over qualified for their jobs, when their minimum qualification required was only Graduate;

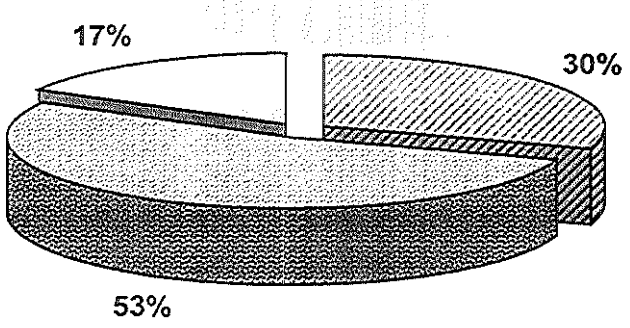
- Some 537 PhD respondents (43%) needed only Post Graduate degree whereas they had acquired doctorate degree.



- Such situations might give a wrong signal about the brightest minds with highest academic degree, not having avenues for lucrative jobs.
- This could also give a word of caution for the policy makers to explore the appropriate job opportunities with the intervention of private sector to the academic field.

5.9 Desirable qualification required for the present post

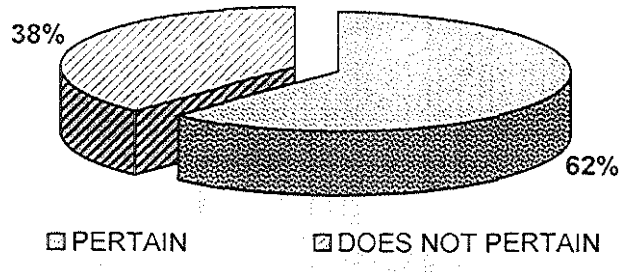
- The pie diagram given below clearly indicates the same trend as discussed at 5.8 above.



- The desirable qualification for the job was postgraduate, whereas 30% of the PhDs were over qualified for the post. Interestingly, 17% of the respondents had qualification other than the postgraduate degree.

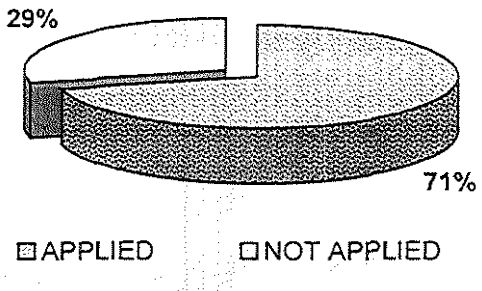
- Evidently, the job market for PhD leaves much to be desired and, has policy implications. This calls for an appropriate role for policy makers especially, whether there could be more intervention of private sector in the academic field.

5.10 Present Job work pertains / not pertain to specialization



- Only 38% of the respondents' (463) job pertains to the specialization they have had during their PhD programme;
- Therefore, either the PhD programmes in Indian universities / institutes will have to fully train the candidates for obtaining the right kind of jobs, or the, candidates would have to be fully made aware of the available job opportunities at the right places at the right time.
- Therefore, job market analysis may be introduced as a faculty responsibility in the Universities.

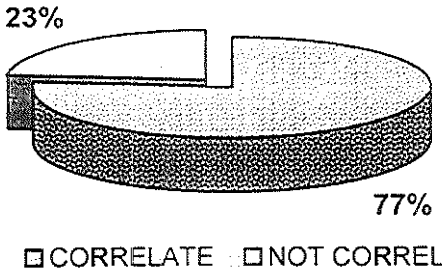
5.11 Application of Knowledge gained in Research Work to present job



- The figures indicate that only 29% of the respondents are having opportunity to apply their research capabilities to the present job.
- It implies that 71% are over qualified for their present job and /or they grabbed whatever they got after 5-6 years of struggle while completing their PhD programme.

5.12 Correlation of present job with doctorate degree.

- Around 77% of the respondents (940 out of 1221) indicated they were able to apply the knowledge acquired from the Ph.D. to their present jobs. Remaining 23% did not responded to this question. Either they are unemployed or their nature of job is different.
- The comparative response of correlation of knowledge gained during PhD programme with present job is depicted in the pie-diagram below:



Some of the major application of their PhD programme related to the following: -

- Helps in better teaching;
- Local industrial (chemical) problem solving;
- Understanding of new materials;
- Present R & D assignment;
- All the basic science applied to pharmaceuticals is being used for present job responsibilities;
- Application in national nuclear emergency programme mainly through atmospheric contamination transport and control measures;
- Application in ground water exploration / application of knowledge in understanding water quality problem to some extent;
- Carrying out further research in developing devices in plastic electronics.

5.13 Getting special incentives in present job after obtaining PhD degree

- The Table-5.5 below indicates that only 33% of the respondants have got special incentive as a PhD scholars and, 67% did not have any benefit;

Table-5.5: Special Incentives in present job		
Special incentive status	Respondents	%
Getting incentive	402	33%
Do not get incentive	819	67%
TOTAL	**1221**	100%

- Considering the fact that the Central Government gives two additional increments for a PhD, though it is not a big encouragement having spent a minimum of 3 and normally 5-6 years doing the PhD;
- Govt. certainly needs to examine the possible opportunities that can come handy for the ones who complete the PhD degree.

5.14 Would the benefits be better, if having a professional degree other than PhD?

- The response in **Table-5.6** below gives an interesting feature that 29% of the respondents feel that they would have been more benefited had they acquired some professional degree other than PhD.

Table-5.6: Benefits by professional degree other than PhD		
Benefits by professional degree other than PhD	Respondents	%
Yes	354	29%
No	867	71%
TOTAL	1221	100%

- This brings to focus the debate about Scientists vs. MBAs. As there is a growing perception that the study of science and particularly the PhD–the most coveted subjects of yesteryears - are no longer popular. In the present economic scenario, the sciences and doctorates are in reduced demand, while the B.Tech. – MBA combination is most fashionable: the starting salary of an IIM graduate is the dream of all. Even B.Techs. command handsome salaries, lot of disposable money and are well placed in life. On the other hand, PhDs spend almost as long as the MBAs, but cannot gain a high salary even after years of experience.
- The result would be that the brightest minds would lose interest and track of their research inquisitiveness. They would think that it is a mistake to have gone in for the highest academic degree, for it limits the avenues for lucrative jobs.

5.15 Benefits / Outcome after obtaining the Doctoral degree

- The perception of the respondents (with multiple answers) has been given in the desc

Table-5.7: Benefits / outcome after obtaining PhD degree	
Agreement statement on obtaining degree	Respondents
o Invitation to different academic / professional courses	818 (67%)
o Better prospects for moving abroad	818 (67%)
o Prospects of getting more lucrative job	610 (50%)
o The doctoral degree has enhanced prestige	537 (44%)
o Others	61 (5%)
TOTAL	**2844** (100%)

- The perception of the respondents on the overall impact of the doctoral research progrmme has made an improvement in their performances. The frequency response on the multiple answers as given in the **Table-5.8** below is self-explanatory:

Table-5.8: Overall Impact of doctoral research programme in performance	
Aspects which improved the performance	Respondents (No. & %age)
o Analytical thinking	952 (78%)
o Applying new skills	818 (67%)
o Being more focused	708(58%)
o Others	98(8%)
o Did not help	48(4%)
TOTAL	2624(100%)

response viz.

- A) Job position of respondents before enrolment for PhD;
- B) Job position of the respondents during their PhD programme; and,
- C) Time gap in getting job after awarding of PhD

- A) Job position of respondents before enrolment for PhD;
  - This graph indicates that the distribution of 216 male (66%) and, 108 female (34%) and their job status with numbers over a period of 9 years period who had been in job before getting enrolled for the PhD programme.

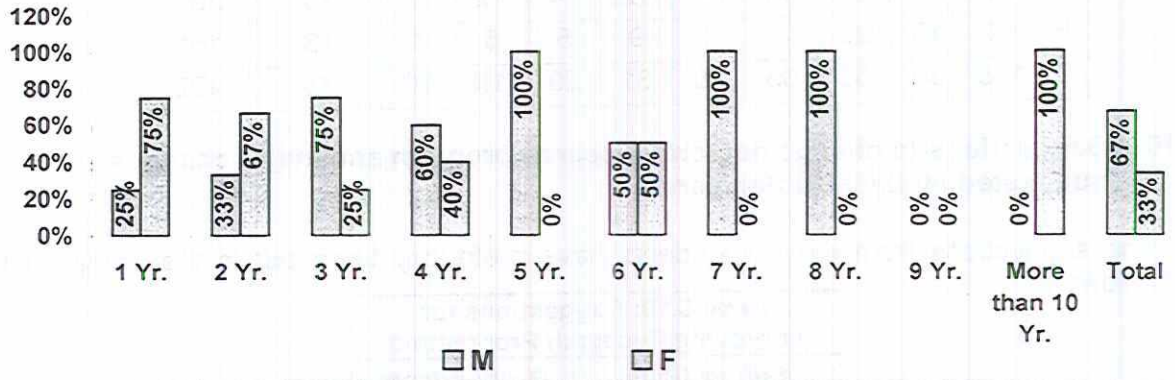


	Table-5.9: Job position of respondent before Enrolment for PhD											During PhD Program
	1 Yr.	2 Yr.	3 Yr.	4 Yr.	5 Yr.	6 Yr.	7 Yr.	8 Yr.	9 Yr.	More than 10 Yr.	Total	
M	12	12	36	36	24	12	24	12	0	4	216	378
F	36	24	12	24	0	12	0	0	0	0	108	97
T	48	36	48	60	24	24	24	12	0	4	324	475

- B) Job position of the respondents during their PhD programme;
  - This graph indicates that the distribution of 378 male (80%) and, 97 female (20%) were able to get the job during their PhD programme and, did not face any problem for getting the job;
- C) Time gap in getting job after completing PhD programme
  - This graph indicates that the distribution of 261 male (62%) and, 161 female (38%) and their job status with number of years (up to 9 years period and beyond) that got job after completing PhD programme.
  - For example, 61 males and 54 females got job within 1st year after completing their PhD and, so on....

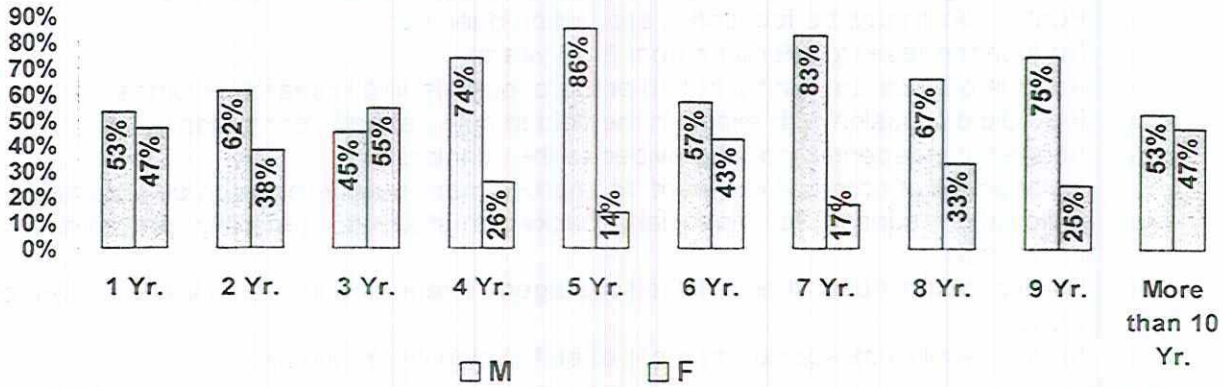


Table-5.9A: Time gap in job position after awarding PhD											
	1 Yr.	2 Yr.	3 Yr.	4 Yr.	5 Yr.	6 Yr.	7 Yr.	8 Yr.	9 Yr.	More than 10 Yr.	Total
M	61	24	24	48	24	12	24	12	12	20	261
F	54	15	29	17	4	9	5	6	4	18	161
T	115	39	53	65	28	31	29	18	16	38	422

5.16 Suggestions to change doctoral research program and major changes suggested by the PhD Scholars-

- The suggestions from the respondents have preferably been put in the Table-5.10 below: -

Table-5.10: Suggestions for improving Research Programme	
Suggestions	**Respondents**
Yes	1026 (84%)
No	195 (16%)
Total	**1221 (100%)**

- We got about 84% responses. Among them about 56% suggested improving the infrastructure in the form of better laboratory facilities, more journals (international), books, instruments etc. Next comes better course work (17%), evaluation of research work (13%), collaboration with industry / institutions (6%). These have been put in rank-order that espoused them.

  - Better laboratory facilities;
  - Course work need improvement;
  - Collaboration among the intra / inter departmental faculty should be increased;
  - Collaboration with industry be explored;
  - Collaboration with other Indian / foreign institutions be explored;
  - Regular review of research work be done within department / inter-department / intra-university;
  - Evaluation of research results and methods should be done at regular intervals;
  - Guide should be more cooperative;
  - Better Infrastructure facilities, more journals (international), books, instruments should be available in the department / institute;
  - Field-based work be encouraged;
  - Project work should be based on research activity;
  - Identifying research problems, which has potential to make it big with the industry;
  - Early assignment / identification of research problem needs to be done;
  - Publication should be focused & application oriented;
  - Reduce the research duration from 5 - 6 years;
  - Adequate funds are earmarked to procure journals and research volumes;
  - Periodic discussion with expert in the field should be made compulsory;
  - Academic independence be provided to the scholars;
  - Introduction of competitive award, to improve more quality research be introduced;
  - Fellowship /stipend for financially backward students generally provided and, enhanced;
  - Politics within departments be discouraged. There should be openness towards students;
  - Student should be sponsored more often to scientific meetings;

- Guide should concentrate more on applied research;
- Judicious / Honest / unbiased evaluation be resorted to;

Major Changes suggested by the Ph.D. Scholars

- Candidates with sound knowledge in the subject and commitment to teaching should only be appointed as teacher in college;
- Reduce teacher student ratio. Appointment of more teacher / Research scholars be made;
- Substandard Academic institutions must be wound up / closed;
- Ph.D. is not to be bound by any NET examination;
- Degree courses should be modified based on recent developments in the subject. It should be applied and, job oriented;
- There should be project-based evaluation in M Sc;
- Nature of examination system should be changed;
- Education system should be more research oriented;
- Application of Basic Research in Industries;
- Ph.D. students should be admitted through merit basis only, quota system should be abolished;
- Develop more career guidance centers;
- Every scientific research must have some technological aspects;
- Introduce tough selection procedure in university to substantially improve the over all research quality in the country;
- PhD. research must be oriented in such a way that the programme is motivated towards applied research (viz.) process development, product development etc.;
- Project funds should be properly utilized;
- Remove the current reservation policy and provide reservation based on economic status and not based on castes.
- Interestingly few suggested: "reduce research duration from 5-6 years". Does this mean that the PhDs should be completed in this time period?

5.13 Odyssey[1] of PhD Research

It is evident from the analysis presented in this chapter, that Career profile for PhD work and thereafter landing to get a suitable job is a challenging task. A detailed analysis is presented below which has emerged as part of the open-ended opinion and interaction at various levels-university staff, guides, research scholars and other concerned. These can be summed up as follows: -

After completing PhDs:

- Even with PhD qualification, one slogs in the non-standard self-finance colleges / institutes, because State Govts. have stopped recruitment of lecturers in Govt. Colleges and Govt. aided / UGC aided Colleges / Institutes;
- Even many Private Industries / Firms are not forth coming to provide recruitment to many PhD scholars, because of lack of collaborations;
- This is one of the reasons, why many PhD scholars are migrating to other commercial areas / leaving abroad for better livelihood and respectable jobs / positions
- In technology sector jobs like Computer software, Biotechnology / Pharmacy, there is not much discrimination, because of demands of higher qualification. Whereas, in heavy engineering sector, PhD's are not entertained, as it acts as disqualification, because, they may become popular & outshine others;
- If top management is appreciative, it is the middle management who is detrimental to the growth of a PhD qualified persons

[1] **Odyssey** ~~ Long adventurous journey, series of wanderings

- Middle Management (MM) sees that PhDs do not get exposure, non-PhDs create a sort of conspiracy in a way that PhD becomes totally useless till one gets frustrated and, leaves the company;
- Even if one completes PhD with Govt. scholarship, lack of area-specific-jobs becomes criminal wastage of Govt. money;
- Discrimination between Science (basic research) & Engineering (applied research) PhD is another factor sending wrong signals, as both have to spend time in universities to complete the degree;
- PhD students, after long exile, if they do not commensurate financial benefits nor comfortable & higher job positions, they feel frustrated on 2 counts;
    - Loss of golden period of personal life;
    - Substantial loss of individual earnings;
- Such wrong signals are discouraging graduates, who almost stop talking / thinking about PhD programme;
- Future youth will obtain degree and go to highly lucrative jobs or abroad to earn dollars. In the process we would neither produce highly qualified manpower in India nor abroad (unlike earlier generation of 50s to 80s), when they used to go through Ms / PhD route. In the long run, it is India's loss, unless some policy change is brought about to encourage the PhD;
- Industry-Academia Institutions' Interaction is a long gap. Any project given to academic institution takes its sweet time for completing & even gives unsatisfactory results in the name of research, which Industry can not accept;
- Middle management often in Industry is lethargic and tends to dislike people with particularly higher education, , So there must be policy change to tread a middle path and forwarding look-up management policy
- Constitutional Equality: should be in letter & spirit e.g. if there are provisions for higher education then there should be commensurate job prospects afterwards;
- This also calls for uniform & standardized pattern of examination to be followed in all universities like: "Graduate Aptitude test in Engg.-GATE" for admissions as well as jobs, so that discrimination of different types can be that Assessment is fair and transparent at all stages; e.g. few years Information Tech. like: MCAs, M.Sc & M Techs. have been more in demand / on board or drawn at par with PhDs faculty, as "Qualification is just a 'hygiene' factor as what matters is performance".
- There is a need for change in the curriculum that should have intellectual depth and wide application.

5.19 Conclusions:

- Placement of majority of PhDs in government sector indicates that hitherto only Govt. has been investing substantially in teaching, research & development. Now there is a need for industry and private sector, not only to increase their investment but also create more job opportunities for highly qualified professionals in suitable cadre, so that process of upgrading technology and production system mix is improved at a greater pace, to match the global competition. Opportunities are require for both men and women.
- The spread of those going abroad (16%) to 21 countries around the globe indicates an adventurous nature of Indian scholars and their ability to meet the challenges anywhere with a strong desire to contribute their knowledge, wherever opportunities are there. Creation of such opportunities within the country is therefore, a prime necessity. The strongest motivating factors for the scholars to do PhD have been "Enhanced respect from the society" (73%), "ability to shoulder better responsibilities" (51%), "opportunity to take up post doctoral fellowship" and "better chances for getting higher jobs" (42%). This applies to both men and women.
- Interestingly, a vast majority (65%) lost the opportunity to do further research on got disinterested in it after getting the job.

- Over half (56%) of PhDs, were over qualified for the job, i.e. qualification required for the job being post-graduate or less. It is further interesting to note that only 38% had got the job pertaining to their area of specialization. And further, that only 29% got opportunity to apply their research capabilities to their job. Opportunities available are limited and there is need for expanding the job market besides doing some campus level selection before the PhDs get the degree and go away.
- Around 49% of scholars were fully satisfied after completing PhD, whereas quite a large proportion (41%) was partially satisfied.
- Predominantly and expectedly 425 scholars are from the Teaching profession, followed by 26% PhDs from R&D sector, 18% from S&T Research, 12% from Academic and 2% from management sector.
- Only on-third of the respondents had got special incentives in their jobs after completing PhD. The Central Govt. gives 2 special increments for a PhD but this is not adequate compensation for 3 to 6 years spent on acquiring degree.
- Of the 84% who gave opinion on impact of the PhD offered some suggestions about 56% suggested improving the infrastructure in the form of better laboratory facilities, more journals (international), books, instruments etc. Better course work (17%), evaluation of research work (13%), collaboration with industry / institutions (6%) were also indicated.
- Les than 30% of the respondents feel that they would have been more benefited had they acquired professional degree other than PhD. The plus factor for doing PhD helped the scholars to develop: a) analytical thinking (78%); b) applying new skills (67%); and c) more focused (58%). Other advantages are: a) better prospects for moving abroad (67%); b) invitation to different academic professional courses (67%); c) prospects for getting more lucrative jobs (50%); and d) enhanced prestige in the society.
- Interestingly, a) around 26% of the respondents had the job before taking up enrolment for PhD with the ratio of male: female being 66:34; b) 39% got job during their PhD programme with the ratio of male: female being 80:20; and c) around 35% got job after completion of their PhD, under the ratio of male: female being 62:38.
- The Chapter also covers the issues on "Odyssey of PhDs: After completing PhDs" based on open-ended opinion and interaction at various levels. The findings would provide a lot of insight to the policy makers about the problems being faced by the PhD holders after completing their degree. Suitable policy modification on job strategy and whether any norms can be envisaged for the intervention of private / industrial sectors respectively for the funding of HRD, need active consideration.

CHAPTER-VI: SUMMARY OF FINDINGS AND, CONCLUSIONS

Chapter-VI:

Summary of Findings and, Conclusions

Preamble

6.1 The present study attempts to profile the out-turn characteristics about doctorates from selected institutions for the years 1999-2000 to 2001-2002. The support system for their research work leading to completion, disciplinary / sub-disciplinary details, influencing factors that played major role and factors that constrained their research were investigated. The study also attempted to explore the career profile and the activities (thus cover only those who are in the research & development (R&D) system of the doctorates) as covered by the period of study. The study also reflects the proportion of highly qualified manpower that has remained within the R&D system and related careers, besides, what they are contributing and how many of them are moving out to separate domains. Further the researchers who have moved abroad and nature of their activities have also been uncovered. The study provides a glimpse of the contribution, timely completion-the quality, type, motivating and, de-motivating factors that have played a role in completing their PhDs.

6.2 This Report has been organized into seven chapters, followed by Appendices. The layout of the Report, section by section, is briefly discussed here.

6.3 **Chapter-I: Introduction**: provides an overview of PhDs in Science faculty in India and a brief comparison at international scenario.

6.4 A brief year-wise comparison of out-turns during the reference period between all the universities / institutes are given at a glance in the Table below : -

Table-6.1: Out-turn under Science faculties during the reference period: 1999-2002

Reference period / Year-wise	Total No. of universities / institute as per UGC	Out-turn from all the universities / institutes	Out-turn from the 24 selected universities / institute	%Age of Out-turn from the 24 selected universities / institute vis-à-vis total population	Remarks
1999-2000	247	3885	1099	28.28	This reflects slightly a declining trend
2000-2001	256	3727	1039	27.87	
2001-2002	269	4012	0915	22.80	

Comparing the Table-6.1 with the Figure 1.2 in Chapter-I, we see the total number of doctorate degree awarded e.g. per 100 universities over the years has been more or less

constant or declining in recent years. The case of science faculty group has been notable in this regard. It showed that this decline continues and it may persist for a long time.

6.5 But why is this happening? One of the main reasons could be that science is no longer an important subject in the field of job opportunities. PhDs are mostly appointed in the academic sector. A smaller academic job market cannot absorb the new PhDs. For instance after completing Ph.D. degree in science the student does not get jobs easily in industry or business. The training received by the PhD students is neither what they want nor does it prepare them for the jobs they wish to take-up. Whereas due to globalization, a fresh graduate obtaining some management or computer or IT degree / diploma gets a lucerative job in various industries or MNCs. These days' business, industry, non-government organization and even government need well-informed and skilled employees.

6.6 Another reason for the malady is government investment in higher education has remained more or less constant approx. at 3% over the years.

6.7 The academic models vary from institution to institutions. Relatively few scholars require any pre-Ph D training program / M Phil before undertaking PhD programme in many universities there are no standardized procedures for the admission or registration of PhD scholars. Many researchers take admission in the PhD program only to obtain financial support in the form of scholarships after they pass out the national level examinations JRF / Gate. As the number of Ph D degrees awarded by diverse institutions increases it may be necessary to reflect on the quality of our Ph D programme and the doctoral thesis that are produced. An aspiring scientist learns the tools of the trade, during the period of a Ph D program, generally serving as an apprentice to a master. This type of PhD work requires a significantly greater length of time, for completing all the requirements for a Ph D. Some PhD degrees are associated with greater specialization and involve researchers from reputed institutions. Most of these PhD candidates are sponsored from their institutes and work on problems that they may be required to tackle in their workplace. These are completed in shorter time periods and are generally more applied in nature.

6.8 The study provides a glimpse of the contribution, timely completion-the quality, type, motivating and, de-motivating factors that have played a role in completing their PhDs. These researchers are among the most coveted entry-level researchers within our S&T system, thus detailed profile would help us to provide better-informed judgment to the policy makers for improving the quality and motivation at this level.

6.9 **Chapter-II: Objective and Methodology,** This Chapter, provides description of the methodology followed as per the advice of the Local Project Advisory Committee (LPAC).

The approach of the study covered two phases. Under first phase all the selected 25 Institutions were visited. These comprise of: Nine (9) central universities; ten (10) institutes of national importance; two (2) institutes deemed to be universities; and, four (4) state universities. Direct interactions was established with registrar's office, administration wings, faculty members, research scholars, experts etc. to get their perceptions about the quality of PhD research, constrains and factors that require special attention. Thesis supervisors were also contacted to get response from them in terms of factors they perceive facilitated reach and the constraining factors that inhibited them during their research supervision. The broad issues under the specially structured Questionnaire covered: viz. a) information about the university / institute; b) Background Information about the departments; c) year-wise PhDs details; d) Linkage with the industrial problems, if any; e) criteria for intake of candidates for the PhD programme; f) Provisions for guides; g) External experts for their governing / academic / research-evaluation and, other details. This entry-level questionnaire acted as reference material for defining the population that formed the basis of further analysis, under the phase-II.

6.9 Phase-II, involved contact with the PhD scholars having completed the Doctorate during the reference period of the study and, generated data on their responses through specially designed questionnaire. This questionnaire covered the aspects on: a) general background information about the scholar; b) academic information; c) requirements for the admission; d) category, linkages and output in PhD programme; e) motivation and constraints; f) career profile and other details. The responses came through postal / electronic mail and, through website from 1221 PhD scholars.

6.10 With a huge list of departments (given in detail at ***Annex-2.1***), the NRIF, for operational convenience, has classified all the science faculties into 5 broad categories, viz. a) Life / Biological Sciences; b) Physical Sciences; c) Chemical Sciences; d) Mathematics & Statistics; and, e) Inter-disciplinary sciences. (These classifications have been given in detail at ***Annex-2.2***)

6.11 The **Chapter-III: Characteristics of PhD Scholars**: This chapter analyzes the population of PhD scholars: 'total' (3053), 'net' (2043[1]) and 'respondents' (1221) to establish the characteristics of sample / respondents, who had completed doctorate in faculty of sciences during the period from 1999-2000 to 2001-2002, from the 24 selected universities and institutes. The University / Institute-wise population indicates that among 9

[1] After approx. 1000 questionnaires returned undelivered because the PhD scholars had moved to the new places without informing their base-university / institute (*alma mater*).

central universities (CU), the percentage of respondents over the net sample population with-in each university varied from 14% in Hyderabad University to 99% in Aligarh Muslim University during 1999-2000 to 2001 to 2002. Likewise, among the institutes of national importance (IoNI) the percentage varied from 20% in IIT Kharagpur to 93% in Indian Statistical Institute, Kolkatta. On the other hand among the deemed universities (Dmd U) the %age varied from 23% in TIFR, Mumbai to 95% in IISc, Bangalore. The percentage variation for the same among the state universities (SUs) varied from in Madras University to 95% in Pune University.

6.12 Top Ten Universities / Institutes on the basis of maximum number of respondents have been IISc, Bangalore, Jadhavpur University and, BHU (above 100). The other universities / institutes the response was less than 100. In declining order were Pune university (98); AMU (96); Delhi University (59); JNU (50); JMI (49); Lucknow University (49); and IIT Mumbai (36).

6.13 The overall gender distribution between the total and sample population more-or-less goes at the same level in that order with male-67% and female-33%, for total 70% male and 30% female in the sample. The total, net sample and the respondent's population, varied from institute to institute. However, with-in the institute the highest female percentage out-turns comes from JNU (at 74%) followed by AMU (at 62%), IIT, Madras (at 54%) and, Madras university (at 54%) respectively.

6.14 As per the category-wise and gender-wise distribution of PhD scholars the highest number of female out-turn has been from CUs (at 172), followed by SUs (at 97); Dmd Us (at 64) and, IoNI (at 33) out of the total respondents population of 366.

6.15 Area-wise and Social category-wise position among the respondents also revealed an interesting feature. Around 72% of the respondents come from the general category. The distribution of respondents between rural is 29% (258) and, urban 71% (623) respectively.

- OBC classification is the next highest with 21% (258). Their distribution between rural is 42% and urban 58% respectively.
- ST classification stand at 4% (45). Their distribution between rural is 27% and urban 73% respectively.
- SC classification stands at 3% (37). Their distribution between rural is 32% and urban 71% respectively.
- The above classification indicate that urban residents have a better access to the universities / institutes because of greater awareness and better educational facilities.

Provision of hostel accommodation and the cost of the lodging and boarding etc missed the attention both of the interviewers and respondents.

6.16 Annual family income of PhD scholars at the time of joining PhD program indicates that 31% of the respondents (379) had family income less than Rs.50, 000 p.a at the time of joining PhD programme. Around 26% had up to Rs.1.00 lakh p.a. and, 26% had between Rs.1 to 2 lakh p.a.The income bracket of less than and above Rs.4.00 lakhs has been inversely proportional to the number & percentage of respondents in that group. One can accordingly see that few of the PhDs are from the high-income groups: only 12% come from families with an annual income of more than 2 lakhs.

6.17 The sample selected has been quite comprehensive in terms of type and category of institutions covered, regional representation, gender-wise coverage, social category coverage as also rural & urban representations.

6.18 The number (1221) and percentage of 60% responses from the PhD scholars with whom contact could be established gives a fairly valid base for statistical interpretation of data and drawing conclusion, subject to the limitations mentioned in **Chapter-II**.

6.19 The study de-mystifies the perception that only scholars with higher family incomes go for PhD. A good number of scholars (84%) from lower income brackets (annual income below Rs.2.00 Lakhs) reflect a healthy development for a nation promoting equality of opportunity under "Directive Principles of State Policy" under the constitution.

6.20 "Services" followed by "Teaching" and "Agriculture" were the principal family occupations of the scholars (82%). The share of 25% of scholars from Agricultural background reflects the emerging awareness of the rural elite to pursue higher education. The overall trend though encouraging does show that "Business Class" is as yet more inclined to go for education that pays more in return.

6.21 The analysis also shows that it is not the prerogative of the wards of the highly qualified parents to pursue PhD studies, the opportunities of higher education and research are now being pursued by scholars of even matriculate parents. Again this augurs well for a developing country like India.

6.22 However, relatively unsatisfactory level of membership of professional bodies by scholars of various kinds of institutions indicates a need for better support in this context by the authorities concerned.

6.23 Pursuit of excellence reflected in the academic interest as the prime motivating factor, though a good indicator of march forward, would need further probing on the underlying factor.

6.24 The major aspects covered in this Chapter have been as per objectives of the study from the stage of: a) enrollment / registration for PhD; b) background about academic information; c) requirement for admissions; d) category; d) linkages & output in PhD programme; e) motivation and, f) constraints.

6.25 The interview (75%) followed by entrance test (25%) were the prime methods for enrolment /selection of the PhD scholars. Universities, both central and state, preferred the interview method.

6.26 In the Quality of Research Work, the emphasis in order has been on: a) Improvement in Methodology (30%); b) Addressing the Topical Issues (21%); c) Addressing Fundamental of basic research (11%); and d) Improvement in Chemical Process (10%). And, the balance under others had been 28%. Interestingly, over 50% of scholars had taken-up research topics with industrial application, whereas the others had taken up topic other than industries under the aspects indicate above.

6.27 There was general preference for having the guide from outside the department. 56% CUs were more open to permit guides for PhD from the out side, whereas SUs preferred Scientists from the Research Laboratories to act as guides. Industries are ranked third to take up an active role in associating with the SUs to act as guides to the PhD scholars.

6.28 Preference of outside guide was on Life / Biological sciences (20%); Chemical sciences (14%); Mathematical / Computer sciences (13%); and, Physical sciences (8%) in that order.

6.29 Majority (68%) of the scholars had, fortunately received fellow-ship (either JRF or SRF). Among the ones who received fellowship, 36% came from SUs, followed by CU (31%), DmD Us (20%) and, loNI (13%) in that order. About 30% in the case of Life / Biological sciences to 18% in the case of Mathematical / Computer sciences, 15% in the case of Chemical sciences and, 5% in the case of Physical sciences had received fellowship. Remaining 32% of the respondents were either employed or were financed by

their families and / or any other agencies. Their percentage varied in the descending order from CUs (36%), SUs (29%), DmD Us (23%) and, IoNI (13%).

6.30 Many respondents / researchers agreed that lack of funded projects or partly funded projects created financial problems for most of the scholars.

6.31 Majority (68%) of scholars was in the age group of 30 to 40 years who completed PhD during the reference period. They were involved in research on full time basis (68%) and part time basis (62%). Their PhD was fully sponsored by either some agencies or parents.

6.32 On the whole, majority of the respondents i.e. 57% (700) completed PhD on full-time basis, followed by 27% (325) on part-time basis, whereas around 8% of respondents got sponsorship.

6.33 CUs 28% completed the PhD on part-time basis, 33% had sponsorship and 36% full-time basis. Similar pattern obtained for the DmDUs, SUs and IoNIs

6.34 The period of completion of PhD ranged from 3 years (12% of scholars) to 9 years (3%). Majority of the respondents completed their PhD within 6 years with 24% taking 4-6 years, 20% upto 5-6 years, 21 % over 7 years. Majority of male respondents took 6 years while females had taken approx. 4 years to complete their PhD.

6.35 A substantial (36%) of the scholars had faced problems during their PhD programme.-males (21%) and females (15%). On the whole, larger proportion of (48.4%) females felt constraints in their PhDs as opposed to 30% males. Non-cooperation from the guide had been a peculiar one and exploitative type of relationship was the main reasons of delay.

6.36 Some scholars (13%) faced financial problems. It would be interesting to correlate this with the family economic status of the PhD student – and also with the expected time for the research to be completed. Over 50% of PhD scholars had faced multiple problems e.g. the requirement of finishing the PhD (while overcoming various obstacles), reduced or zero scholarships, and the anxiety regarding job prospects. Around 10% had to take–up part-time jobs.

6.37 Many Indian universities and PhD guides did not insist on the requirement of publishing papers. As a result out of the 38% that had publications roughly half were in national journals. Yet the publication of Life / Biological science's scholars had the ratio of

28:13 in international vs. national journal. The corresponding ratio for Mathematical / computer science's in the ratio of international vs. national 10:14; Chemical science's 13:11; Physical science's 4:8; Inter disciplinary science's 55:45.

6.38 The **Chapter-V: Career Profile of PhDs in Science. The Research Process, Facilities and Output:** Placement of majority of PhDs in government sector indicates that hitherto only Govt. has been investing substantially in teaching, research & development. Now there is a need for industry and private sector, not only to increase their investment but also create more job opportunities for highly qualified professionals in suitable cadre, so that process of upgrading technology and production system mix is improved at a greater pace, to match the global competition. Opportunities are require for both men and women.

6.39 The spread of those going abroad (16%) to 21 countries around the globe indicates an adventurous nature of Indian scholars and their ability to meet the challenges anywhere with a strong desire to contribute their knowledge, wherever opportunities are there, creation of such opportunities within the country is therefore, a prime necessity. The strongest motivating factors for the scholars to do PhD have been "Enhanced respect from the society" (73%), "ability to shoulder better responsibilities" (51%), "opportunity to take up post doctoral fellowship" and "better chances for getting higher jobs" (42%). This applies to both men and women.

6.40 Interestingly, a vast majority (65%) lost the opportunity to do further research on got disinterested in it after getting the job.

6.41 Over half (56%) of PhDs, were over qualified for the job, i.e. qualification required for the job being post-graduate or less. It is further interesting to note that only 38% had got the job pertaining to their area of specialization. And further, that only 29% got opportunity to apply their research capabilities to their job opportunities available and need for expanding their market besides doing some campus level selection before the PhDs are awarded the degree.

6.42 Around 49% of scholars were fully satisfied after completing PhD, whereas quite a large proportion (41%) was partially satisfied.

6.43 Predominantly and expectedly 425 scholars are from the Teaching profession, followed by 26% PhDs from R&D sector, 18% from S&T Research, 12% from Academic and 2% from management sector.

6.44 Only on third of the respondents had got special incentives in their jobs after completing PhD. The Central Govt. gives 2 special increments for a PhD but this is not adequate compensation for 3 to 6 years spent on acquiring degree.

6.45 Of the 84% who gave opinion on impact of the PhD offered some suggestions about 56% suggested improving the infrastructure in the form of better laboratory facilities, more journals (international), books, instruments etc. Better course work (17%), evaluation of research work (13%), collaboration with industry / institutions (6%) were also indicated.

6.46 Les than 30% of the respondents feel that they would have been more benefited had they acquired professional degree other than PhD. The plus factor for doing PhD helped the scholars to develop: a) analytical thinking (78%); b) applying new skills (67%); and c) more focused (58%). Other advantages are: a) better prospects for moving abroad (67%); b) invitation to different academic professional courses (67%); c) prospects for getting more lucrative jobs (50%); and d) enhanced prestige in the society.

6.47 Interestingly, a) around 26% of the respondents had the job before taking up enrolment for PhD with the ratio of male: female being 66:34; b) 39% got job during their PhD programme with the ratio of male: female being 80:20; and c) around 35% got job after completion of their PhD, under the ratio of male: female being 62:38.

6.48 The Chapter also covers the issues on "Odyssey[2] of PhDs: After completing PhDs" based on open-ended opinion and interaction at various levels. The findings would provide a lot of insight to the policy makers about the problems being faced by the PhD holders after completing their degree. Suitable policy modification on job strategy and whether any norms can be envisaged for the intervention of private / industrial sectors respectively for the funding of HRD, need active consideration.

6.49 **Some more Insight:**
The NRIF stretched its inquiry wider in order to elicit views from a cross-section of PhDs. This included academics, some retired and some still involved in research, research scientists in government laboratories, opinion-makers, policy-makers and others. A different set of questions was framed for this inquiry: -

- What constraints were faced during their PhDs?
- Whether PhD holders could give suggestions that could improve doctoral research?
- Which changes could they suggest in the existing educational research system for better career options?
- Do PhDs apply some part of the knowledge gained in their research work to their present jobs?
- How to construct a detailed profile of research priorities, linkages and motivation to enable better-informed judgments by policy makers?
- Can they provide support, suggestions and guidance as resource persons?

These interviewees agreed completely with the assessment of difficulties highlighted by PhD researchers both in terms of research and in looking for jobs afterwards.

Poor laboratory Network and facilities:

Few researchers serving in a government laboratory felt it is pretty obvious that lack of proper facilities and poor infrastructure hamper PhD work. In India, most laboratories have limited funds. Because of that relevant journals are not available. Unfortunately, science libraries are not properly networked. Therefore, the researcher is unable to take advantage of richer libraries. Lack of proper systems and infrastructure is largely due to bureaucratic hurdles and not because of any technical difficulty. It really de-motivates all but the most dedicated students.

Funds Crunch and Plagiarism:

- The researchers agreed that lack of funded projects or partly funded projects created financial problems for most scholars. The research attention is thus diverted from assiduous research to exploring and imploring funders. They revealed that while one is crossing such hurdles, sometimes other troubles crop up: pilferage or stealing of research work. This situation can be maddening.

Scientists vs. MBAs

There is a growing perception that the study of science and particularly the PhD–the most coveted subjects of yesteryears - are no longer popular. In the present economic scenario, the sciences and doctorates are in reduced demand, while the B.Tech. – MBA combination is most fashionable: the starting salary of an IIM graduate is the dream of all. Even B.Techs. Command handsome salaries, lot of disposable money and are well placed in life.

[2] **Odyssey** ~~ Long adventurous journey, series of wanderings

On the other hand, PhDs spend almost as long as the MD, but cannot gain a high salary even after years of experience.

Basic Research Overlooked:

- It is reported, "the methods, procedures and rationalities used by both Indian and Western scientists are same. But the similarity ends there. In Western societies, scientists who work at the frontiers of research enjoys a lot more freedom than their counterparts. Our scientists spend more time applying for grants than on research".

- "There has been a lot of talk about strengthening the top of the science pyramid by improving scientific and research facilities." Whereas in India, the bottom of the pyramid is so weak that strengthening the top will not be of much help. "Education and research facilities in India are microscopic for a country with the size of a continent and with a population of a billion people." The trouble is compounded by the fact that looking at such problems on board some of the brightest prefer to work abroad.

- There is a growing tendency of allowing students to take any subject for research, suiting their convenience. Such students are not genuinely careful about the quality of PhD degree. And, their researches are generally without relevance to society and to country's needs, such researchers sometimes get leave from their jobs for doing research for a PhD. They may rejoin their job without completing their research work. This is a sheer waste on both counts and should be discouraged. Some teachers get easily registered without getting updated in the courses that are pre-requisites for research in that field. There are cases where a researcher left half way.

Publication of Papers:

- Few researchers cites a recent case: a sample set of 1101 research papers in physics published by Indian authors in 1997, was collected from 29 high impact physics journals. Most of these involved collaboration between multi-institutions in India and abroad. Out of these 902 papers had institutional affiliations of first author in India, implying thereby their Indian origin. These were considered of some merit and deserved citation frequency. 199 had originated in foreign laboratories but had Indian participation. Major contributions came from 19 institutions and formed 37% of the total Indian output. This is inevitable in today's global scenario, in which resources are shared in institutions across the nations.

- *The study is important because IF (journal impact) is increasingly applied in India for deciding appointments to academic and research positions, assessment promotions and pruning nominations for research awards. Papers published in high impact journals tend to receive high citation count (but do not always do so) and those published in low impact journals receive low citation. These two indicators of research evaluation are also considered as highly correlated. However, the data studied reveal a different story. For 57% of papers though reported in high impact journals received low citation count. 20% received high citation count but were published in lower impact journal. Some did not receive any citation even after a long period.*

- *All this is contrary to expectations. Policy makers and PhDs should consult with each other as to which of the two, IF or citation count, should be adopted in future for research evaluation, and how much should be given to each measure.*

- *Sectors where PhDs are hot and in demand are: viz. Biotechnology; Neno-technology; Bio-Informatics; Management; Pharmacy; Statistics; and cutting-edge segments like: Equity Analysis;*

- *Sectors where PhDs are not in demand: In the field of academics, scholars need not go in for PhD, unless, they want to get into the government sector (Even though the Govt. recruitments have been drastically reduced and / or not easily available).*

Need for Applied Research:

- Interactions revealed that the present market leaders and multinational companies are set to create landmarks not because they have better brains but because they are in the right place at the right time. They are committed and diligent, strictly adhere to time schedules and have professional managements. With the forces unleashed by liberalization and technological revolution, they ride the boom.

- For example; IT: foreign companies today outsource to India their software operations. This has been possible because the government contributed–indirectly– by creating educational institutions that produced the third largest pool of technically qualified workers in the world. This policy helped to jump start software export, with the help of highly qualified research-oriented scientists with an industrial orientation. The government introduced computers in India in a big way in 1980's, and set up C-DOT which enabled the communications revolution.

Research Evaluation:

- The impression going round that PhD has limited value and hence enrolment for PhD studies is dropping has some genuine basis. But the PhD advocates believe that it is not 'drop' but 'slow upward move'. Besides the reasons discussed earlier, pointed out some discrepancies in the data, compiled and research evaluation. Some anomalies were found in the data compiled by different agencies regarding the number of doctorates in science and engineering, they did not tally with each other. (*Kindly refer Chapter-I, Table 1.1 above*).

Suggestions:

- *Indian Science Libraries, the government researcher suggested, should be properly networked to meet the requirements of high-speed modern world, where the sluggards lose the race. Students should have free online access to science journals and enough funds should be made available for libraries on a priority basis to enable unhindered access to information and knowledge.*
- The *doctorates should apply the expected results of their research to the future challenges in jobs and social environment. They should give suggestions for improvement in policy making and their implementation.*
- A *research body should be set up at the university level to interview the candidates thoroughly in all aspects of the subject they want to research on.*
- *For the policy makers, the doctorates have a prescription: A core group of doctorates should be picked up to explore possible requirements in all ministries. They should recommend areas of research in agriculture, industry, technology, space, etc. They should make suggestions for subjects, improve research and adopt modern techniques. They should have ample facilities, finance and encouragement so that they are motivated to strive for the betterment and the development of the country. Inter-connection and interaction between the relevant departments may be encouraged for the implementation of the suggestions of the core group. Bureaucratic involvement*

should be restricted to sanctioning funds only. Action must be taken up with a team spirit and with the utmost transparency and urgency.

- *It is proposed that the government should provide a sufficient number of research fellowships. Study leave with full salary should be allowed for serious senior aspirants to PhD*

- *Similarly high quality research should benefit from PhDs for they are the cream of the academic community. They are knowledgeable people. Their views should be respected. They should have freedom for research.*

- *The Indian science professional that will bring India long-lasting global success in the knowledge-based economy will have to follow global trends.*

- *Therefore, we in India should switch over to more applied research, as the technological revolution was brought about by the scientific brain."*

- *PhD scientists are confident that they can provide the policy-makers a wide variety of alternatives for decision-making. Research and researchers help to achieve 'an integrated vision', if given freedom, funds and encouragement.*
- This kind of data provided by responsible agencies creates doubts about authenticity, since the data sets do not match with each other. And it is these documents that provide the base for S&T planning and policy-making. This affects the attitude of the common people regarding pure science and engineering courses. *Proper care must be taken by these agencies to collect information on sensitive subjects.*

- *Thus, based on the findings of this study, it is recommended that "Union HRD Ministry, should make mandatory on the part of all Universities / Institutes / Colleges to built up manpower information first at the institute level and, then consequently at the state / country-level".*

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CHAPTER -VII: SUGGESTIONS & RECOMMENDATIONS

- Preamble
- Specific suggestions by cross-section of PhD degree holders
- Second Phase of this study, under reference
- Suggestions to improve thdoctoral research programme
- For PhD progrmmes

CHAPTER-VII:

SUGGESTIONS AND RECOMMENDATIONS

Preamble

The NRIF study suggestions and recommendations are based on the input of 1221 respondents and, extended input from: academics, some retired and some still involved in research, scientists in government laboratories, opinion-makers, policy-makers and others.

Specific Suggestions by cross-section of PhD degree holders:

Based on the interaction with the cross-section of PhD degree holders and keen observers we have received specific suggestions for policy framers:

- *There is a lack of area-specific jobs. Not enough attention is given to specific problems. In that case PhD work appears a criminal waste of government money.*

- *There is a growing perception that the quality of doctoral programmes has been steadily falling. That selection of researchers is governed by favouritism, patronage and reservation basis. They plead that "quality control in science studies and research should be maintained and preserved. This can be achieved by strictly adhering to merit.*

- *Corporate sector should be asked to highlight the initial contribution of researchers for their present day fortune. They should be involved in funding, sponsoring, and patronizing and promoting various research findings. That means active blending of scientific ideas with their application.*

- *Likewise, DST need to support a study to monitor on pilot basis review of several Indian Scientists research articles, scientific journals, reviews, notes, letters, editorials, and other scientific communications and, where does they stand in Science Citation Index database. Besides preparing bibliographic information on similar data as available from Social Sciences Citation Index database, and the Arts & Humanities Citation Index database. This information will help DST to tabulate the number of articles written by India in particular and, Third World researchers in general about the information published in the journals that would be covered. That is, DST can identify all articles with first authors who list in India and, the Third World country as their address.*

- *There is a strong belief in the scientific community that research work should be evaluated very scrupulously. Generally the PhD performance indicators are impact factor (IF) of a journal in which a paper is published and the citation frequency of a particular paper. Since IF is an average of citation numbers of all published papers in a given year, it only gives an idea of the merit of the journal and not of the merit of a given paper. The citation count is a better indicator of the worth of the paper, while the journal's IF is sometimes not objective and is often misleading. Likewise, there can be Examination of "Science" through Lotka's Inverse Square Law of Scientific Productivity: law (which describes the frequency of publication by authors in a given field and also people's reactions to his optimism); Similarly, need to gather information about how many patents are produced in science PhD's?*

- **Second Phase of this study, under reference:**

  The present pilot study under reference gave a passing reference about: how long it has taken for the respondents to do a PhD? However, it could not examine in brief or detail more vital issues like viz.

  - a) What has been the mean time, standard deviation for the completion of PhDs?

- b) What are the comparative data for other countries?
- c) How long does it take for the degree to be awarded after thesis submission?
- d) How the thesis evaluated and the scholar defended the research findings.
- e) Whether any papers were published from or before the PhD thesis, if so, published in which journals?
- f) What is the citation index of papers published (i.e. when an article is cited many times, it can be considered to have had a significant impact on the conduct of scientific research)?
- g) What are the impact factors of the journals?
- h) What are the impact factors of the universities studied in India?
- i) Examination of "Science" through Lotka's Inverse Square Law of Scientific Productivity: law (which describes the frequency of publication by authors in a given field and also people's reactions to his optimism);
- j) How many patents are produced in science PhD's?
- k) What has been the number of science & engineering PhD's in other countries during the corresponding period?
- l) Whether Indian PhDs would automatically improve, if it were insisted, that there must be at least 2-3 peer-reviewed publications in the doctorate–and these should be accepted papers, not merely 'communicated'. This might have restricted the number of PhDs but could enhance their quality?
- m) Data Envelopment Analysis (DEA): being a tool, a technique, used to construct relative scientific and technological indicators. It allows comparing the values of one specific indicator of each "unit of analysis" (institutions, governments, research groups etc.);
- n) Matthew's Effect which consists of the accruing of greater increments of recognition for particular scientific contributions to scientists of considerable repute and the withholding of such recognition from scientists who have not yet made their mark;
- o) Whether Research Assessment Exercise (RAE) as is run every four years in the UK by the Higher Education Funding Councils, could be replicated with modification in India? (REA is the exercise that measures research activity in British academic institutions and thus determine how the councils' research budget will be distributed among the country's universities;
- p) And, the other related issues.

However, among other things, these issues could well be considered for the Second Phase of this Study, subject to the kind approval of NSTMIS, DST, GoI.

Suggestions to improve doctoral research program:

Picking the thread from the Chapter-VI: Summary of Findings and Recommendations, we got about responses of 84% (1026) PhD respondents on how to improve PhD research programme. Among them about 56% suggested improving the infrastructure in the form of better laboratory facilities, more journals (international), books, instruments etc. Next comes better course work (17%), evaluation of research work (13%), collaboration with industry / institutions (6%). Few of the major ones are listed below: -

- Manpower Information System: With reference to limitations indicated in Chapter-I, we propose: *"Union HRD Ministry, should make mandatory on the part of all Universities / Institutes / Colleges to built up manpower information system first at the university / institute level and, then consequently at the state / country-level"*;

- Degree courses should be modified based on recent developments in the subject, especially to cover applied and, job oriented aspects.

- An entrance test should be introduced in all the doctoral programmes akin to the Graduate Aptitude Test. Ph.D. students should be admitted through merit basis only, quota system should be abolished.

- PhD. research must be oriented in such a way that the programme is motivated towards applied research (viz.) process development, product development etc.;

- Education system should be more research oriented. Application of Basic Research in Industries;

- The scholarship values need to be enhanced to Rs.5,000 per month for post-graduate studies and, Rs.7.000 per month for doctoral studies with an annual increment of Rs.500 for a maximum of four years;

- There is need to establish a "National Doctoral Programme", that could help to increase motivation the prospective doctoral candidates and encourage their high calibers;

- All vacant faculty should be filled-up with PhD degree and /or meritorious post-graduates with a binding on them to complete their PhD;

- An assured placement scheme should be introduced as in the case of Department of Atomic Energy;

- In the field of academics, the candidates should go in for PhD, until and, unless they are keen to join government sector;

- For PhD programmes:
- Indian Science Libraries / Universities / Research Institutions should be properly networked.

- Students should have online access to science journals (international), books, instruments with enough funds should be available in the department / institute should be made available for libraries on a priority basis to enable unhindered access to information and knowledge. Publication should be focused & application oriented. Adequate funds are earmarked to procure journals and research volumes;
- Course work need improvement: There should be the right kind of institutional framework covering subject-matter / applied research / course work, lab work, field work, Industrial visit in the universities and institutions so that a researcher gets a fair chance and is not unduly exploited by a guide.
- Appropriate funding with better laboratory facilities need to be introduced on merit of the PhD programme;
- Collaboration among the intra / inter departmental faculty should be increased;
- Collaboration with industry be explored;
- Collaboration with other Indian / foreign institutions be explored;
- Every university need to constitute research advisory committees soon after enrollment of scholars for PhD process is completed. These research advisory committees should review the work within department / inter-department / intra-university, of each scholar on quarterly basis to strengthen the Guide-Student' relationships so as to complete the PhD research process within stipulated time;
- Evaluation committee be introduced to review / evaluate research results, methods, student-guide relationship at regular intervals; Guide should concentrate more on applied research. Judicious / Honest / unbiased evaluation be resorted to;
- Periodic discussion with expert in the field should be made compulsory;
- Academic independence be provided to the scholars;

- Identifying research problems, which has potential to make it big with the industry;
- Early assignment / identification of research problem needs to be done;
- Reduce the research duration from 5-6 years;
- Introduction of competitive award, to improve more quality research be introduced;
- Politics within departments be discouraged. There should be openness, towards students;
- Student should be sponsored more often to scientific meetings. *Their participation to seminars, conferences and science meets should be encouraged. Thus they contribute to science research projects.*

ANNEXES / APPENDICES

ANNEXES

Annex-2.1: List of Selected Universities / Institutes and the Name of the Selected Science Faculties

Sr. No.	University / Institute	No. of Depts.	Name of the Science Faculty / Depts.
A. Central University (CU): Nine			
1.	Aligarh Muslim University,	13	Zoology; Botany; Bio-chemistry; Chemistry; Physics; Geology; Geography; Statistic; Mathematics; Bio-technology; Applied-Mathematics; Applied-chemistry; Applied-physics
2.	Allahabad University;	11	Physics; Applied Physics; Bio-Chemistry; Zoology; Chemistry; Statistics; Math's; Botany, Defence & Strategic Programme; Earth & Planetary Science
3.	Assam University, Silchar	6	Ecology and Environment Science; Life Science; Astro-Physics; Condensed Matter Physics; Chemistry; Mathematics
4.	Banaras Hindu University,	13	Physics; Bio-Chemistry; Zoology; Chemistry; Statistics; Math's; Geology; Botany; Bio-Technology; Geography; Geophysics; Home Science; Computer Science
5.	Delhi University,	12	Anthropology; Physics; Chemistry; Botany; Zoology; Geology; Plant Molecular Biology; Bio Chemistry; Microbiology; Genetics; Bio-Physics; Electronics Science
6.	Hyderabad University,	7	Mathematics; Computer Science; Physics; Chemistry; Biochemistry; Plant Sciences; Animal Sciences;
7.	Indira Gandhi National Open University (IGNOU)	1	School of Sciences [1] #
8.	Jamia Millia Islamia, Delhi	5	Physics; Bio Science; Geography; Chemistry; Math's;
9.	Jawaharlal Nehru University	4	School of Environmental Studies (SES); School of Physical Science (SPS); School of Life Science (SLS); Center for Bio-Technology (CBT)
B. Institutes of National Importance (IoNI): Ten			
1.	AIIMS, New Delhi	9	Anatomy; Bio-chemistry; Bio-physics; Biotechnology; Bio-statistic; Microbiology; Pathology; Pharmacology; Physiology
2.	IIT Khargakpur, Bihar	6	Biotechnology; Physics & Meteorology; Geology &Geophysics; Chemistry; Computer Science; Mathematics;
3.	IIT Bombay,	7	Earth-science; Math's; Physics; Bio-science; Computer Sciences; Environmental sciences; Chemistry
4.	IIT Delhi, New Delhi	7	Chemistry; Computer Science; Mathematics; Physics; Polymer Science; Atomic Science; Biochemical Science
5.	IIT Kanpur	3	Physics; Chemistry; Math's
6.	IIT Madras,	5	Chemical Engineering & Biotechnology; Chemistry; Computer Sciences; Mathematics; Physics
7.	IIT, Guwahati	3	Bio-technology; Chemistry; Physics
8.	ISI, Kolkatta	5	Physics & Applied Math's; Statistics & Mathematics; Applied Statistics; Computer Sciences; Quantitative Eco. Research Unit (Under Social Science)
9.	National Institute of Pharmaceuticals Education & Research (NIPER), Mohali, Punjab-160062	7	Medicinal Chemistry; Pharmaceutical Analysis; Natural Products; Pharmacology; Pharmaceutics; Biotechnology; Pharmaceutical Technology (Bulk Drugs Formulations)
10.	Sree Citra Tirunal		Achuta Menon Centre for Health Science Studies;

[1] # **IGNOU:** Does not award PhDs. Whereas "School of Sciences" offers and, prepares Few Certificate Courses which form part of BPP, PPC, BA, B.Com, BCA , BTS programmes etc.

	Inst. Of Medical Sciences & Technology, Thiruvanathpuram	37	Biomedical Technology Wing (with 22 Depts.); Hospital Wing (with 14 Depts.)
Sr. No.	**University / Institute**	**No. of Depts.**	**Name of the Science Faculty / Depts.**
C. Deemed University: Two			
1.	IIS, Bangalore	6	Biochemistry; Cent. High Energy Physics; Solid State & Structural Chemistry; Math's; Org-Chemistry
2.	Tata Institute of Fundamental Research, Mumbai	9	School of Mathematics; Theoretical Physics; Astronomy & Astrophysics; High Energy Physics; Nuclear & Atomic Physics; Condensed Matter Physics & Materials Science; Chemical Sciences; Biological Sciences; School of Technology & computer Sciences
D. State University: Six			
1.	Lucknow University,	8	Physics; Bio-Chemistry; Zoology; Chemistry; Statistics; Math's; Geology; Botany
2.	Madras University, (UwPoE: For Herbal Sciences)	31	Mathematics; Statistics; Computer Science; Geography; Geology; Applied Geology; Analytical Chemistry; Inorganic Chemistry; Organic Chemistry; Physical Chemistry; Energy & Environmental Science; Polymer Science; Crystallography & Biophysics; Nuclear Physics; Theoretical Physics; Botany; Zoology; Biochemistry; Biotechnology; Anatomy; Endocrinology; Genetics; Medical Biochemistry; Microbiology; Pathology; Pharmacology & Environmental; Toxicology; Physiology; Mathematics; Chemistry; Zoology;
3.	Jadhavpur University, Kolkatta (UwPoE: Mobil computing & Communication)	5	Mathematics; Physics; Chemistry; Life Science; Geological Sciences
4.	Pune University, (UwPoE: Bio-informatics & Biotechnology)	12	Chemistry; Physics; Communication Science; Geology; Microbiology; Biotechnology; Botany; Environment at Science; Geography; Mathematics; Statistics; Zoology;
Total	**25**	**231**	

 # IGNOU: Does not award PhDs. Whereas "School of Sciences" prepares Courses which form part of BPP, PPC, BA,, B.Com, BCA , BTS programmes & Few Certificate courses and,.

Annex-2.2: Classification of Natural Sciences, Mathematical Science & Computers and, Inter-disciplinary & their Sub-classification

Classification Heads	Includes
Life / Biological Sciences	Biological Sciences, General
	Bacteriology
	Bio statistics
	Biotechnology
	Cell Biology
	Anatomy
	Botany
	Ecology
	Animal Science
	Genetics, Human & Animal
	Animal Biology [Zoology]
	Biotechnology
	Biochemistry
	Biophysics
	Bio-informatics
	Microbiology
	Applied Microbiology
	Molecular Biology
	Neurosciences
	Nutritional Sciences
	Micro-Bio Technology
	Pathology, Human & Animal
	Pharmacology, Human & Animal
	Physiology, Human & Animal
	Reproductive Biology
Physical Sciences	Physics
	Applied Physics
	Applied Electronics
	Aerodynamics
	Astronomy & Astrophysics
	Atomic & Molecular Physics
	Condensed Matter Physics
	Energy Management
	Electricity & Electromagnetism
	Fluid Mechanism
	Heat & Thermodynamics
	High Energy Physics
	Nuclear Physics
	Nano-technology
	Plasma & High Temperature
	Polymer
	Solid State & Low Temperature
	Radio-Physics
Chemical Sciences	Chemical Science
	Analytical Chemistry
	Crystallography
	Crystal Growth & Characterization
	Inorganic Chemistry
	Material Chemistry
	Industrial Chemistry
	Minerals
	Organic Chemistry
	Medical / Pharmaceuticals
	Organo-metalic & Cluster Chemistry
	Physical Chemistry
Mathematics & Statistics	Mathematics-Basic
	Applied Mathematics
	Statistics
	Statistics & Probability
	Social Sciences-Mathematical methods
	Computational Mathematics
	Operational Research
	Topology
	Information Sciences
	Computer Science
Earth & Atmospheric Science	Applied Geology

Classification Heads	Includes
	Applied Geophysics
	Geo-exploration
	Geology
	Geophysics
	Geochemistry
	Geography
	Mineralogy
Inter-disciplinary	Environmental Sciences • Biodiversity, • Environmental Monitoring • Environmental Bio-Technology • Environmental Pollution Control • Environmental Protection through Organic Cultivation • Environmental Management • Environmental Impact Assessment • Geo Informatics for Environmental Management • Pollution • Energy studies • Restoration ecology • Coastal ecology • Marine Biology, Micro Biology & Bio-chemistry • Marine Science • Wetland Conservation • Soil and Water sciences • System Applications to Water Resources Development Management • Forest Products Technology Others • Science & Technological Policy • Medical Physics

Annex-2.3: Potential of Excellence (PoE) by University Grants Commission (UGC) and Accreditation by National Assessment & Accreditation Council (NAAC)

- **Potential of Excellence (PoE)**

With the approval of Ministry of HRD, during 1999, UGC launched the scheme to identify universities with the Potential of Excellence in the Higher Education (HE). The programme envisages improving the quality of HE with main objective of improving academic programmes, updating staff quality and, teaching, drawing up appropriate academic policies, setting up good laboratories inducting trained personnel in addition to augmenting the existing infrastructure.

Accordingly, High Powered Expert Committee (HPEC) formulated questionnaire to seek required information that was circulated to all concerned.

By end of1999, 78 universities had responded and, only 55 universities turned up for presentation. Finally in the meeting of HPEC on 27th October 2000, 11 universities were found suitable for further scrutiny and recommendation for consideration under the 1st phase. Later 12 additional universities had also been recommended under the programme. The recommendation had envisaged a sum of Rs.30 crores in suitable installments for a period of 5 years, which was an addition to the general developmental grants. However, out of the 25 universities selected for the study under reference only 6 (as given in the box) have been included.

- NAAC: National Assessment & Accreditation Council

The NAAC has been set up by the UGC to help all participating institutions to assess their performance vis-à-vis set parameters. NAAC in rating agency for accreditation of academic excellence across India, and is the country's first such effort. Benefits of Accreditation are helping institutions in the following ways: -

- To know its strengths, weaknesses and opportunities through an informed review process.
- To identify internal areas of planning and resource allocation. Also enhances collegiality on the campus.
- Outcome provides funding agencies objective data for performance based resource allocation.
- This initiates institutions into innovative and modern methods of pedagogy.
- Gives institutions a new sense of direction and identity.
- Provides society with reliable information on quality of education offered.
- Employers have access to information on the quality of education offered to potential recruiters.
- Promotes intra and inter-institutional interactions.

Process for Accreditation: NAAC's process of assessment is directed towards holistic, systematic, objective, database, transparent and shared experience for institutional improvement. The old grading system was based on scoring system under five grades is being replaced by 9 point scale system of grades.

Criteria for Assessment:
Any assessment and subsequent accreditation is made with reference to a set of parameters so that the standing of an institution can be compared with that of other similar institutions.

NAAC has identified the following seven criteria to serve as the basis of its assessment procedures:

- Curricular Aspects;
- Research, Consultancy and Extension;
- Student Support and Progression;
- Healthy Practices;
- Teaching-Learning and Evaluation;
- Infrastructure and Learning Resources;
- Organization and Management;
- Old and new Grading system;
- The grading of the universities based on the old system is shown below in the boxes.

The old and new grading system adopted is given for illustration below:

Table-A: *Old Grading System*	
Grade	*Institutional score (Upper limit exclusive)*
A*****	>= 75
A****	70 - 75
A***	65 – 70
A**	60 – 65
A*	55 – 60

NAAC: Grading System allotted to our selected Institutes as per the old system

- **Central University:**
  - Hyderabad.....Five Star;
  - Lucknow.....Four Star;
- **State university:**
  - Madras.....Five star;
  - Jadhavpur.....Five Star;
  - Pune.....Five Star;
- Other institutes have either applied or not cared to apply

- The New Grading System: If the overall score is more than 55%, the institution gets the "Accredited status" and any score less than that will lead to "Not Accredited" status. The accredited institutions are graded on a nine-point scale as given in the Table-B above with the scale values.

Table-B: *New Grading System*	
Grade	*Institutional score (Upper limit exclusive)*
A++	95-100
A+	90-95
A	85-90
B++	80-85
B+	75-80
B	70-75
C++	65-70
C+	60-65
C	55-60

{Ω Ω Ω Ω Ω XXX Ω Ω Ω Ω Ω}

APPENDICES

Study Sponsored by

National Science and Technology Management Information System Division (NSTMIS),
Department of Science & Technology (DST),
Technology Bhawan, New Mehrauli Road,.
New Delhi-110016,

"Pilot Study on the Magnitude, Career Profile and Professional Achievements of the PhDs in Science , . From The selected Central Universities / Institutions in India"

"Data Formats Devised for Canvassing from the Selected CUs / IoNI"

By

Natural Resources India Foundation (NRIF)

Introduction:

Through this study we are trying to assess out-turn of the doctorates (i.e. the ones who were awarded the Philosophy of Doctorates-PhDs) under science faculty in the country; their absorption in the national stream or whether they have gone abroad for further research or job opportunities.

The outturn would give details both on the quantity and type of doctorates under different fields of Sciences [illegible]. Through this study we would develop some benchmarks to characterize their institutions, whether their research activity leading to doctorate has been supported through NET / GATE or sponsored and finally what is their pattern of professional / career activity of the PhD degree holders.

The number of PhDs produced might be useful as an indicator to assess the highly qualified manpower availability in the science and technology sector. At the same time it is important to know: 'is India producing enough PhDs in emerging areas to withstand the global competition? And to what extent our academic standards in our university system' can transform, acclimatize and switchover faster to meet the global challenges, etc.

In India, the academic models vary with institutions. Relatively few require any pre-Ph D training program / M Phil, before undertaking PhD programme. In many universities there are no procedures for the admission of registered Ph D scholars. Many researchers take admission in the PhD program only to obtain financial support in the form of scholarships after they pass the national level examinations JRF / Gate. As the number of Ph D degrees awarded by diverse institutions increases it may be necessary to reflect on the benchmark of our Ph D programs and the doctoral theses that are produced.

Objectives of the Study:

- Generating detailed statistics of PhD's in terms of discipline / sub-disciple under Science [illegible], gender, entry-level qualifications / input requirements, scholarship / funding support, time taken, etc.
- Types of scientific / technological outputs / benefits derived from research work, technological challenges generated from the research and, academic achievements helped in securing jobs;
- Magnitude, career profile, professional achievement of PhDs, their present status in R&D, pattern of absorption in India and identify the number of PhD's who have and /or are moving abroad;
- The PhD thesis having closer linkages with demands of the industry;
- Whether the PhDs are addressing newer areas of research / topical issues having a direct impact through global competitions;
- To determine the factors that facilitated researchers / thesis supervisors in the PhD research programs.

Reference Period: confines to three FY periods viz.: 1999-2000; 2000-2001; 2001-2002
Besides covering FY: 2002-2003.

A Database development of PhD scholars

Q1: Information from university

1. Name of the University / Institute: _____

2. Name of the science dept.

3. Contact person in the Science Department:

Name:

Address:

Phone:

E-mail:

4. Background information about the department

Year of establishment

Number of specialized centers/ research areas in the dept.

Average number of faculty members

Courses taken up in the department

Average intake of PhD scholars each year in the department

Are there breakup in category of PhD scholars: full time; Part time; sponsored scholars ,etc

Pl. provide details in this regard

4. **Year wise PhDs: Continuing** (*from the previous year*), **Admitted** (*during the year*) **and, Completed** (*during the year*) **from the Central University/ Institution** **Figure in No. ( )**

Dept./ Discipline	1999-'2000			2000-2001			2001-02		
	Cont.	Admit	Comp	Cont.	Admit	Comp	Cont.	Admit	Comp

NRIF

5. Year-wise details of the PhD degree holders, 1999-2002

Source: University Department

Sr. No	Name	Sex M/F	Year of Passing	Branch of Specialization	Contact Address

6. Year-wise details of the PhD degree holders ,1999-2002

Source: Research scholars in the dept/other sources

Sr. No	Name	Sex	Year of Passing	Branch of Specialization	Contact Address

NRI

7. Are the students encouraged to take up industrial problems as their PhD research topic?

   Yes / No

   Please specify if possible

8. Does the PhD research in the department in general involves linkages with:

   Industry YES / No

   Govt. sponsored programs Yes / No

   Others (pl. specify)

9. Criterion for intake of candidates for the PhD program:

   Minimum qualification:

   Extra course-work required:

   Experience or industry sponsorship:

10. Does the dept. have provision for:

   (a) Involving research guide from other departments in the university?

   YES / NO

   External guide:

   (b) Within the same discipline YES / NO

   (c) Outside the discipline YES / NO

11. Does the dept. involve external experts in their governing/academic/research-evaluation commute?

	Governing Council	Academic Council	Research evaluation committees
(a) From industry			
(b) From govt. bodies			
(c) Research laboratories			
(d) Other universities			
(e) Others			

AR

12. Has the department got special grants/incentives for infrastructure/ other development Activity?

YES / NO

If Yes, Please specify

13. Other characteristics of the PhD program you would like to specify?

Study Sponsored by
National Science and Technology Management Information System Division (NSTMIS),
Department of Science & Technology (DST),
Technology Bhawan, New Mehrauli Road,
New Delhi-110016

Pilot Study on the Career Profile and Professional Achievements of the PhDs in Science From The selected Central Universities / Institutions in India"

"Format Devised for Canvassing from Scholars Holding Doctorates"

Canvassed through aegis of

Natural Resources India Foundation (NRIF)

Please return this questionnaire to the following address:
R P Mattoo, President,
Natural Resources India Foundation (NRIF),
93, GH-9, Pocket, Sunder Vihar, New Delhi-110087 (India); T/ Fax: +91-11-25253185;
E-mail: rpmattoo@eth.net; nrif@rediffmail.com;
Mobile (Delhi): 9810243385

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- Whether the PhDs are having closer linkages with demands of the industry; addressing newer areas of research / topical issues having a direct impact through global competitions;
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Reference Period: confines to three FY periods viz.: 1999-2000; 2000-2001; 2001-2002
Besides covering FY: 2002-2003;

INDIVIDUAL PROFORMA

(To be filled in by Scholars holding doctorate)

[BACKGROUND INFORMATION (GENERAL)]

1. Name : .....
(Block Letters)

2. Age : .....

3. Sex : .....

4. Address of
correspondence : .....
(Block Letters)

.....

.....

E-mail address: .....

5. Do you belong to Urban / Rural background? ☐ **Urban** ☐ **Rural**
Please tick the applicable U / R

6. To which social group you belong? ☐

(General – 1; Scheduled Caste-2, Scheduled Tribe-3; Other Backward Caste-4)
(Please. put the appropriate number)

7. Please identify yourself with Annual Income group of your family at the time of joining doctoral research program?
Annual Income(Rs.Lakhs)

Below 0.50 ☐
0.50 - 1.00 ☐
1.00- 2.00 ☐
2.00-3.00 ☐
3.00-4.00 ☐
Above 4.00 ☐

(*pl. note: this would be the approximate income of the family per month)

8. Please identify yourself with the main occupation (background) of your family at the time of joining doctoral research program?

Agricultural background ☐
Teaching profession ☐
Business background ☐

Service ☐
Others (pl. specify) _____

9 Education profile of your parents
Please tick the choice most appropriate

Mother		Father	
Matriculation	☐	Matriculation	☐
Graduate	☐	Graduate	☐
Post-graduate	☐	Post-graduate	☐
Doctorate	☐	Doctorate	☐

[BACKGROUND INFORMATION (ACADEMIC)]

10. Topic/Title of your doctoral thesis:

(a) Discipline of your PhD thesis : _____

(b) Year of enrollment in PhD program : _____

(c) Year of PhD award : _____

(d) Did your PhD research involve :
Pl. tick the appropriate)

Course Work ☐
Lab Work ☐
Field Work ☐
Industrial Interface ☐
Others (pl. specify) _____

11. Academic Qualification Details:
(Starting from Graduation and Above)

Sl. No.	Degree	University/Institution	Year of Award	* Class / Grade	Subjects	Merit / Award

*If applicable

12. Other Professional Qualifications (pl. specify- Technical, Management etc.)

13. Membership of Professional bodies:

REQUIREMENTS FOR Admission/Registration to THE PHD PROGRAM

(Pl. note department implies department from where you have completed your PhD)

14. Please specify the applicable selection criteria for PhD enrollment in the dept:

(a) Minimum Qualification required : _____

_____

Selection of topic:

- **Course Work** ☐
- **Lab Work** ☐
- **Field Work** ☐
- **Industrial Visit** ☐

(b) Entrance Test ☐ **Yes** ☐ **No**

(c) Interview : ☐ **Yes** ☐ **No**

Work experience or industry sponsorship : _____

_____

(e) Publications : _____

_____

(f) Others (please specify) : _____

_____

15. Did you receive fellowship during your PhD program?

☐ **Yes** ☐ **No**

If Yes, then please qualify the type of Fellowship received

Fellowship		Institutions/Agency
NET	☐	----------
GATE	☐	----------
JRF	☐	----------
SRF	☐	----------

Others (Pl specify) _____

16. Please indicate your scholar category during the PhD program :
(Pl. tick the suitable; one or more then one as applicable)

- Full time ☐
- Part time ☐
- Sponsored ☐
- Other ☐

CATEGORY, LINKAGES & OUTPUT in the PhD PROGRAM

17. In which category you associate most closely your PhD research?
(Pl. tick the suitable; one or more then one as applicable)

- Addressed a fundamental problem ☐
- Made an improvement in methodology ☐
- Made an improvement in process (chemical process, etc) ☐
- Any other (pl. specify) _____

_____

18. Does your dept. had provision for taking research guide from:

- Other departments ☐
- Industry ☐
- Research Laboratory ☐

19. Was your PhD research oriented or could be identified with possible industrial application?

If Yes, then can you please specify: ☐ Yes ☐ No

_____

20. Apart from PhD thesis (final output), what other outputs you had during your PhD Work? (pl quantify)

(a) Publications in journals
International _____

National _____

(b) Presented papers in conferences
International _____

National _____

(c) Patents _____

(d) Industrial process/know-how Developed _____

(e) Others (pl. specify) _____

MOTIVATION & CONSTRAINTS

21. What were the factors that motivated /reasons for you to do PhD
(Pl. tick mark the appropriate ones)

- Sponsored by your organization ☐
- To meet minimum requirements of your organization you where employed ☐
- To obtain a particular kind of job/position ☐
- Purely academic interest/ a desire to gain more knowledge in your field of specialization ☐
- Peer pressure ☐
- Family ☐
- No other better option ☐
- Others (pl. specify) _____

22. Did you feel that you where particularly constrained some aspects that affected your doctoral research? (pl. specify)

☐ **Yes** ☐ **No**

_____

_____

23. Can you give some suggestions that you feel could be factor(s) in improving doctoral research program in your department

_____

_____

24. What changes you suggest in the existing education/research system for a better career option

CAREER PROFILE

25. Did your PhD degree help you:
(Pl. tick mark the appropriate ones)

(a) in getting a job	☐ Yes	☐ No
(b) in getting higher position	☐ Yes	☐ No
(c) in getting a post-doctoral fellowship	☐ Yes	☐ No
(d) in getting more important responsibilities	☐ Yes	☐ No
(e) in getting respect from society	☐ Yes	☐ No
(f) was of no help	☐ Yes	☐ No
(g) others (pl specify)		

26. Did your PhD degree fulfill your expectations?

Fully	☐ Yes	☐ No
Partially	☐ Yes	☐ No
Not at all	☐ Yes	☐ No

(pl elaborate your choice further)

27. Are you still pursuing further research in the subject domain/specialization of your thesis research?

☐ Yes ☐ No

If yes, then can you please specify what types of outputs you have generated from this work?

28. Details of employment

Sl. No.	Designation	Name of Organization	Period	Nature of Work Academic/Teaching/ Manufacturing/ Service/ Managerial

Please qualify administrative further (General; Scientific)

29. What was the minimum qualification required for your present post
(pl. tick the applicable)

Graduate ☐
Post-graduate ☐
Doctorate in science ☐
Any other (pl. specify) _____

30. What was the desirable qualification required for your present post
(pl. tick the applicable)
Post-graduate ☐
Doctorate in science ☐
Any other (pl. specify) _____

31. Does your present work pertain to your specialization?

☐ Yes ☐ No

32. Did you get special incentive in your job after obtaining doctorate degree?

☐ Yes ☐ No

(If Yes, pl. qualify further what was the nature of incentive)

_____

33. Are you able to apply some part of the knowledge gained in your research work to your job?

☐ Yes ☐ No

(If Yes, pl qualify further)

34 Overall in what aspect(s) you feel doctorate research has improved your performance in your job? (pl. tick the applicable choices)

In analytical thinking ☐
In being more focused ☐
In applying new skills ☐
Did not help ☐
Others (pl specify)

35. Pl. indicate your Agreement with the Statements below on obtaining the Doctorate degree? Rating (1-5)

The Doctoral degree has enhanced ☐
Invitation to different academic - professional committees/meetings etc ☐
Better prospect of moving abroad ☐
Prospect of getting a more lucrative job ☐
Others (Pl. Specify)

36. Do you believe instead of your going in for doctoral research you could have been more benefited by undertaking a professional degree?

☐ Yes ☐ No

If Yes, pl. qualify further in terms of degree you feel could have helped you more)

37. Could you correlate your present job with your doctorate degree?

☐ Yes ☐ No

Date:..... Signature.....

Place:..... Canvassed by Name.....