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Anitha Kurup
Jagadish Arora

Trends in Higher Education

Creation and analysis of a database of PHDs

National Institute of Advanced Studies
Bangalore, India

TRENDS IN HIGHER EDUCATION

CREATION AND ANALYSIS OF A DATABASE OF PHDS IN INDIA

NIAS - INFLIBNET - TCS Project

Anitha Kurup
Associate Professor and Co-Anchor, Education Programme
National Institute of Advanced Studies
IISc Campus, Bangalore - 560 012, India
Email: bkanitha@gmail.com

and

Jagdish Arora
Director
Information and Library Network Centre (INFLIBNET)
Ahmedabad, India

NIAS Research Team
Ms. Maithreyi R.
Ms. Hamsa Kalyani
Mr. Kantharaju B.

INFLIBNET Team
Mr. Rajesh Chandavarkar
Ms. Nilam Chavda

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EXECUTIVE SUMMARY

The world is increasingly moving towards a knowledge economy, where industrial trade relations are being replaced by an intricate system of information exchange (c.f., Gilpin, 1987). This revolution has shifted the focus to individual nation's abilities and resources to produce and generate new knowledge that can place it on top of the power hierarchy. Creation of new knowledge depends largely on a robust education sector, particularly higher education and research output of the country. Realizing the potential of higher education, several countries have made huge investments in this sector.

Investment in higher education, particularly academic research, has come to be recognized as a potential source that could aid a nation's development through production of knowledge. Traditionally, countries such as the USA, Japan and other European nations such as the UK, Germany and Finland have been forerunners in academic research and R&D. Therefore, in terms of wealth intensity, GDP and Human Development Index, these countries such as Finland, UK, USA, Japan and other EU nations have also been at the top. However, these trends are giving way to new front-runners, such as Brazil, Russia, India and China (BRIC nations) that are posing a tough competition to the old world leaders.

There is already a leaning towards acceptance of and demand for utilization of overseas regions as well as human resources for intelligent production activities by countries such as the US. Recognizing the importance of having qualified research personnel, first world countries such as the US and the UK are drawing heavily on the qualified intellectual human resource base (namely doctoral researchers) of India and China for knowledge-intensive jobs in R&D and medical fields, which are the driving forces behind the nations' innovation and consequent wealth.

To optimize these available opportunities, India needs to undertake a serious study of its academic research and R&D activities in terms of available resources, infrastructure, finance and manpower. Currently, India invests only about 3 to 4% of its total R & D in academic research. Despite the annual growth in number of PhDs

awarded (an increase of 30.6 percent from 1990 to 1999 as reported by Khandaria, 2004), India is still far behind countries such as US, China and Germany in terms of the number of researchers added to the country's workforce. Only 0.65 of the total number of students in higher education are enrolled at the PhD. level. The density of research personnel in India is only 1.49 when compared to 139.5 in USA, 122.4 in China, 71.0 in Japan, 28.0 in Germany and 20.4 in France.

The lack of adequate researchers to meet the growth in teaching and R&D sectors has brought about a large imbalance in the workforce, a concern that has been raised by Prime Minister Manmohan Singh (2006) himself. Such an imbalance is the result of the absence of systematic studies that have analyzed the higher education scenario in the country with respect to disciplinary trends, institutional and regional performances, number of graduates, post-graduates and doctorates to optimize the fit between demand and supply, etc. Data on such important educational indicators is crucially lacking, and where available, is of poor quality and out-dated.

In the light of the above-mentioned scenario, a large-scale study of the trends in PhD production (academic research capacity) of the country was undertaken by the National Institute of Advanced Studies (NIAS), Bangalore, in collaboration with Information and Library Network Centre (INFLIBNET) and Tata Consultancy Services (TCS) for the 10-year period from 1998-2007. The extensive analysis was facilitated by the availability of individual records of PhDs awarded with INFLIBNET, for 238 universities across the country with a wide range of bibliographic data such as author's name, year of award, title, subject, discipline, thesis advisor, sex of candidate, university and department that awarded the degree and location of the university. The availability of individual records has also ensured the reliability and validity of the data analyzed.

The objectives of the study were:

- To assess characteristics of doctorate degrees obtained by individuals in various disciplines across 10 years (1998-2007)
- To undertake region-wise, discipline-wise and gender-wise analysis of the doctoral degrees awarded
- To study the distribution of doctoral degrees across different disciplines in different universities over specific periods of time
- To explain the rise or drop in the number of doctorates awarded in select universities during specific periods to explain the rise or drop in the number of doctorates awarded in specific disciplines during particular periods

Methodology

The main source of data for the project was made available through INFLIBNET set up by UGC for sharing of library and information resources and services among universities and research institutions in the country. The creation of a database of PhD. holders in the country through INFLIBNET was conceptualized as an integral part of the study because of the lack of information as well as discrepancies in reported numbers by other sources on PhDs awarded in the country. Despite the large database created by INFLIBNET, data for some important areas of study such as engineering, medicine and agriculture were less represented on the INFLIBNET database. Hence, efforts were made to strengthen the data for these domains by contacting All India Council for Technical Education (AICTE), Medical Council of India (MCI) and Indian Council for Agricultural Research (ICAR). In addition, individual premier institutions such as the IITs and IISc, NITs, and other technical, agricultural and non-technical universities were contacted and additional data was obtained to fill the gaps.

The study covers a sample of the total PhDs awarded in the country for the 10 year period from 1998-2007. The total number of PhD records analyzed is 45,561. A comparison of our sample (up to 2005) reveals that our data covers 39.9 percent of the total number of PhDs reported by UGC up to 2005[1] . The number of PhD degree granting institutions covered in our sample is **216**, which is **42.3** percent of the total number of universities and research institutions in the country (i.e. of 511 institutions).

[1]Data up to 2005 has only been considered as there is no comparative numbers for the later years reported by UGC

Analysis Plan

The total data obtained has been analyzed as follows:

1. The total PhD production in the country has been analyzed
2. Annual trends in growth and decline in numbers have been analyzed
3. A comparison of PhDs awarded to men and women has been made
4. Discipline-wise comparison of the total number of PhDs awarded has been made
5. A year-wise growth/fall in PhDs under individual disciplines has been studied
6. A gender-wise comparison of total PhDs awarded for each discipline has been made
7. An analysis of the sub-disciplines of major disciplines has been made
8. A zone and state wise comparison of total PhDs as well as under individual disciplines has been made
9. A comparison of trends within Science (i.e. Agriculture, Medicine, Engineering and Natural Science) has been made
10. A comparison of trends within Arts (i.e. Social Science and Humanities) has been made
11. Finally, a comparison between Arts and Science has been made

The Statistical Package for Social Sciences (SPSS) and MS Excel software programmes were utilized to order, group, calculate frequencies and percentages and cross-tabulations, and to develop graphs and tables

Analysis

1. Trends in Total PhDs Awarded in the Country

The total number of PhDs recorded for the 10 years was **45,561**. While the number of PhDs awarded has doubled from 1998 to 2007 data on enrollments still show that the number of students who enter at the doctoral education level is still low (only 0.25 of the total number who enrolled at the graduate level enroll at the PhD level). Further the completion rate of PhD in India is only about 50 percent.

With respect to gender, of the total number of PhDs awarded, **66.4** per cent of the PhDs (i.e. **30,264**) has been obtained by men, and only **33.6** per cent of the PhDs (15,297) has been obtained by women. The percentage of women's enrollments in higher education drops from 40 percent at the graduate level and 42 percent at the post-graduate level to 38 percent at the Research level.

The overall trend in PhDs shows a growth from the initial to the terminal period. This, however, has been interspersed with a large fall in numbers in 2001, a smaller dip in 2005 and another small dip in numbers in 2007. While the reasons for the large fall in the number of PhDs during these periods could be traceable to several reasons, it may also be the result of the problems of the database. In 2001, the introduction of computerization of theses may be partly responsible for the loss of data. However, it may also be due to the IT revolution that fully emerged between 1998 and 2000 that attracted several youngsters with better job-prospects. Consequently the lower enrollments at the PhD level during these years may be reflected in the lower completion rates approximately 3-4 years later in 2001.

The highest number of PhDs between 1998 and 2007 has been awarded in the **Natural Sciences** (**11,449** PhDs which is **25.1** percent of the total number of PhDs) followed by **Humanities** (**10,970**, which is **24.1** percent of the

total number of PhDs). Other disciplines such as **Agriculture** (**12.9** percent of the total PhDs), **Engineering** (**8.6** percent of total PhDs) and **Medicine** (**7.2** percent of total PhDs), which are important sectors of the economy show a lower performance in comparison. This maybe due to the professional nature of Engineering and Medicine and high economic prospects of careers in these fields compared to research in these disciplines.

The Natural Sciences recorded a higher number of PhDs during the initial period (from 1998 – 2003), after which the position has been taken over by the Humanities. The growth in Agriculture is seen from the year 2000, when it overtook other disciplines such as Engineering & Technology and Medicine. However the growth in Agriculture has tapered off towards the end of the period, with the numbers falling below Engineering & Technology in 2007. Disciplines that have consistently recorded lower number of PhDs are Engineering and Technology, Medicine, Commerce and General Science.

2. Disciplinary Trends in PhDs Awarded in the Country

A. Agriculture:

The total number of PhDs. recorded by INFLIBNET in Agriculture for the 10 years is **5871**. There has been a rapid growth in the number of PhDs from 152 in 1998 to 768 in 2000. After a small drop in numbers in 2001, there has been an increase in numbers in 2002 (809 PhDs) after which there was a slow down in number of PhDs up to 2006. The year 2007 witnessed a sharp fall in numbers with the graph coming close to the original period (352 PhDs in 2007). With respect to gender ratios, **24.1%** of the total PhDs in Agriculture from 1998-2007 has been awarded to **women** while **75.9%** of the PhDs has been awarded to **men**. **Plant related sciences** are the most popular fields of study in Agriculture (having **2900** PhDs, which amounts to **49.4** percent of the total). **Animal related sciences** such as Veterinary Science, Dairy Science, Fisheries and Aqua-Culture, etc have received the second largest number of PhDs (**1236**, accounting for **21.1** percent of the total). Fields that have received the least numbers include Environmental Studies, Agro-Physics and Agro-Chemistry.

B. Natural Science:

The total number of PhDs awarded in the Natural Sciences across 10 years is **11,449**, which is higher than in any other discipline. The trend in PhDs awarded across the 10 years shows an increase in PhDs awarded in the Natural Sciences from 1998 to 2000, followed by a sharp dip in the number of PhDs in 2001, and a subsequent increase from 2001 to 2003. From 2003, the number of PhDs has again dropped till 2005, followed by an increase in number of PhDs awarded between 2005 –2007. In terms of gender ratio, **32.8 %** of the total number of PhDs has been awarded to women, while **67.2 %** of PhDs has been awarded to men across the 10 years, in Natural Sciences.

Chemistry has the largest number of PhDs in 10 years (**3556**, which is **31.1** percent of the total). The second largest number of PhDs has been awarded in **Botany** (**1645**, which is **14.4** percent of the total), followed by **Physics** (**1622**, which is **14.2** percent of the total). The disciplines that have received the least numbers include Atomic Energy, Astronomy and Environmental Sciences.

C. Engineering & Technology:

The total number of PhDs awarded from 1998 to 2007 in Engineering is **3921**. The annual trend in the number of PhDs indicates a growth in numbers towards the end of the last decade, and particularly a greater rise in numbers from 2004 – 2007. With respect to the annual turn- out of PhDs, it can be observed that the growth in numbers from the initial period to the terminal period of our study has been large (an increase of 16.8 percent per annum[2]). Only two periods of decline in numbers are noticed – one during 2001 when the number of PhDs awarded is lower than for the initial period (190 in 2001 compared to 255 in 1998) and a small drop in numbers in 2004. As mentioned earlier, the considerable decline in numbers in 2001 maybe partly a result of the problems of the database. The total number of PhDs awarded to men in Engineering across the 10 years is **3127** (which is **79.8 pe**r cent of the total) while **794** PhDs in Engineering have been awarded to women (which is **20.2** per cent of the total).

With respect to sub-disciplines[3] , **Mechanical Engineering** and its application have received the highest number of PhDs (**586**, amounting to **14.9** percent of the total). **Civil Engineering** accounts for **12.8** percent of the total (with **501** PhDs) while **Electronics** and Electrical Engineering accounts for **12.4** percent (with **487** PhDs). Disciplines such as Architecture, Aerospace Engineering, Industrial Engineering, Energy and Metallurgy have the least number of PhDs.

D. Medicine:

The total number of PhDs awarded in Medicine for the 10 years is **3298**. As in the case of Engineering, the number of PhDs in Medicine is far lower compared to other science and arts disciplines. This could be due to the professional nature of both courses, and the minimum industry requirements of only a post-graduation for employment. Trends related to PhDs in Medicine show a decline in numbers from the initial to the terminal period. From 1998 to 2007 a decline of **33.2** percent has been recorded. The number of doctorates in Medicine awarded to **men** in the 10 years was **2109**, which is **63.9** per cent of the total. The number of PhDs awarded to **women** is **1189**, which is **36.1** per cent of the total. The difference between the number of PhDs awarded to women and men is the least in Medicine, when compared to other science fields (namely Agriculture, Natural Science and Engineering). The largest growth in the number of PhDs in Medicine across our study period has been from 2001 – 2004 for men. The period of growth has been longer for women compared to men (from 2001 – 2006), though the percentage of growth has been much lesser for women (40.8 percent compared to 60.9 percent growth for men), despite the extended period.

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[2] *Provided other things remained constant*

[3] *The largest number of PhDs in Engineering and technology has been awarded under the broad category of Engineering and Allied Sciences. Since a further break up of the category was not available, it has not been considered for further discussion*

E. Social Sciences:

The total number of PhDs awarded in the Social Sciences for the 10 years (from 1998 to 2007) is **8010**. From the initial to the terminal year there has been a steady growth in the number of PhDs awarded in Social Sciences. However the trends show wide annual fluctuations in the number awarded, as well as a non-linear growth pattern. Men with a PhD in Social Sciences outnumber women as in every other discipline. However the difference in numbers awarded to the groups is less compared to other disciplines with the exception of Humanities. The total number of PhDs awarded to **men** was **5035** (accounting for **62.9** percent of the total) and the total awarded to women was **2975** (accounting for **37.1** percent of the total).

The highest number of PhDs under Social Sciences has been awarded in the field of **Education** (**1491** PhDs, accounting for **18.6** percent of the total PhDs in Social Sciences). **Economic**s with **1443** PhDs in the 10 years has received the second highest portion of PhDs (**18** percent of the total). Fields that have low numbers include Cognitive Science, Regional Studies, Rural Development, Social Problems and Services, Public Administration, Communication, Journalism and Anthropology.

F. Humanities:

The total number of PhDs awarded in the Humanities across 10 years is **10,970**. A positive trend by way of an increase in participation in the number of women with a PhD in Humanities is noticed compared to other disciplines. A total of **4623 women** have received a PhD in Humanities for the 10 years (which is **42.1** percent of the total). The number of PhDs awarded to **men** was **6347** (which is **57.9** percent of the total).

Among the sub-disciplines of Humanities, the largest share of PhDs has been awarded under **Language and Literature** (**7091**, accounting for **64.6** percent of the PhDs in Humanities). **History** accounts for the second largest chunk of PhDs in Humanities (**1373**, which is **12.5** percent of the total). Subjects that have received the least number of PhDs include Folklore, Psychology and Organizational behavior, Theology, etc.

3. Zone wise / State-wise Analysis of PhDs

The highest number of PhDs has been awarded in the **North zone** (which has received **43.1** percent of the total number of PhDs sampled). The North zone thus accounts for a significantly higher number of PhDs when compared with other zones. This finding is significant in the light of the fact that the total number of institutions sampled in the North **(56)** and South **(51)** are almost equal (though a lower percentage of total universities in the North has been sampled). Yet, the South zone accounts for only half the number of PhDs awarded in the North. The **North-East** accounts for the **least** number of PhDs in the 10 years with only **4.3** percent of the total PhDs awarded. However, the number of universities and research institutions available in the North-East is also lower than for all other zones (20). Therefore the number of students having an opportunity to complete doctorates in

the North-East may also be low. **Centra**l zone shows the **second lowest** number of PhDs **(9.2** percent of the total) in the 10 years followed by East (10.1 percent of the total). East, which has a large number of universities and research institutions (**83** of which **42.2** percent were covered in our sample), has contributed significantly lower numbers.

The regions with a higher proportion of women who have received PhDs include the **Centra**l zone (**43.6** percent PhDs to women and **56.4** percent to men), **North-Eas**t zone (**37.2** percent PhDs to women and **62.8** percent to men) and the **North** zone (**36.9** percent to women and **63.1** percent to men). The **West** zone has the lowest proportion of PhDs awarded to women (just **24.9** percent to women compared to **75.1** percent to men), followed by the **East** zone (**27.6** percent to women and **72.4** percent to men) and **South** zone (**29.7** percent women and **70.3** percent to men).

Across all disciplines, the highest number of PhDs has been awarded in the North zone, followed by the South. The least number of PhDs across disciplines has been awarded in the North-East zone.

With respect to individual zones themselves, the highest number of PhDs in the South (**32.1** percent), East (**30.3** percent), West (**29** percent) and North-East (**38.9** percent) has been awarded in **Natural Sciences**. The Central and North zones have the highest number of PhDs in **Humanities** (**34.1** percent and **24** percent of the total PhDs awarded in the zone, respectively). All zones with the exception of the Central and East zones have received the least number of PhDs in General Science. The Central zone has received the lowest number of PhDs in **Agriculture (22**, which is **0.5** percent of the total PhDs in the zone). This maybe due to low number of agricultural institutes in the zone compared to other zones. The East has the lowest number of PhDs in **Medicine** (**15, 0.8** percent of total PhDs in the zone). The East also shows low numbers in **Agriculture** (**23, 1.2** percent of total).

With respect to individual states, of the 28 states and 7 union territories in the country, 8 states (Andhra Pradesh, Harayana, Karnataka, Madhya Pradesh, Maharashtra, Tamil Nadu, Uttar Pradesh and West Bengal) and 1 Union Territory (New Delhi) have accounted for **33,417** PhDs (which is **73.4** percent of the total PhDs). The data shows the highest number of PhDs to be awarded in **New Delhi** (**17.3** percent of total). New Delhi's contribution to the total PhD database is much higher compared to other states. **Uttar Pradesh** has produced the second largest number of PhDs (**5421**, which is 11.9 percent of the total). Despite Maharashtra having the highest number of universities and research institutions (**96**) in comparison to the other states, it contributes only **8.7** percent of the total PhDs. However, this may be a result of the low percentage of institutes sampled in Maharashtra (only 26 percent). More number of states from the **Southern zone** (Andhra Pradesh, Karnataka and Tamil Nadu) are among the states that have contributed the highest number of PhDs (together they account for **18.1** percent of the PhDs).

4. Comparison of Trends in Science

The total number of PhDs for 10 years in the Sciences (which includes Natural Sciences, Engineering & Technology, Medicine and Agriculture) is **24,539**. Of this, the highest proportion of PhDs has been awarded in **Natural Sciences** with **11,449** PhDs (**46.7** percent of the total), followed by **Agriculture** which has **5871** PhDs (**23.9** percent). Engineering and Technology and Medicine have a relatively modest number of PhDs in comparison (Engineering accounts for **16.1** percent while Medicine accounts for **13.4** percent). In comparison to the other disciplines, Medicine has shown the least growth.

An analysis of the gender distribution of PhDs in the Science fields shows that **men** have received more PhDs (**70.8** percent of Science PhDs) than **women** (**29.2** percent of total), on the whole, as well as in individual Science disciplines. The difference in the proportion of PhDs awarded to men and women is the least in **Medicine** (**36.1** percent to **women** and **63.9** percent to **men**), and the highest in **Engineering and Technology** (**20.2** percent to **women** compared to **79.8** percent to **men**).

5. Comparison of Trends in Arts

The total number of PhDs awarded under Social Sciences and Humanities is **18980**. **Humanities** has a higher proportion of PhDs (**10,970** which is **57.8** percent of the total), compared to **Social Sciences** (**8010**, which is **42.2 percent** of total).

A higher proportion of women have received a PhD in **Humanities** (**42.1** percent) compared to **Social Sciences** (**37.1** percent). It is interesting to see that even in subjects traditionally considered to be “for girls’, men outdo women in the number of PhDs. Overall, the percentage of women with a PhD in Arts is 40 percent while, 60 percent men have received a PhD in Arts.

6. Comparison of Trends in Science and Arts

A comparison of all Science and Arts subjects shows the total number of PhDs in **Sciences** (**24,539**) to be higher than for **Arts** (**18,980**). **Sciences** account for **53.9** percent of the PhDs awarded in the 10 years, while the **Arts** disciplines account for **43.6** percent of the PhDs. The ratio of **women** receiving a PhD in Arts is much higher (**40** percent) when compared to **Science** (**29.2** percent).

Recommendations

The need for an analysis of the higher education scenario, particularly research and development capacity in India cannot be underscored enough.

Important lessons in how to stay competitive can be taken from countries such as the USA, UK, China and Australia, which despite a better performing higher education and research sector, periodically engage in critical self-evaluation to consolidate and retain their edge. For example, the U.S. Secretary of Education has set up a Commission on the Future of Higher Education in the United States as of September 2005 with an investment of US$ 134 billion over the next 10 years to be in the forefront in higher education and innovation. Innovations in financing of higher education, teaching and research and portable students' funding has helped the UK overcome the crisis of inadequate funding and failing accountability in its universities in recent times. Cost-sharing and cost-recovery reforms were introduced in China to stimulate growth in higher education (Agarwal, 2006). To bring about such systematic changes an in-depth knowledge of the performance of the higher education sector and a critical analysis of its functioning is required .

India, despite an early advantage shows a considerable decline in performance in academic research and doctoral education output at present (Chatterjea & Mollik, 2006). The reasons for this are numerous, and include problems of inadequate resources and facilities for doctoral students, poor numbers of high-quality faculty required to advise students, poor financing of higher education, in particular doctoral education in India, etc. **In addition to these an important factor remains the lack of adequate current data on higher education and academic research that will be useful in steering India towards building academic research and R&D capacity.**

A preliminary attempt has been made through the **'Trends in Higher Education'** project, a **joint initiative** of **National-Institute of Advanced Studies (NIAS)** and **INFLIBNET**, supported by the **Tata Consultancy Services (TCS)**, to analyze the current PhD scenario in the country and provide a set of useful recommendations. The recommendations drawn from the findings of this study are given below:

1. Creation and Maintenance of a Comprehensive National level Database on PhDs:

Data on higher education, particularly India's future available research capacity, measured in terms of the output of doctoral candidates, faculty available to advise students, institutions for doctoral education, their regional and state-wise spread, etc. are extremely important for planning. In the absence of such information, INFLIBNET and NIAS have attempted to create a network of institutions that provide information regarding doctoral degrees awarded annually.

a. This network needs to be strengthened, expanded and provided with the required mandate to access information from all degree granting institutions, including agricultural, technical and medical institutions, deemed universities, private and public sector institutions, etc., to have current data on the education scenario.

b. Such data needs to then be periodically subject to analysis, to implement relevant policies in order to help India maintain a competitive edge in research.

c. A single agency in charge of the database of annually awarded PhDs in the country, which can coordinate with all institutions, is necessary to avoid duplication of the data and differences in numbers reported. Such an agency should also become a **nodal point of communication** to all – policy makers, researchers, educationists, students, etc who may require access to such data for further analysis or reference.

d. There is an urgent need to create an awareness of the importance of this database to the nation. This should be linked to INFLIBNET, which has been set up by UGC and is the nodal agency for maintaining the bibliographic details of theses submitted by scholars in all universities of India. While it has been successful to a great extent in maintaining and updating national theses database, more efforts needs to be made to strengthen it and make it comprehensive.

e.The PhD database can be strengthened using new enabling technologies to link individual institutional libraries with the national database. This will facilitate access to information regarding research undertaken as well as allow access to electronic theses submitted to various universities in the country. This linkage of libraries which can provide access to an individual thesis is extremely important since such data is unavailable elsewhere in the country. **Since libraries receive a copy of all theses submitted at their institutions, they are in the best position to maintain an accurate record.** However, optimal use of technology and developing e-theses format requires adequate technology training for all university librarians.

f. This should be complemented by developing an online database of PhD students' profiles. Online submission of the students' profile details should be made mandatory by all universities. The information in the profile should include: a) name of the researcher, b) gender of the researcher c) major discipline under which the PhD was undertaken d) PhD Topic e) Advisor's name f)year of joining g) year of submission h) department,

i) university which awarded the PhD j) State k) Current occupation l) part-time or full-time, etc. For ease of use, the online profile tracking system should have drop-down menus with multiple choices for selection of discipline, zone, state etc. This online profile must also have mirror sites in the North, East, South, West, in different states and at INFLIBNET. This information needs to be publicized and done on a campaign mode with a defined time period of one year. The universities must be an integral part of this campaign.

2. Improving Productivity by Establishing Linkages between PhD Output and Changing Job Market

The total number of PhDs across the 10 years covered in the study is 45,561. The number of PhDs covered in the study is approximately 39.9 percent of the total PhDs awarded in the country (up to 2005). In terms of the actual PhD production in the country itself, only 0.25 of those enrolled at the graduate level enroll at the PhD level.

a. As a first step, it is important for policy planners in the country to study the occupational profiles of PhD holders and understand to what extent there exist a gap between demand for and supply of doctorates. Several reports and researches have documented the absence of the availability of highly trained faculty to address the student-teacher ratio in higher education. In addition to these requirements, it is important to understand to what extent this gap in PhD out-turn must be filled, and in what domains of knowledge.

b. In addition to the number of PhDs awarded, there is a need to analyze the production of PhDs in relation to the history of the university, the departments and the year of starting of the departments, number of faculty, infrastructural facilities available, etc.

c. Another important dimension will be the quality of PhDs in terms of its contribution to the body of knowledge through publications in journals and books, its forward and backward linkages to technology and society and its contribution to the contemporary knowledge production process. These are vital aspects and ways to record the same need to be developed. However, in the absence of numbers, which is the first step, such analysis will not be possible.

3. Improving Women's Representation in Research

In terms of gender differences, women's enrollment in higher education has grown from 10 percent in the 1950s to 38 percent as of 2006. At the PhD level, there has been a growth in women's enrollment numbers, from 30.05 percent in 1998-99 to 38.5 percent in 2003-2004. However the percentage of enrollments drops from 40 percent at the graduate level and 42 percent at the post-graduate level to 38 percent at the research level. Only 33.6 percent of the total PhDs awarded in the 10 years has been awarded to women.

This suggests a need to re-examine the doctoral education process, and improve provisions for women, to ensure their greater participation. The declining number of women in academic research indicates a loss of skilled / trained human power as well as the loss of diversity which can contribute to innovation in research. Since the period of doctoral education crucially clashes with women's age of marriage and family in India, special provisions such as part-time PhDs, more flexibility in terms of time period for completion, scholarships, etc may be useful in increasing their participation.

4. Ensuring Balanced Research Output Across Disciplines

A Discipline-wise analysis of PhDs reveals lower numbers in Agriculture (12.9 percent of the total PhDs), Engineering (8.6 percent of total PhDs) and Medicine (7.2 percent of total PhDs), which are important sectors that contribute to the growth in the economy.

a. It is important to analyze whether the current production of PhDs in these disciplines would be adequate to meet the demands in the field. New advances in these disciplines brought about by developments in Biotechnology, Material Science, Nano-Science, Neuroscience, Cognitive Science etc. demand more human power for research to make greater advancements and therefore it would be important to ensure the match between availability of researchers for new expansions in these various domains.

b. More importantly, new forms of research agreements, policies and contracts may have to be drawn up in order to match the trends that are are currently popular in the various fields. For example, the professional nature of Engineering and Medical fields with higher economic prospects of careers in these fields compared to research in these disciplines, and the high cost of Engineering and Medical education may be probable deterrents for students. **Thus, to remain competitive higher educational, corporate and industrial policies must find new solutions, such as salary and job protection for the period of research, sabbaticals for PhD, higher remuneration or visibility, provisions to build important research networks, etc.**

c. A periodic assessment of research production of the various disciplines is important in order to match supply with demand. Trends among the various disciplines show differences in annual performance. While Natural Science recorded a higher number of PhDs during the initial period of the study (from 1998 – 2003), it has been taken over by the Humanities during the latter period (2006-2007). A sudden growth in Agriculture was seen from 2000, when it has overtaken other disciplines such as Engineering & Technology and Medicine. However the growth in Agriculture has tapered off towards the end of the period, with the numbers falling below Engineering & Technology in 2007. Disciplines that have consistently received a lower number of PhDs are Engineering and Technology, Medicine, Commerce and General Science. **These trends indicate the importance of periodic assessments and current data on research productivity of the various disciplines, in order to match it to the present needs and demands, to stimulate disciplines that encounter adverse conditions through beneficial policies and keep track of international competition.**

d. There is a need to support and enhance research in newly emerging areas of study of interdisciplinary nature through new organizational arrangements and policies. Interdisciplinary research both in the Sciences as well as the Arts , in areas such as Agro-physics, Agro-chemistry, Energy Studies, Cognitive Sciences, Regional Studies, Rural Development, etc. have immense potential to answer real world problems more holistically, due to the complex nature of these problems. **Research of interdisciplinary nature may also require special administrative and managerial provisions.** It is therefore important to provide support to these disciplines through academic and administrative mechanism at universities and research institutes that will facilitate research in these areas. These could include provisions for registering for PhDs of interdisciplinary nature, reorganization of departments into schools or centres on broad lines that will allow different departments to collaborate with each other, allowing inter-university collaborations to draw on specialized faculty and resources for research, etc.

5. Improving Agricultural Productivity Through Research

The Agriculture PhD production in the country has shown a gradual increase since 1998, but has declined considerably towards 2007 (from 152 in 1998 to 724 in 2006, but has dropped to 352 in 2007). While the decline may be traceable to problems with the database, a World Bank report has indicated that among other factors, lack of productivity- enhancement investment in areas such as research and extension are responsible for this decline.

a. This indicates the need is for a research personnel base which will be able to engage with new areas of research in agriculture so that the changing paradigm brought by such events as the as WTO regulations, climate change, population growth, new plant pests and diseases, etc can be addressed. It is, therefore,

important for policy planners to keep in mind the need for qualified technical human power with research capacity. This will help in facing the new challenges that will affect agricultural production and in turn India's economy.

b. New emerging interdisciplinary areas of study are seen in Agriculture also and require new mechanisms that can facilitate research in these fields and enhance Agricultural productivity. These fields such as Environmental Studies, Agro-Physics and Agro-Chemistry have, however, received the least number of PhDs under Agriculture. These areas being of recent origin, universities and institutes may not yet be fully equipped with administrative facilities, faculty specializations or processes for interdisciplinary collaborations across departments since they have the potential to more holistically address real world problems, by drawing from several disciplines.

6. Addressing Shortages of Trained Scientific Power in Engineering by Developing Mechanisms to Attract Students Towards Research

It has been estimated that the Engineering Processes Outsourcing (EPO) in India will rise to 17.6 percent CAGR and reach US$ 20 billion by 2010 (Ingalsuo, 2009). While this could perhaps signal a further growth in the number of engineering post-graduates, it also suggests a need for India to take positive steps in the direction of strengthening engineering research. A positive trend of growth in the number of PhDs in Engineering and Technology is seen from the study. However, in the light of Rao Committee Report's (2002) predictions that India will face a shortage of an additional 10,000 doctorates by 2008, the current growth rate may still be inadequate.

a. Strengthening of research facilities in engineering, with more institutions and faculty besides select premier institutions such as IITs, engaging in research is needed if this scenario is to be corrected.

b. Gender difference in participation in research in Engineering shows a cause for concern and must be addressed if India is to meet the shortage in trained human power in Engineering and Technology. Gender-wise study in Engineering shows a difference of more than 75 percent in award of PhDs between women and men. This may be due to traditional conceptions such as Engineering and Technology being considered male disciplines. To increase its research personnel base and overcome the estimated shortage of human power, it is important to undertake policies that will address these gender imbalances and develop a diverse and adequate manpower base.

7. Addressing the New Trends of Growing Gender Disparity in Medicine

Medicine (and allied bio-medical fields that have traditionally seen a greater participation of women) has witnessed an increase in the gender gap in the number of PhDs awarded (from the difference in the proportion of PhDs awarded to women and men has increased from 17.6 percent in 1999 to 36.6 percent in 2007). While there has been an overall decrease in the number of PhDs in medicine in 2007, there has been a greater decline in numbers for women (47.4 percent decline) than for men (23.6 percent).

Absence or decline of women's presence in fields that they have historically shown larger participation in is a cause for serious concern. There is a need to re-examine these trends in order understand the factors that can reverse them at the earliest.

8. Retaining Interest in Humanities and Social Sciences

Despite the poor funding for research in Humanities and Social Sciences, the Humanities and Social Sciences have both received a higher number of PhDs than all the other disciplines, after Natural Science. This appears to be a positive trend and it may be important to convert this growth with efforts by various agencies to encourage research in these disciplines. Since these disciplines focus largely on the linkage of knowledge with society, they form an integral part of any research question and provide important directions for development. All real world problems are located within society and hence addressing the societal dimensions which are critical is possible only through research in Humanities and Social Sciences.

a. Thus, there is a need to analysis the number of institutions available state-wise for research in these areas, the number of faculty available to advise students, funds for research and the production of PhDs in these disciplines. Data of this nature needs to be systematically generated, subjected to analysis, documented and more importantly disseminated, in order to have an optimal and sustained growth of research capability across disciplines. It may also be necessary to correlate the employment potential of these doctorate holders at the National and International levels.

b. Quality of the PhDs produced in these disciplines need to be given attention. It is commonly perceived that the Humanities and Social Sciences do not require large funds since they mostly do not require laboratory and instrumentation facilities. Hence there is a large presence of Social Sciences and Humanities departments in the country across universities. However, this has resulted in inadequate funding for Humanities and Social Sciences research with universities receiving less than minimum support in terms of access to journals and books as well as support for field studies. Such trends impact the quality of the research undertaken and PhDs produced and is a matter of concern that needs to be addressed at the national level.

9. Increasing Scientific Research Capacity Across all Science Domains

Trends in the Sciences have shown a large difference between the number of PhDs produced in Natural Sciences on the one hand and in Agriculture, Medicine and Engineering and Technology on the other. The smaller number of students opting for research in the latter disciplines may be due to the professional nature of the courses, and the minimum industry requirements of post-graduation for employment. These trends may also be a result of the high cost of medical and engineering education, large loans taken by families to avail these educational opportunities and the necessity to repay these loans urgently.

In order for India to remain on par with international research capacities and contribute to research in new emerging fields such as Biotechnology, Nanotechnology, Genetic Engineering, Human Genetics, Neurosciences, etc., it is important to ensure adequate research human power in these fields. It is also important to match job requirements, skills, qualifications and educational outcomes of completing a doctorate degree in these fields. Similar analysis needs to be made of the advantages, professionally and monetarily, to be gained by a higher level of education in these professional courses.

10. Bringing Gender Equity in Science Research and Higher Education

Women's participation in all fields of science is significantly lower, compared to men's. The difference in the proportion of PhDs awarded to men and women is least for Medicine (36.1 percent to women and 63.9 percent to men) and the highest for Engineering and Technology (20.2 percent to women compared to 79.8 percent for men).

Since women compose one half of the potential workforce, their critical absence from fields such as Engineering and Technology and Agriculture indicates a larger loss for the country's innovation climate and research capacity. Hence it will be crucial to attract talented and qualified women to research through attractive schemes, as well as by facilitating their participation in research by understanding women's dual responsibilities and time constraints. While some efforts in the Sciences have been undertaken by national agencies such as the Department of Science and Technology (DST), the Department of Biotechnology (DBT) and the University Grants Commission (UGC), it is important to broaden these provisions to other fields such as Agriculture and Engineering and Technology also.

11. Need to Balance Distribution of Research Capabilities across Zones and States

Large differences are observed in the spread of PhDs across the various regions of the country. Not only has the highest number of PhDs been awarded in the North zone, it is also significantly higher than for other zones. This difference needs to be carefully analyzed because even with the number of institutions sampled in the North (56) and South (51) being almost equal the North accounts for more than double the number of PhDs as the South. Further, the East, despite having a higher number of institutions (86 of which 42.2 percent were sampled), has contributed only 10.1 percent of the total PhDs in 10 years (compared to 43.1 percent by the North).

a. Further analysis with respect to the research culture, research performance capabilities, quality and efficiency in these different zones needs to be undertaken to optimize the PhD turnout of the country.

b. **The new developments in the North-East higher education and research scenario require attention.** The North-East has the lowest number of PhDs compared to all zones (4.3 percent of the total). It also has significantly lower number of research universities and institutions compared to the other zones (20). Further the difference in PhDs produced in the various disciplines of Science is large. Of the total number of 874 Science PhDs awarded in the North-East, 87.4 percent is in Natural Sciences compared to 1.7 percent in Medicine, 2.6 percent in Agriculture, and 8.2 percent in Engineering and Technology.

The history of institutions of higher education in the North-East and growth in the number of institutions, students and researchers is a recent phenomenon. **It is important for policy planners to recognize these new developments in the region and support the growth of research and academic culture by setting up new institutions, forming policies, setting up fellowships and other such provisions to encourage the growing research culture, while also balancing out the vast differences in research across disciplines.**

b. More importantly data on state-wise distribution of PhDs is required, since all policies and planning are undertaken at the state level. However such data is largely lacking. State-wise data for disciplinary trends in PhDs, number of institutes available for research in particular disciplines, university/ research institute-wise number of degrees awarded, gender-distribution of PhDs in different disciplines, availability of jobs within the state for doctorate degree holders, economic sectors emphasized by the state government in relation to the PhDs awarded, etc are largely absent. Data sampled for the project itself show large differences in the states' production of PhDs. A total of 8 states (out of 28) and 1 union territory (out of 7) have produced approximately 73.4 percent of the PhD. Thus, an individual state's PhD output needs to be analyzed further, with respect to the number of institutions and faculty available for research as well as governmental policies, to bring about a more balanced growth among the states.

c. A gender-wise distribution of PhDs across the different zones shows a cause for concern in the South, East and West zones (less than 30 percent of the PhDs are awarded to women).

Despite a high rate of enrollment of women in higher education in states such as Maharashtra, Tamil Nadu, West Bengal and Karnataka, and other states in the West and South (Refer appendix II, table 1) gender disparity is higher among these states and zones at the PhD. level. It will be important to study the factors responsible for this gender disparity at the doctorate level despite the greater participation of women in higher education in these states.

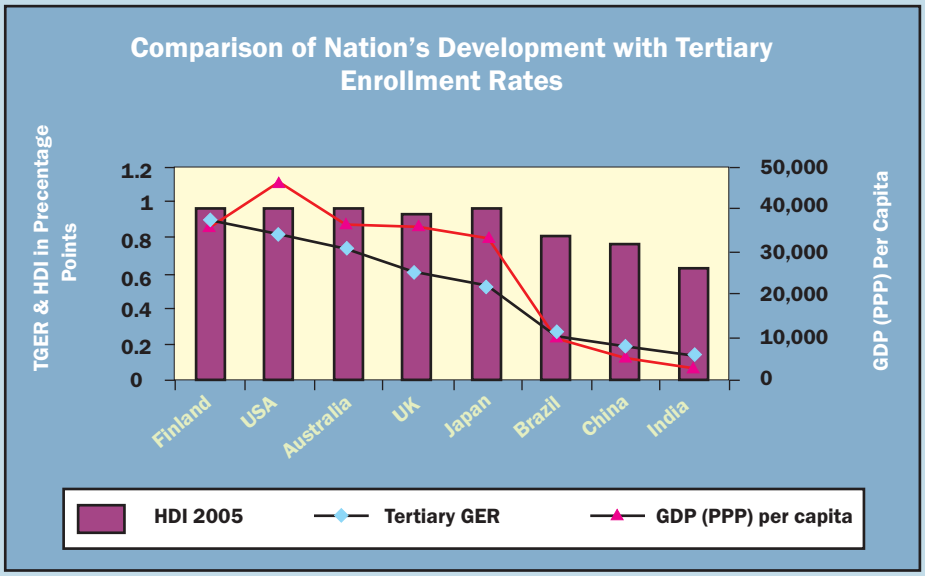
d. In order to fully understand the regional differences in doctoral education it is important to have data on PhDs university, state, and region-wise. Data of this nature is extremely crucial to address fair distribution and equity in higher education. The distribution of research capabilities has by and large been concentrated in certain metropolitan cities / states / regions so far. However, such data needed for planning has been altogether absent or limited thus far and it would be important for national agencies to focus attention and resources in collecting and analyzing data of this nature.

MAIN REPORT

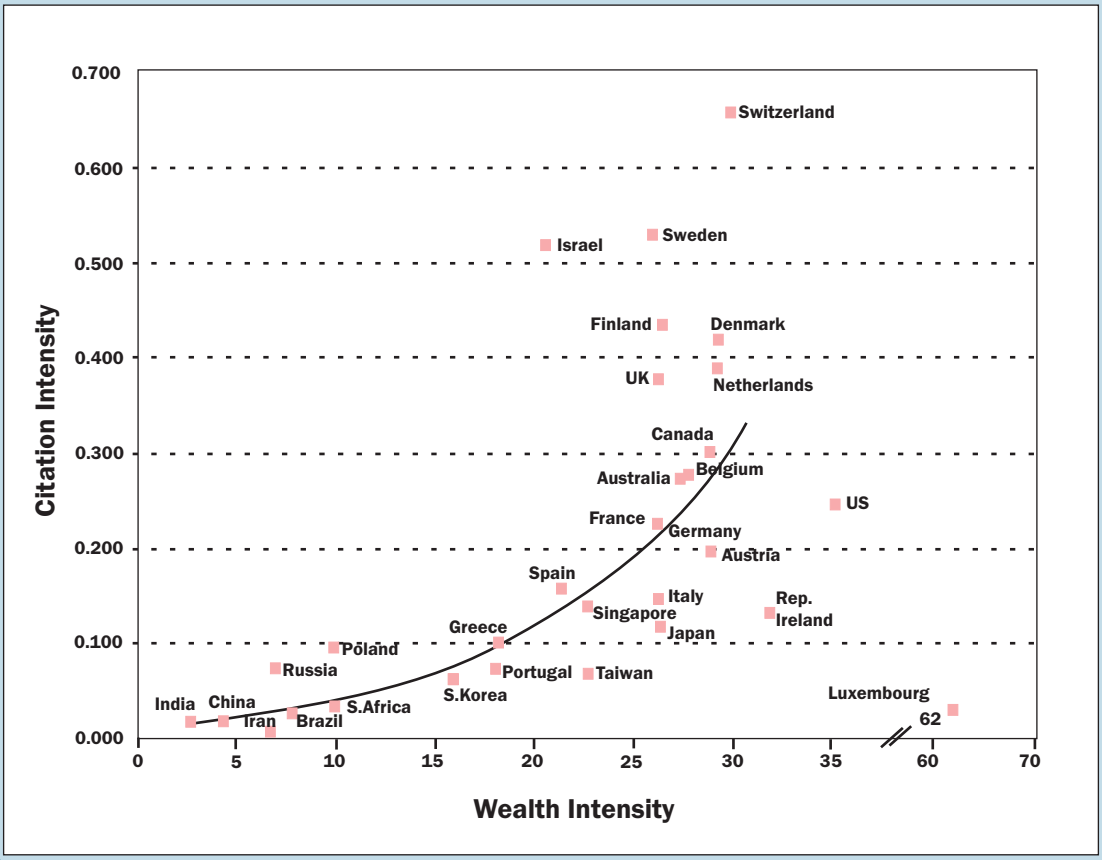
UNDERSTANDING DOCTORAL TRENDS
(ACADEMIC RESEARCH INDICATORS) FOR SUCCESS IN A KNOWLEDGE-BASED ECONOMY

The world is increasingly moving towards a knowledge economy, where industrial trade relations are being replaced by an intricate system of information exchange (c.f., Gilpin, 1987). This revolution has shifted the focus onto an individual nation's abilities and resources to produce and generate new knowledge that can place it on top of the power hierarchy. Creation of new knowledge depends largely on a robust education sector, particularly on the higher education and research output of the country. Realizing the potential of higher education, several countries have made huge investments in the sector. A reflection of this realization has been the tremendous expansion of higher education worldwide in the last century. From 500,000 students representing one percent of the college-age population enrolled in higher education in 1900 (c.f., Banks, 2001), 100 million people representing 20 percent of the global cohort in 2000 were enrolled in higher education. There has been a growth of over two hundred fold within the span of a century. This trend in growth of enrollment continues with ratios exceeding even 80% in some industrialized countries (UNESCO, 2004).

These new developments in higher education have redefined its role. Higher education is now increasingly recognized as fuelling economic activity, in order to gain economic returns (Yang, 2003). Investment in higher education, particularly academic research, has come to be recognized as a potential source that could aid a nation's development through production of knowledge. Lending credibility to these arguments are several studies that have analyzed the economic contributions of the higher education sector to a nations' development. Solow (1957) predicted that a nation's productivity depends on more than labour and capital, and especially on the acquisition and application of knowledge through R&D. It has been estimated that the return of investment (ROI) for publicly funded R&D is 20 – 67 percent, and between 20 -100 percent for private investment in R&D (since private investment contributes to creation of jobs, new ventures and companies and return on sales) (US National Academy of Sciences, 2007). An analysis conducted by Agarwal (2006) also showed that there was a broad positive correlation between the Gross Enrolment Ratios (GER) in higher education and the per capita GDP of countries. Other studies have estimated that a country's wealth intensity (per capita income adjusted to purchase price parity) can be correlated to its investment in R&D, in particular with its academic R&D (Rama Rao & Anitha, 2009).



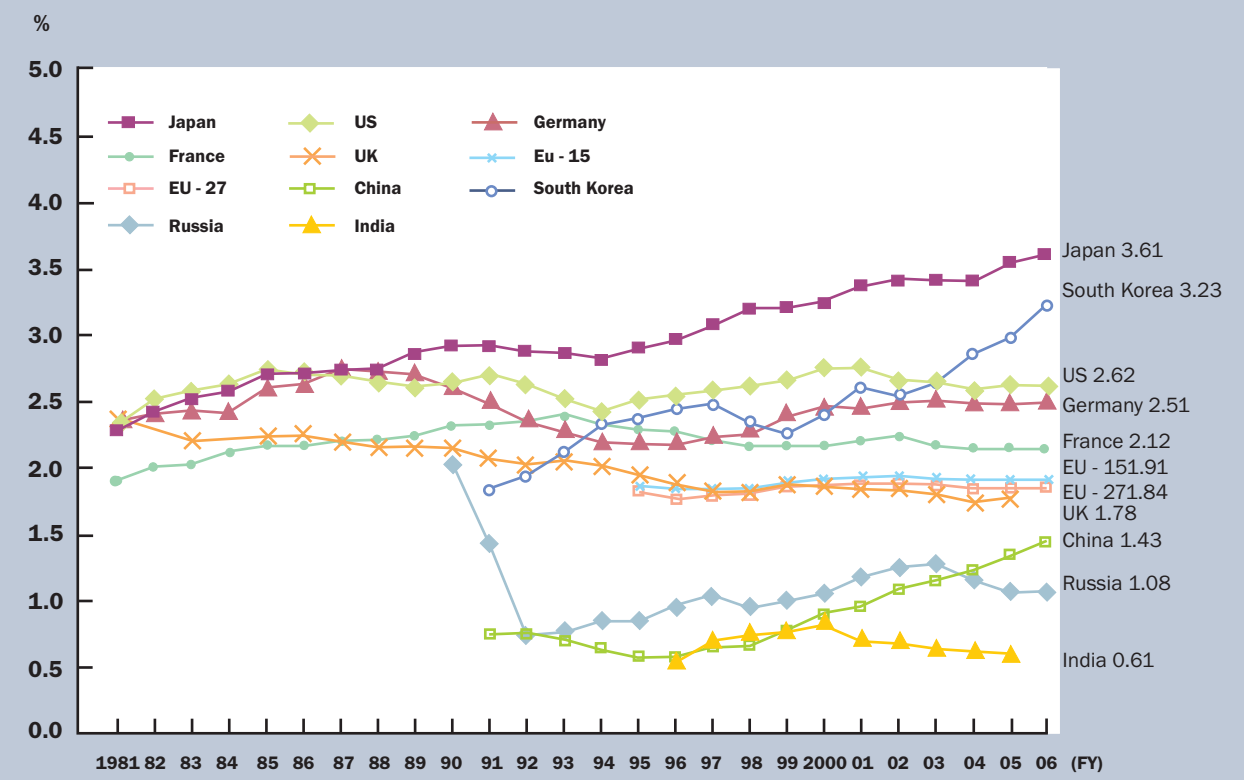
[1]Graph 1: Comparison of Nations' Development with Tertiary Gross Enrollment Rates (TGER)



[2]Graph 2: Showing a Comparison Between Science Citation Index* and Wealth Intensity of Nations

[1] *Source: Paradigm Shifts in Indian Education System Best Practices for Northern, presented at EduSummit 2009, Confederation of Indian Industry*

[2] **National Science Citation Intensity (measured as the ratio of the citations to all papers to the national GDP) is shown as a function of the national Wealth Intensity (or GDP per person) for 31 nations. GDP and Wealth Intensity are given in thousands of US dollars at 1995 purchasing-power parity. Sources: Thomson ISI, OECD and the World Bank.(From: King, D., 2004)*



Source: MEXT, 2007

Graph 3: Showing Comparison of R&D Expenditures for Selected Countries as a Percentage of the GDP

An analysis of a nation's development (using indicators such as Human development Index [HDI] and Gross Domestic product [GDP]), shows a broad positive correlation with its national Tertiary Gross Enrollment Ratios (TGER) (Refer Graph 1). Similar positive comparisons can be made between wealth intensity of countries and their measure of scientific output (measured using the national science citation intensity) (Refer Graph 2).

Countries such as the USA, Japan and other European nations such as Finland and the UK that have invested a larger share of GDP in R&D, have also been forerunners in wealth intensity, GDP and Human Development Index (refer graphs 1, 2, 3).

However, these trends are now giving way to new front-runners, such as Brazil, Russia, India and China (BRIC nations) that are posing a tough competition to the old world leaders. While enrolments in higher education are either growing slowly or are stagnant in most developed economies, emerging economies like China, Brazil, India and Malaysia are showing a rapid rise in enrolments. Further, countries like China, which increased its research personnel base from 40,000 in 1998 to over 1.2 million in 2006, have overtaken other European nations. With higher education and R&D receiving added focus in these countries, the BRIC nations are also set to overtake other countries in wealth and economic productivity.

These countries and others are increasingly adopting new strategies to increase their research and innovation capacities. These include expanding the knowledge-base of students and researchers, strengthening research institutions, and promoting exports of high technology products and research output (National Academy of

Sciences, USA, 2007). For example, China has adopted a pro- R&D policy since the 1990s. It has increased government spending on basic research to reform old structures in a fashion that supports a market economy. Thus they have geared up to build an indigenous capacity in science and technology. Understanding the implication of these trends, the US National Academy of Sciences (2007) has stated that these trends will spell a new geography of knowledge production. The consequences of such changes, it has stated, will be that "...workers in virtually every sector ... (will) face competitors who live just a mouse-click away in Ireland, Finland, China, India, or dozens of other nations whose economies are growing." (In '*Rising Above the Gathering Storm*').

There is already a trend towards acceptance and demand for utilization of overseas regions as well as human resources for intelligent production activities by countries such as the US. The US and the UK are drawing heavily on the qualified intellectual human resource from India and China, having recognized their importance. Thus, their large research base in knowledge-intensive jobs in R&D and medical fields has become the driving force behind their nations' innovation climate and consequently wealth. This base is further supported by the establishment of several off-shore R&D units of their biggest MNCs such as Motorola, Microsoft, Texas Instruments, IBM, etc in the last decade, in India and China.

India's Position in the Global knowledge Economy

These trends spell a positive period of growth and development for India and other developing nations. A report by Pricewaterhouse Coopers has projected that in US $ terms, India will overtake the UK and Japan in GDP and equal the United States in PPP. Other reports have estimated that India's captive student population will reach 486 million (i.e., 34 percent of its total population) by 2025 (CII EduSummit 2009). Along with this, working population, between the ages of 15-59 years, is estimated to increase only in India. This would mean that one of every five of the global work force would be an Indian (UN world population database, 2004).

Table 1: Comparison of current and projected working age population in selected countries

Country	2000 (%)	2050 (%)
India	17	19
China	23	14
USA	5	5*
W. Europe	3	2
Japan	2	1

*USA adds qualified people significantly by its liberal immigration policy.
Source: UN World Population Prospects Database 2004

India is thus well-positioned to seize the unfolding opportunities for economic development and prosperity. However, in order to realize this potential several important issues in research and higher education need to be addressed. Currently, India invests only about 3 to 4% of its total R&D in academic research. By contrast, the US, which is nearly 15 times more prosperous than India, invests 20% of its total R&D in academic R&D. Given the fact, that the R & D expenditure of the US is 30 to 40 times more than that of India's, it is surprising to note that the absolute differentials in academic R & D between the two countries is more than a factor of 200. This only suggests that there is an urgent need to substantially increase the investment in academic research which necessarily will include a huge increase in the number of trained scientific personnel. (Rama Rao & Anitha, 2009)

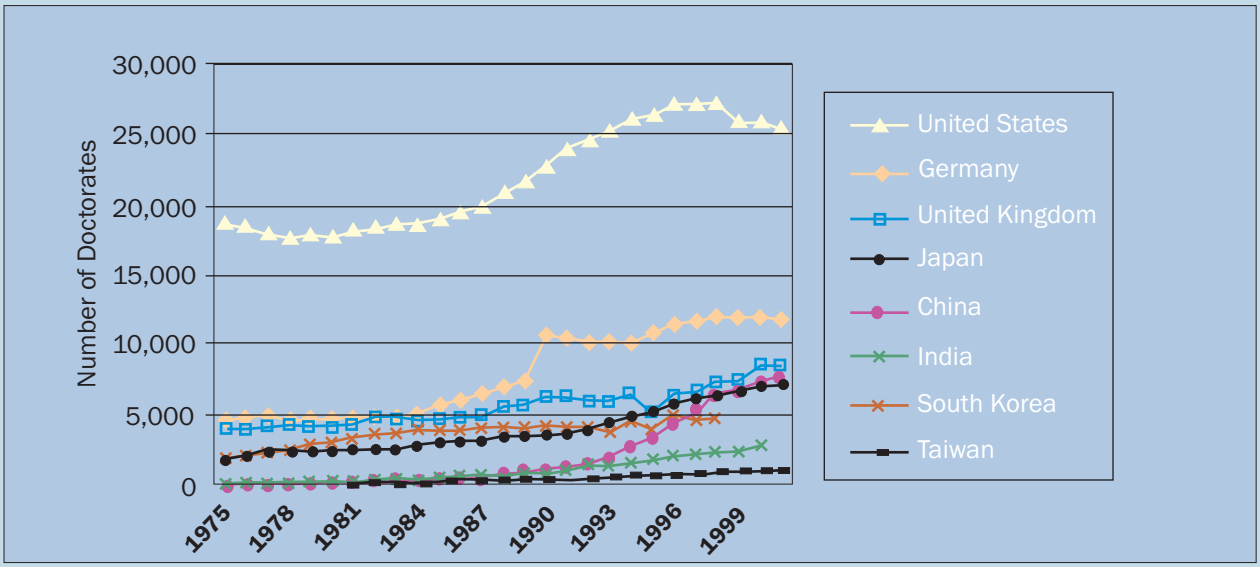
The lack of investment in academic research has telling consequences on its available research personnel base. Despite the annual growth in numbers (an increase of 30.6 percent from 1990 to 1999)[3], India is still far behind countries such as the USA, China[4] and Germany[5]. Only 0.65 of the total number of students in higher education in India are enrolled at the PhD. level. Prathap has reported that the density of research personnel is only 1.49 for India compared to 139.5 for the USA, 122.4 for China, 71.0 for Japan, 28.0 for Germany and 20.4 for France (Refer graph 5).

Table 2: Comparison of annual production of PhDs for a few selected countries

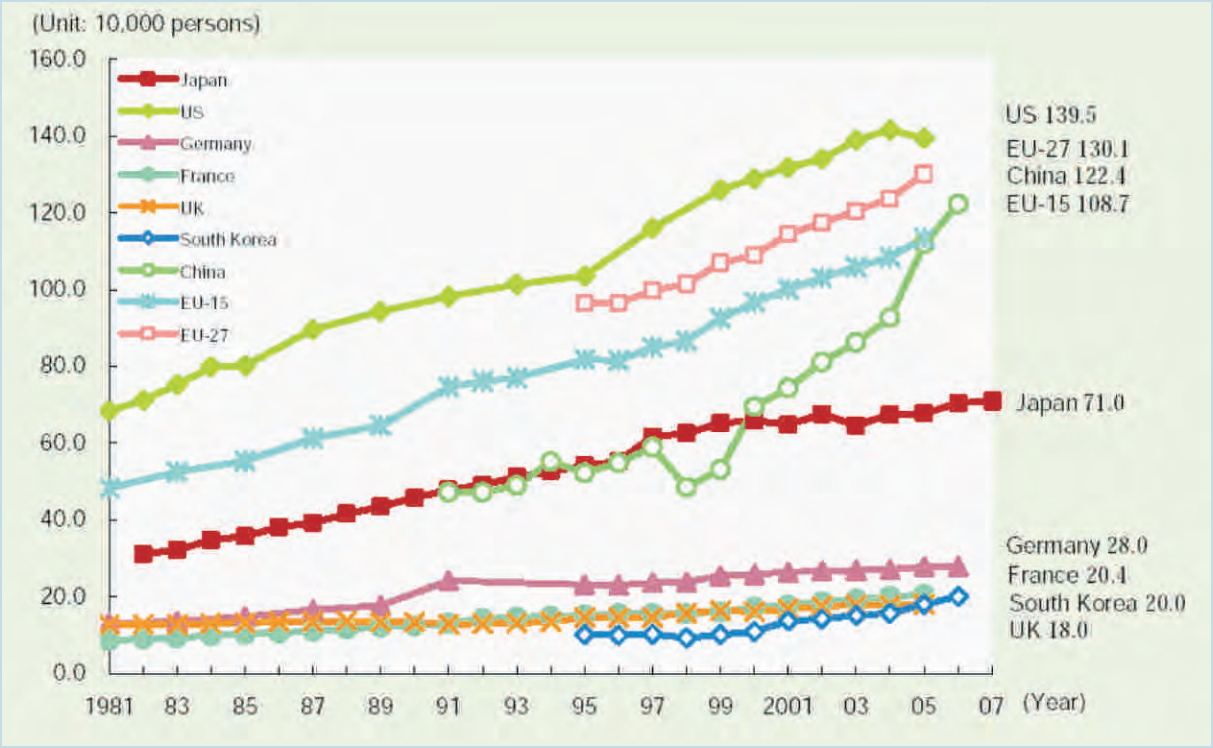
Year	India	US	UK
1998	10817	44,077	11338
1999	10852	44,808	1150
2000	11534	44,904	14120
2001	11899	44,160	14210
2002	13450	46,042	14875
2003	17853	48,378	15255
2003	17853	48,378	15255
2004	17898	52,631	15775
2005	18730	56,067	16515
2006		60,616	16635
2007			17545

[3] *Khandaria, 2004*
[4] *China has increased its PhD production from 14,706 in 2002 to 27,700 PhDs in 2005*
[5] *Germany awarded 25,952 PhDs in 2005 compared to India which awarded 18,730 PhDs for the same year*
[*] *Provisional numbers reported by UGC*
[◊] *Calculated by adding the number of PhDs awarded discipline-wise by UGC, since the total numbers were unavailable*

Graph 4: Showing growth in PhDs for a few selected countries



Graph 5: Showing growth in number of researchers in selected countries.



A similar shortage in production of skilled and technically qualified manpower is seen with respect to Science and Engineering and Technology, which are important domains of knowledge required for a nation's development. Banerjee and Muley's (2008) comparison of India's Science and Engineering PhD production vis-à-vis other countries showed India (with 6500 PhDs) to be way behind China, the USA and Germany and slightly behind Japan and the UK. (Refer table 3).

Table 3: Comparison of PhDs in Science and Engineering, across countries

Year of Data		2006	2006	2004	2003	2003	2002	2002	2005
Country		India	USA	Japan	China	UK	S.Korea	Germany	Australia
Academic Output									
Bachelors		237000	74200	98400	351500	19500	64900	32800	13500
Masters		20000	39000	--	35000	5000	13500	--	3100
Doctorates	Science	5500	14200	2900	32000	4800	1100	6800	1300
	Engineering	1000	8400	3900	4300	2000	1900	2000	600
	Total	6500	22600	6800	36300	6800	3000	8800	1900
Percentage	Masters /Bachelors	8.4%	52.6%	--	10%	25.6%	19.4	--	23.2%
	Doctorates / Bachelors	0.4%	11.3%	4.0%	1.2%	10.4%	2.9%	6.2%	4.7

(Source: Adapted from Engineering Education in India Rangan BanerjeeVinayak P. Muley,IIT Bombay on 31 May 2008 at Mumbai Presentation at ORF Seminar)

The data suggest an urgent need to examine the academic research environment and manpower production in the country, in order to bring about the essential changes to make India globally competitive. Importantly, considerable attention needs to be given to the creation of a competitive pool of skilled human power in academic research and development, to the creation of world class universities and institutions and to enhancing the knowledge infrastructure (Rama Rao & Anitha, 2009). Subsequent government policies and plans are also now trying to address this situation through emphasis on research and development. The Seventh and Tenth Five year Plans have already given impetus to research and development. In the 11th Five Year Plan, it has been proposed to increase the number of PhDs five-fold, through additional mechanisms such as increasing the stipend of doctoral candidates, providing teaching assistantships for meritorious doctoral candidates, establishing a post-doctoral research culture, etc.

The direction in which this investment in higher education occurs is also important. Achieving productivity through increase in gross enrolment ratios in higher education can only occur when there is a match between the skills demanded from a particular economy and its capacity in higher education. Thus, in addition to skilled industrial and IT man power, there will be a demand for teachers, researchers and scientists who can contribute to the growth of knowledge within the economy. In these terms, a shortage in supply would occur because of the shortage in the number of researchers with the relevant skills. For example, only 25 percent of the total faculty in higher education have a doctoral degree (NAAC Self-Assessment Reports 2003-04) and are available to teach at the university level and advice successive batches of researchers. An enormous shortage of qualified faculty has also been documented in a report by AICTE (2006), with a total shortage of 40,000 teaching faculty members, and over 30,000 PhDs. The Prime Minister, Dr. Manmohan Singh (2006), has also brought attention to this imbalance in various sectors stating that despite a potential workforce of one billion in the country, several youth remain unemployed due to the mismatch between skills and employment demands.

Such trends indicate the lack of systematic collection and compilation of data and investigation of trends in higher education in India. There is a lack of information on disciplinary trends, the match between higher education and industry requirements, optimization of output of institutions, loss of skilled human power to higher paying fields, etc. This lack of data is particularly seen at the doctoral level which has the highest potential to contribute to a knowledge economy.

Thus, in order to truly benefit from investment in research and production of a talented set of personnel in research, it is important to analyze the academic research and the higher education sector. Presently, data on doctoral and research trends in India is largely absent, unlike in countries such as the USA, the UK and Japan. (Government agencies in these latter countries systematically record and analyze doctoral trends not only within the country, but also across various countries to stay globally competitive). Further data on doctoral and research trends in the Indian context is outdated in comparison to several other nations such as the USA, the UK, Japan, etc which update their information regularly.

The primary source of data on Indian higher education, particularly on doctoral education is the University Grants Commission (UGC), which publishes the number of PhDs awarded yearly in its annual report for broad disciplines such as Arts, Science, Engineering, Medicine, Agriculture, Education, Law and Commerce. However several problems exist with this data:

1. ***Older UGC reports are non-accessible since the UGC has removed the older reports from circulation. Hence, an analysis of trends, which requires data for several succeeding years, is unavailable.***

2. ***Information for the more recent years from 2006 onwards is as yet unavailable as the UGC is yet to compile information for these years. Hence, the information available is out-dated.***

3. ***Questions regarding reliability of numbers reported by the UGC arise due to lack of meta-details such as regional and institutional distribution, gender-wise break-up and sub-disciplinary break - up of data. Such data is also important for secondary level analyses, cross tabulations and Verification.***

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A few other agencies also provide some limited information regarding doctoral degrees awarded in the country. For example, the Association of Indian Universities (AIU) publishes a monthly record of PhDs awarded in Indian universities. It does not, however, compile this information into monthly or annual reports. Further, it may not contain a record of all PhDs awarded at particular universities as it depends on the notifications it receives from universities. Other sources such as the Department of Science and Technology (DST), Indian Council of Agricultural Research (ICAR)[6], etc., publish data on PhDs awarded in certain specific disciplines (e.g., DST on Science and Engineering; ICAR on Agriculture, etc). Further, like the UGC data, the DST data also does not provide a single point reference for the PhDs. awarded, thereby raising issues of validity and reliability of data. There is a lack of essential meta-details that are required for a comprehensive analysis, and finally, the information available is outdated.

Table 4: DST Data on Science and Engineering

Discipline	1996-96	1997-98	1998-99	1999-2000	2000-01
Science (Total)	4751 (94.1)	5065 (86.3)	4998 (87.8)	8539 (92.2)	8392 (91.9)
Natural Science	3498 (69.3)	3894 (64.4)	3896 (68.4)	3885 (41.9)	3734 (40.9)
Agriculture	1120 (22.2)	971 (18.8)	907 (15.9)	4426 (47.8)	4441 (48.6)
Medicine	133 (2.6)	200 (3.1)	195 (3.4)	228 (2.5)	217 (2.4)
Engineering	298 (5.9)	629 (13.7)	696 (12.2)	723 (7.8)	739 (8.1)
Science & Engg (Total)	5049 (100)	5694 (100)	5694 (100)	9262 (100)	9131 (100)

Table 5: ICAR Data on Agriculture

Year	UGC data	ICAR-CCSHAU data	INFLIBNET data
1998	907	65	25
1999	4426	37	141
2000	4441	545	272
2001	948	547	87
2002	1195	692	234
2003	1142	556	216
2004	1020	525	339
2005	1299	619	158
2006		542	
2007		178	
Total		1868	

[6] *ICAR has established the Krishiprabha e-theses database in Agriculture with the help of CCS Haryana Agricultural University*

Presently one other source involved in the collection and compilation of PhD data is Vidyanidhi – a digital library initiative undertaken by the Mysore University. The database, which was started in 2000 currently contains information from about 4 Indian universities with 1,00,000 PhD records. Metadata for the records are also available with the database. Attempts at analyzing the research and doctoral capacity of the country are further hampered by the lack of uniformity in the limited data available. An example of such discrepancies in data has been reported by Rai & Kumar (2004).

Table 6: Discrepancies in PhD. Data Reported by Four National Agencies for Science

Year	UGC	AICTE	DST	CSIR
1990	2976			
1991	3002	2950	2950	3002
1992	3226	3386		26
1993	3386	3505	3386	3386
1994	3467	3467	3467	3467
1995	3657	3657		3657
1996	3861	3861	3861	3861
1997	3498		3498	3498
1998	3894		3894	3798
1999	3896			

Source: Rai & Kumar, 2004

The authors have stated that such discrepancies in fundamentally important national data create a doubt in the minds of authorities responsible for human power planning and S&T planning in the country.

Creation of a Database of PhDs Awarded in the Country from 1998 -2007 and Analysis of Trends in Higher Education

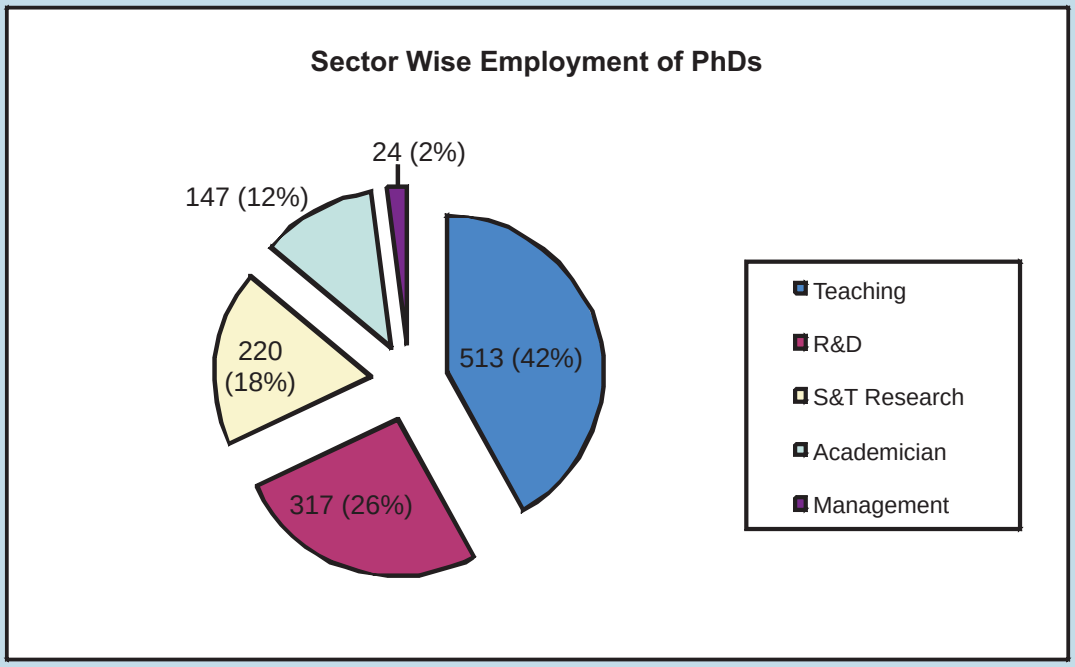
The link between investment in academic research and development and a nation's economic productivity is well established. Investment in research can only produce meaningful results when there is a balanced investment in and planning of research and education. This calls for a systematic study of the academic research and doctoral education fields. While several countries have understood the importance of studying the trends in their higher education and R&D sectors, India is yet to respond to this challenge. Creation of a

comprehensive national database of research personnel and a national study of disciplinary trends in PhDs is largely absent.

Few institutions and researchers have attempted to conduct a limited analysis of the doctoral education and research scenario in the country. For example, several previous studies have reported that the Natural Sciences and Humanities receive the highest share of PhDs. Together they account for three-fourths of the total number of PhDs. (Rai & Kumar, 2004; Khandria, 2004; Jayaram, N, 2008; UGC Annual Report 2005-06)

A study by the National Science and Technology Information Management System (NSTMIS) of DST (2007) has noted that doctorates and post-doctorates are 'key inputs' for science-based innovations. Based on their survey[7], they have provided a distribution of Doctorates according to their present employment status.

Graph 6: Sector-wise Employment of PhD Holders in 2005



Source: NSTMIS Survey, 2005)

In another study, conducted by NCAER for Science and Non-science doctorates (National Science Survey, 2004), the following details were reported with respect to occupations.

[7] *Pilot Study On The Career Profile And Professional Achievement Of The PhDs In Science From Selected Universities/Institutes Of India. (2007). NSTMIS*

Table 7: Distribution of PhD holders according to occupations in 2004 Occupation

Occupation	Science PhDs (in percentage)	Non-science PhDs
Professional, Technical and Related	48.5	54.1
Administrative, executive and managerial	14.1	6.9
Clerical	1.6	1.3
Services	5.7	6.1
Farming, Fishing and related	0	3.1
Production, transport Operators and labourers	1.7	0.6
Non-agricult ural workers	0	0.2
Workers not classified by occupation	14.5	17.1
Housewives	9.1	6.6
Not Employed	4.8	4.0
Total	100	100

Other studies have reported that the growth in PhDs across all disciplines, and particularly in Agriculture, Education and Commerce, has witnessed a sharp increase. Rai and Kumar (2004) have also reported a dramatic growth in the production of doctorates in Engineering from 1997-1998. The authors have also shown that the annual production of PhDs is likely to increase in the future. Through mathematical modeling they have predicted that the Arts, Commerce, Education, Engineering/Technology and Medicine fields will witness further increases in production of PhDs while the proportion of PhDs awarded in Agriculture, Veterinary Science and Science is likely to drop. The rate of growth of PhDs in Science may significantly drop (despite the annual growth in numbers predicted). A summary of their projection of expected percentage and size of PhDs. in various disciplines by the year 2010 is given below.

Table 8: Projected Percentage and Size of PhDs in Various Disciplines in 2010

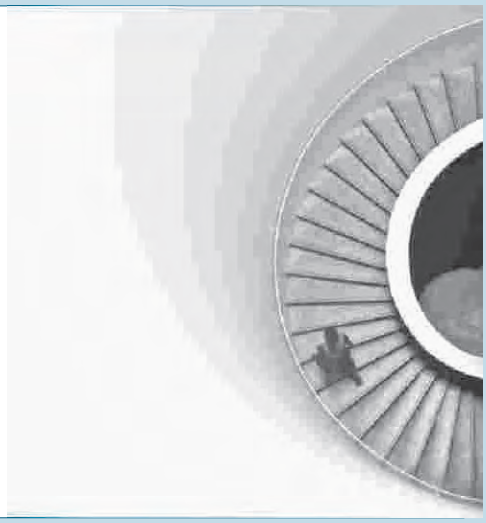
Subject	Ag	Arts	Com	Ed	Engg	Law	Med	Science	V. Sc
%	7	41	6	3	4	1	2	35	1

While the data presented in the reports by several researchers mentioned above have presented valuable findings for the country's administrators and policy makers, these reports are also limited in scope due to the limitations in data, reliance on older statistics, lack of single point references, absence of gender and regional analysis and limited disciplines analyzed.

Going beyond these reports, the present study by the National Institute of Advanced Studies (NIAS), in collaboration with INFLIBNET and Tata Consultancy Services (TCS), has attempted to address the issues of non-availability and non-reliability of data by creating a comprehensive database of PhDs awarded in the country, and conducting an analysis that ranges from the micro to the macro levels.

Data from INFLIBNET, which contains over 2,00,000 records from over 238 universities and research institutes in India were subject to several layers of analysis. The extensive analysis was facilitated by the availability of individual records of PhDs awarded with a wide range of bibliographic data such as author's name, year of award, title, subject, discipline, thesis advisor, sex of the candidate, university and department that awarded the degree and location of the university. The availability of individual records has also ensured the reliability and validity of the data analyzed. The meta-details that were available for individual records have allowed the authors to reorder the data by checking for possible duplications and sorting entries appropriately into relevant categories. This has been especially relevant for PhDs of interdisciplinary nature. Data of interdisciplinary nature is often difficult to classify into broad disciplines such as Science, Arts, Agriculture, Medicine or Engineering. For data of this nature it was extremely useful to have meta-data regarding thesis title, key words and department under which research was carried out, since it gives a better idea about the predominant area of interest of the study. The data collected for the project has also facilitated the possibility of higher level analyses such as examining the disciplinary, gender and regional distribution of PhDs for the first time. This has not been possible so far because only aggregate numbers were reported by the UGC and other sources.

The methodology of the study and an extensive analysis of the data are presented in the following chapters.



METHODOLOGY

Present Study

The present study, **'Trends in Higher Education – Creation and Analysis of Database of PhDs in India'** is a collaborative project between NIAS and INFLIBNET, to collect and update information on the number and characteristics of individuals receiving doctoral degrees in the disciplines of Natural Science, Engineering, Medicine, Social Science and Humanities. The aim was to study and interpret the characteristics and trends in doctorate degrees. This information will be crucial for the government, both national and state, and human power planners, to harness and develop India's capacities to the fullest, and make the country globally competitive and productive.

The objectives of the study were:

- To assess characteristics of doctorate education and degrees obtained by individuals in various disciplines across 10 years (1998-2007).
- To undertake regional, discipline-wise and gender-wise analysis of the doctoral degrees awarded.
- To study the distribution of doctoral degrees across different disciplines in different universities over specific periods of time.
- To explain the rise or drop of doctorates awarded in select universities during specific periods.
- To explain the rise or drop in the doctorates awarded in specific disciplines during particular periods.

Methodology

The main source of data for the project was made available through the Information and Library Network Centre (INFLIBNET). INFLIBNET is an Inter-University Centre (IUC) set up by the UGC for sharing of library and information resources and services among universities and research institutions in the country.

Creation of a database of PhD. holders in the country through INFLIBNET was conceptualized as an integral part of the study because of the lack of information and discrepancies in reported numbers by other sources. In order to create this database of PhD holders, with access to meta-data for individual PhD. holders, INFLIBNET has tied up with 238 universities in the country to obtain theses information through reliable sources in the university. Presently INFLIBNET has 2, 20,206 records.

Of the total data available with INFLIBNET our sample covered 39,327 PhDs awarded from 1998 to 2007. The sample represented 34.4 percent of the data reported by the UGC up to 2005[1].

Despite the large database created by INFLIBNET, data for some important areas of study such as Engineering, Medicine and Agriculture were less represented on the INFLIBNET database. Hence, efforts were made to strengthen the data for these domains by contacting All India Council for Technical Education (AICTE), Medical Council of India (MCI) and Indian Council for Agricultural Research (ICAR). In addition individual premier institutions such as the IITs and IISc, NITs, and other technical, agricultural and non-technical universities were also contacted and additional data was obtained to fill the gaps.

Additional data for Agriculture was obtained through the Krishiprabha database developed by CCS-Haryana Agricultural University, commissioned by ICAR, Indian Agricultural Research Institute (IARI) and University of Agricultural Sciences (UAS) Bangalore. Thus, our sample size in Agriculture was increased from 20.7 percent of UGC data to 31.2 percent[2] with the help of these institutions

For Engineering, data from IITs Mumbai, Guwhati, Kharagpur, Delhi, and Kanpur, NITs Durgapur, Rourkela and Suratkal, Visveshwaraiya Technological University (VTU) Karnataka, and Vishveshwaraiya National Institute of Technology (VNIT) Nagpur, were obtained to fill in the gaps in Engineering data. Therefore, for Engineering also, it has been possible to increase our sample size from 26.3 percent of UGC data to 41 percent[2], with the help of these sources. Data from IIT Madras and IISc were unavailable even after repeated efforts at contacting them. The large volume of PhD records for older institutions may perhaps be a factor that increases the complexity of digitizing and linking the data to larger national databases.

[1] *Since comparative data from secondary sources such as UGC was available only up to 2005, the percentage is calculated using our data up to 2005 only.*

[2] *The percentages have been calculated only up to 2005 because of non-availability of comparative data for later years.*

The total number of PhD records analyzed for a period of 10 years (from 1998-2007) was thus increased to 45,561. The total sample now represented 39.9 percent of the total number of PhDs reported by UGC up to 20052. The number of PhD degree granting institutions covered in our sample is 216, which is 42.3 percent of the total number of universities and research institutions in the country (i.e. of 511 institutions).

Table 9: Comparison of NIAS- INFLIBNET- TCS PhD data with secondary sources.

Year	Agriculture			Arts			Commerce		
	NIAS	REF	Percent	NIAS	REF	Percent	NIAS	REF	Percent
1998	152	907	16.6	611	4467	13.7	38	541	7.0
1999	234	4426	5.3	1837	4641	39.6	135	517	26.1
2000	768	4441	17.3	2300	4902	46.9	138	621	22.2
2001	592	948	62.4	922	5054	18.2	41	728	5.6
2002	809	1195	67.7	2071	5726	36.25	167	857	19.5
2003	745	1142	65.2	2297	8230	27.9	249	1096	22.7
2004	743	1020	72.8	2604	8202	31.7	195	1010	19.3
2005	752	1299	57.9	1471	10310	14.3	129	-	
Sub-total	4795	15378	31.2	14113	51532	27.4	1092	*5370	*17.9
2006	724			2503			171		
2007	352			2364			176		
Total	5871			18980			1439		
Year	**Science**			****Medicine**			**Engineering**		
	NIAS	REF	Percent	NIAS	REF	Percent	NIAS	REF	Percent
1998	535	4016	13.3	241	200		255	744	34.3
1999	1292	3997	32.3	301	195		330	696	47.4
2000	1548	3837	40.3	355	221		373	778	47.9
2001	668	4065	16.4	277	219		190	734	25.9
2002	1241	4650	26.7	378	243		326	779	41.8
2003	1525	5728	26.6	405	317		421	882	47.7
2004	1328	5681	23.4	420	456		352	968	36.4
2005	888	5625	15.9	363	438		473	1058	44.7
Sub-total	9025	37599	24.0	2740	2289		2720	6639	41.0
2006	1106			397			516		
2007	1318			161			685		
Total	11449			3298			3921		

**Calculated with data up to 2004 only*
*** Percentage has not been calculated for Medicine as our data exceeds the numbers reported by the sources referred*
Source: 1. For 1998-2000: DST Data Book (2002) and India Stats.com
2. For 2001-2002: Prasad, L. (2004). PhD profile An Insight. NSTMIS.

The table 9 shows a comparison of the data sampled and the actual number of PhDs awarded across various disciplines. The data sampled ranges from as high as 41 percent in Engineering to as low as 17.9 percent in Commerce. In Medicine, the study data shows the number of PhDs awarded to be higher than that reported by the reference sources.

The sourced data was checked for duplications and errors, cleaned and reordered wherever necessary or reclassified into appropriate domains.

The authors would like to acknowledge at the outset that the data presented in the study is limited, and the analysis that follows has been restricted to interpretation of available data, rather than applied to predict general trends in the population.

Analysis Plan

The total data obtained has been analyzed as follows:

1. The total PhD production in the country has been analyzed
2. Annual trends in growth and decline of numbers have been analyzed
3. A comparison of PhDs awarded to men and women has been made
4. Discipline wise comparison of the total number of PhDs awarded has been made
5. A year-wise growth/fall in PhDs under individual disciplines has been studied
6. A gender-wise comparison of total PhDs awarded for each discipline has been made
7. An analysis of the sub-disciplines of major disciplines has been made
8. A zone and state wise comparison of total PhDs as well as under individual disciplines has been made
9. A comparison of trends within Science (i.e. Agriculture, Medicine, Engineering and Natural Science) has been made
10. A comparison of trends within Arts (i.e. Social Science and Humanities) has been made
11. Finally, a comparison between Arts and Science has been undertaken

The Statistical Package for Social Sciences (SPSS) and MS Excel software were utilized to order, group, calculate frequencies and percentages, cross-tabulations, and to develop graphs and tables.

ANALYSIS

I TRENDS IN TOTAL NUMBER OF PhDs AWARDED

1. A year-wise comparison of total number of PhDs awarded from 1998-2007

Table 1: Total number of PhDs awarded from 1998-2007* ?

Year	Gender		Total
	Female	Male	
1998	644	1258	1902
	33.9%	66.1%	100.0%
1999	1426	2799	4225
	33.8%	66.2%	100.0%
2000	1854	3672	5526
	33.6%	66.4%	100.0%
2001	880	1845	2725
	32.3%	67.7%	100.0%
2002	1711	3352	5063
	33.8%	66.2%	100.0%
2003	1769	3958	5727
	30.9%	69.1%	100.0%
2004	1949	3729	5678
	34.3%	65.7%	100.0%
2005	1325	2810	4135
	32.0%	68.0%	100.0%
2006	1946	3522	5468
	35.6%	64.4%	100.0%
2007	1793	3319	5112
	35.1%	64.9%	100.0%
Total	15297	30264	45561
	33.6%	66.4%	100.0%

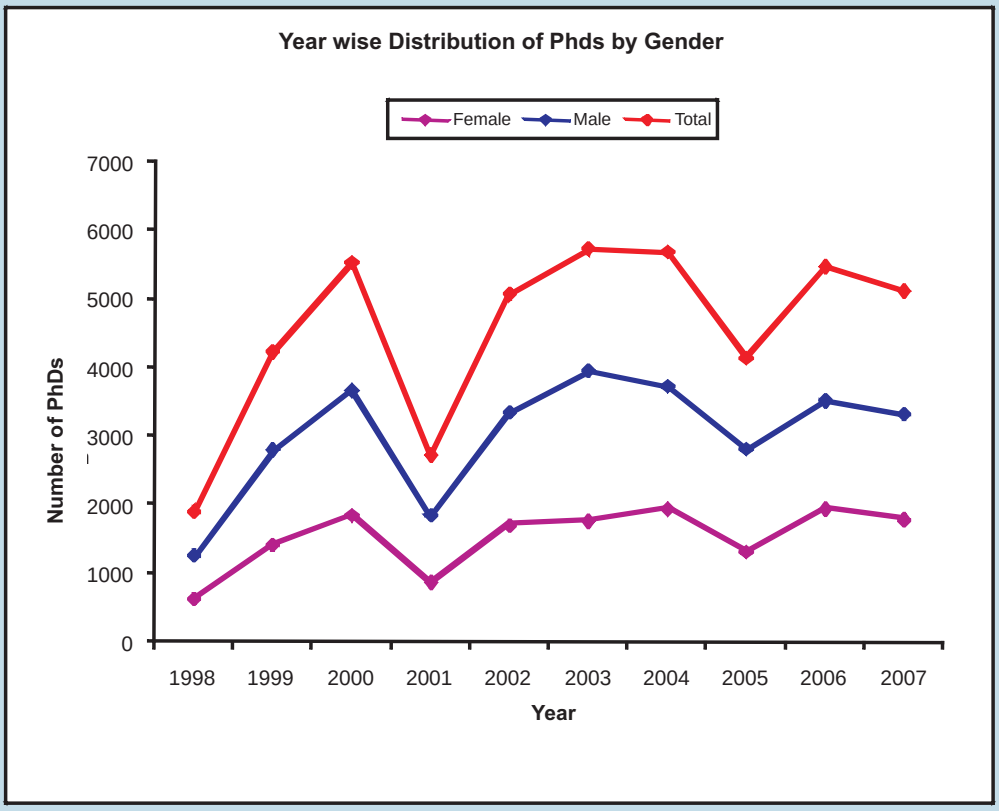
**The data represents 39.9 percent of total PhDs awarded in the country, calculated up to 2005. Comparative data for 2006 and 2007 were unavailable.*

Table 1 shows the number of PhDs awarded for 10 years, from 1998-2007. The total number of PhDs awarded during the period was 45,561. The maximum number of PhDs has been awarded in the year 2003 (5727 PhDs) and the least number of PhDs was awarded in the year 1998 (1902 PhDs).

From Graph 1 (below) it can be observed that the total number of PhDs awarded has increased between 1998 and 2000 (from 1902 to 5526), followed by a steep reduction in the number of PhDs in 2001 (2725). From 2001, the number of PhDs has again steadily increased up to 2003, followed by a marginal dip in the number of PhDs in 2004 and a larger fall in numbers in 2005. The number of PhDs has increased in 2006, followed by a slight fall in 2007. **The large fall in numbers seen in 2001 is reflected across all disciplines. This may thus be a result of a problem with the database and errors that arose in data collection due to the introduction of electronic format for collection of data in 2001. However, the dip for 2005 and 2007 are not reflected uniformly across all disciplines. Hence the cause for the fluctuation needs to be analyzed in detail.**

While the number of PhDs awarded has doubled from 1998 to 2007 data on enrollments still show that the numbers who enter at the doctoral education level is still low (only 0.25 of the total numbers enrolled at the graduate level enroll at the PhD level). Further the completion rate is less than 50 percent. These trends indicate a need to analyze the process that leads to the award of PhDs in the country. More importantly there is an urgent need to analyze the quality of PhDs being produced in the country.

Graph 1: Year – wise Distribution of PhDs by Gender*



** The data represents 39.9 percent of total PhDs awarded in the country, calculated up to 2005. Comparative data for 2006 and 2007 were unavailable.*

2. Gender-related comparison of total number of PhDs awarded over the decade

With respect to gender, of the total number of PhDs awarded, 66.4 per cent of the PhDs (i.e. 30,264) has been obtained by men and only 33.6 per cent of the PhDs (15,297) has been obtained by women (Refer Table 1). Women's enrollment in higher education has grown from 10 percent in the 1950s to 38 percent as of 2006. At the PhD level, there has been a growth in women's enrollment numbers, from 30.05 percent in 1998-99 to 38.5 percent in 2003-2004. However the percentage of enrollments drops from 40 percent at the graduate level and 42 percent at the post-graduate level to 38 percent at the Research level[1]. Further, our data indicates that women comprise only 33.6 percent of the total PhD holders in the country. While the signs of growth are encouraging, and have resulted from special attention given to women's education, they also reveal that a large gap still exists among the genders with respect to participation in higher education, particularly at the research level.

Men, in general compose more than half of the total number of PhDs awarded annually across the 10 years. The ratio of the number of PhDs awarded to men and women has also largely remained constant (Refer Table 1 above).

Similar few differences can be observed for both women and men with regard to the trends PhDs awarded across the 10 years (Refer Graph 1). There has been an increase in the number of PhDs obtained from 1998 to 2001, followed by a sharp decrease in the number of PhDs obtained in 2001; from 2001 to 2003there has been a steady increase in the number of PhDs for men and women. While men have recorded a dip in numbers in 2004, for women there has been an increase in numbers in 2004. However, from 2005 up to 2007, trends for both groups have been similar.

The highest number of PhDs for men was awarded in 2003 (3958, which is 13.1 percent of the total number of PhDs awarded across the 10 years to men). The highest number of PhDs for women was awarded in 2004 (1949, which 12.7 percent of the total PhDs awarded to women across the 10 years). (Refer appendix I, table 1 for the percentage of PhDs awarded for each year as a proportion of the total PhDs awarded to men and women individually).

[1] *Source: Indiastats.com. Accessed on 4 Feb, 2010, 2:00 pm.*

3. Year-wise comparison of PhDs awarded across Disciplines from 1998-2007

Table 2: Discipline-wise Distribution of PhDs Across 10 years*

	Agriculture	Natural Science	Engineering & Technology	Medicine	Social Science	?General Science	Humanities	?Commerce	Total
1998	152	535	255	241	246	70	365	38	1902
	8.0%	28.1%	13.4%	12.7%	12.9%	3.7%	19.2%	2.0%	100.0%
1999	234	1292	330	301	843	96	994	135	4225
	5.5%	30.6%	7.8%	7.1%	20.0%	2.3%	23.5%	3.2%	100.0%
2000	768	1548	373	355	872	44	1428	138	5526
	13.9%	28.0%	6.7%	6.4%	15.8%	.8%	25.8%	2.5%	100.0%
2001	592	668	190	277	357	35	565	41	2725
	21.7%	24.5%	7.0%	10.2%	13.1%	1.3%	20.7%	1.5%	100.0%
2002	809	1241	326	378	854	71	1217	167	5063
	16.0%	24.5%	6.4%	7.5%	16.9%	1.4%	24.0%	3.3%	100.0%
2003	745	1525	421	405	1005	85	1292	249	5727
	13.0%	26.6%	7.4%	7.1%	17.5%	1.5%	22.6%	4.3%	100.0%
2004	743	1328	352	420	972	36	1632	195	5678
	13.1%	23.4%	6.2%	7.4%	17.1%	.6%	28.7%	3.4%	100.0%
2005	752	888	473	363	770	59	701	129	4135
	18.2%	21.5%	11.4%	8.8%	18.6%	1.4%	17.0%	3.1%	100.0%
2006	724	1106	516	397	1112	51	1391	171	5468
	13.2%	20.2%	9.4%	7.3%	20.3%	.9%	25.4%	3.1%	100.0%
2007	352	1318	685	161	979	56	1385	176	5112
	6.9%	25.8%	13.4%	3.1%	19.2%	1.1%	27.1%	3.4%	100.0%
Total	5871	11449	3921	3298	8010	603	10970	1439	45561
	12.9%	25.1%	8.6%	7.2%	17.6%	1.3%	24.1%	3.2%	100.0%

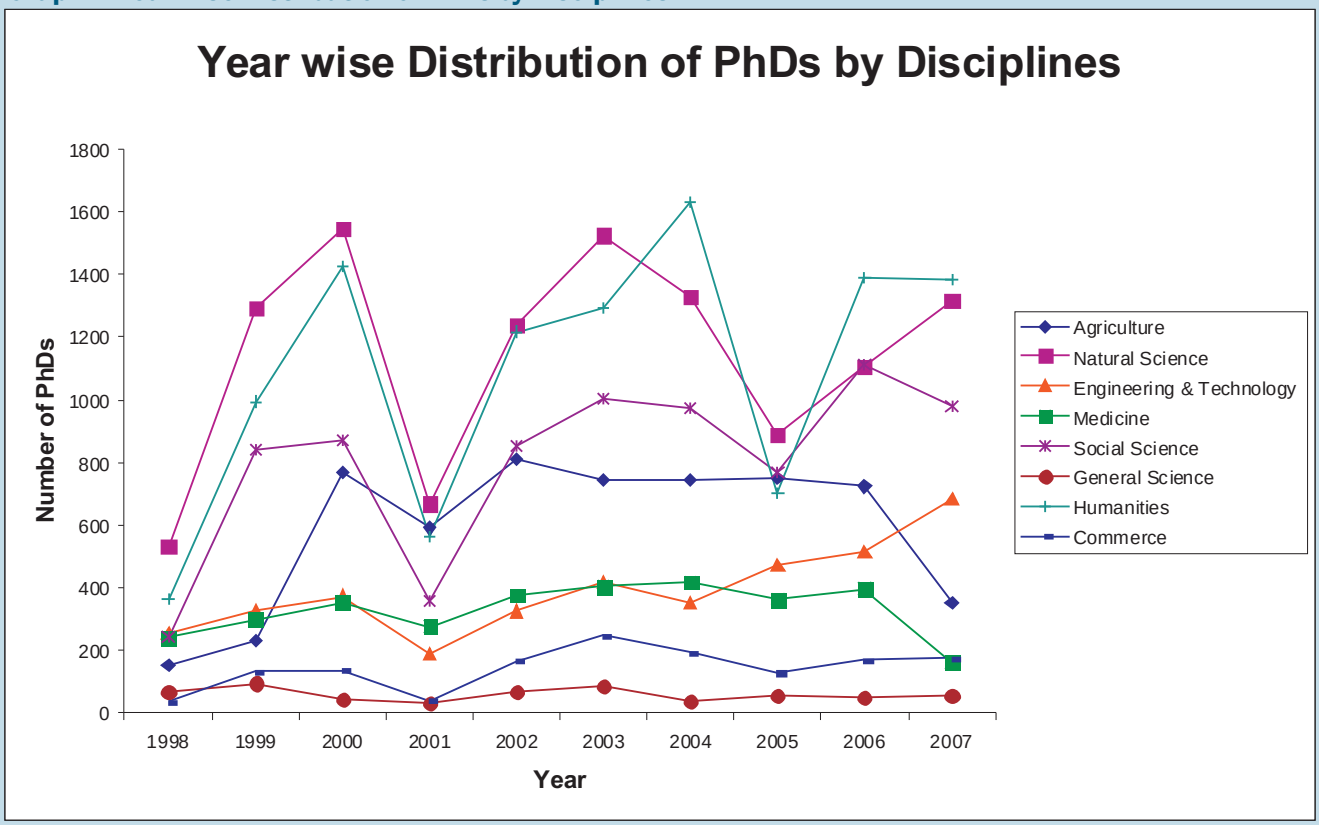
From Table 2 it can be seen that the highest number of PhDs between 1998 and 2007 has been awarded in the Natural Science (11,449 PhDs which is 25.1 percent of the total number of PhDs) followed by Humanities (10,970, which is 24.1 percent of the total number of PhDs). The number of PhDs awarded under Social Science is 8010 (which is 17.6 percent of the total PhDs).

** The data represents 39.9 percent of total PhDs awarded in the country, calculated up to 2005. Comparative data for 2006 and 2007 were unavailable.*

◊ Due to the small sample size of data available for General Science and Commerce, the disciplines have not been considered for further analysis in the report.

Other disciplines such as Agriculture (12.9 percent of the total PhDs), Engineering (8.6 percent of total PhDs) and Medicine (7.2 percent of total PhDs), which are important sectors of the economy show a lower performance in comparison. This maybe due to Engineering and Medicine being professional courses with lucrative careers options and opportunities to earn higher monetary compensation through private practice and consultancy compared to research in these disciplines. However, if India is to remain competitive in cutting edge technological, medical and agricultural innovations, research in these disciplines can hardly be ignored. There is a need for a critical number of researchers in these disciplines also.

Graph 2: Year wise Distribution of PhDs by Disciplines*



From Graph 2, it can be observed that disciplines that have consistently produced a higher number of PhDs across the 10 years are Natural Science, Humanities, Social Science and Agriculture. Among these, Natural Sciences recorded a higher number of PhDs during the initial period (from 1998 – 2003), after which Humanities has been taking the lead. The growth in Agriculture is seen from 2000, when it has steadily increased and overtaken other disciplines such as Engineering & Technology and Medicine. However the growth in Agriculture has tapered off towards the end of the period, with the numbers falling below Engineering & Technology in 2007. Disciplines that have consistently received lower number of PhDs are Engineering and Technology, Medicine, Commerce and General Science. Engineering and Technology has shown a growth from 2001 to 2007 (with a slight decline in 2004 only).

** The data represents 39.9 percent of the total data reported by secondary sources such as UGC, DST, Indiastats.com, etc, up to 2005. Data up to 2005 has only been considered as there is no comparative numbers for the later years reported by these sources*

There could be several reasons for these trends. 1. The professional nature of the courses and better career options soon after graduation and post-graduation degrees in the field compared to Natural Sciences, Humanities and Social Sciences could be a factor leading to lower number of students opting for PhDs in these fields; 2. The high cost of Engineering and medical education in India could be a deterrent for further studies in the field. 3. Further, the fewer number of universities or research institutes offering research programmes in these fields may be a possible reason for lower production of PhDs. 4. More students opting to take up higher studies in these disciplines abroad could be a possible reason. As of 2002, India has become the largest exporter of graduate students to the US, overtaking China. Between 1985 and 2007, Indians earned more than 18,700 (an average of 850 PhDs per year) PhDs in Science and Engineering in the US. They have also earned the largest share of PhDs awarded to foreign nationals in the US in Computer Science (Science & Engineering Indicators, 2008). However, with advances in Engineering & Technology and Medical fields taking place at a rapid pace, it is important for India to have adequate researchers in the field if India needs to be an integral part of the new global order.

II. DISCIPLINARY TRENDS IN PhDs AWARDED ACROSS THE 10 YEARS

A. Agriculture

The importance of agriculture for India's economy cannot be underscored enough. Though accounting for only 21 percent of India's GDP, the sector has been an important segment that has contributed to India's success in achieving self-sufficiency in food supply, generating large scale rural employment and reducing rural poverty to 26.3 percent towards the beginning of the 21st century. However in the recent years, there has been a slowdown in agricultural growth and production. Among other reasons, a World Bank report has indicated the poor composition of public expenditure, with its singular focus on agricultural subsidies and apathy towards other important productivity-enhancing investments such as agricultural research, extension and education of the rural population as reasons for this slow down.

In the light of these trends Nanda et all (2005) have called for a re-examination of trends in agriculture and agricultural education in India. It is important to re-examine agricultural knowledge and manpower availability to ensure the survival of the industry which is pivotal to assuring India's growth and equitable development.

An analysis of the doctorates in Agriculture is presented below.

1. A Year-wise Comparison of the Number of PhDs Awarded in Agriculture over the Decade

Table 3: Year-wise Distribution of PhDs Awarded in Agriculture Across 10 Years*

Year	Female	Male	Total
1998	31	121	152
	20.4%	79.6%	100.0%
1999	47	187	234
	20.1%	79.9%	100.0%
2000	172	596	768
	22.4%	77.6%	100.0%
2001	132	460	592
	22.3%	77.7%	100.0%
2002	182	627	809
	22.5%	77.5%	100.0%
2003	167	578	745
	22.4%	77.6%	100.0%
2004	214	529	743
	28.8%	71.2%	100.0%
2005	186	566	752
	24.7%	75.3%	100.0%
2006	186	538	724
	25.7%	74.3%	100.0%
2007	99	253	352
	28.1%	71.9%	100.0%
Total	1416	4455	5871
	24.1%	75.9%	100.0%

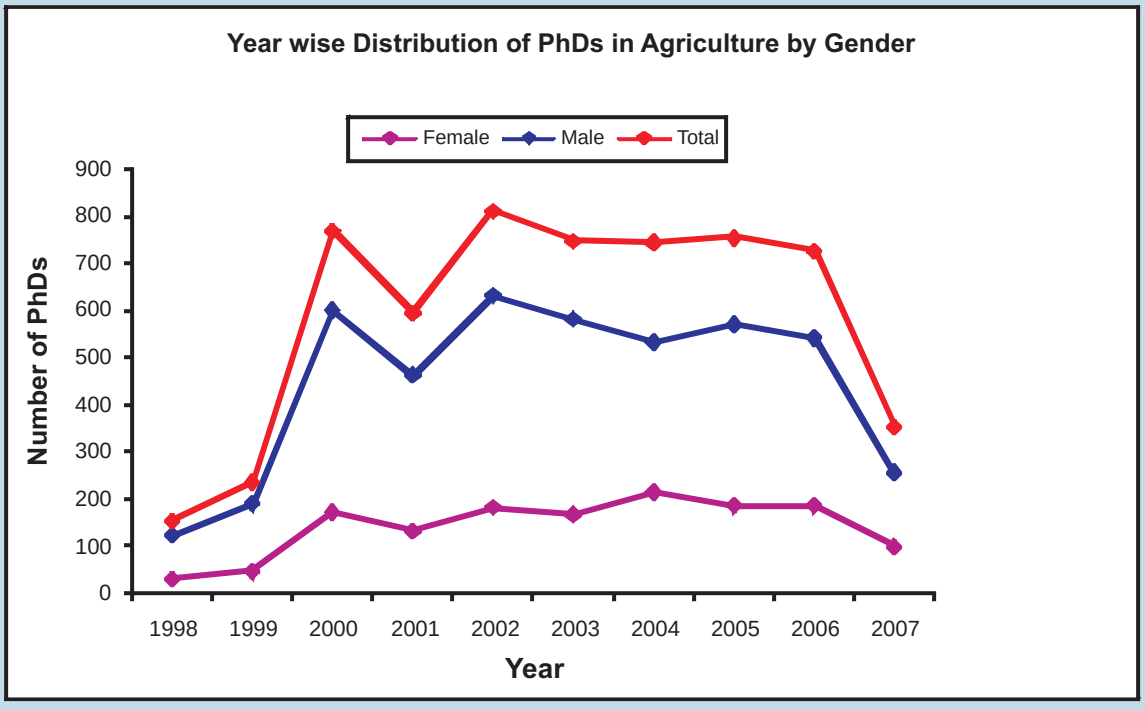
Table 3 shows the year-wise breakup of PhDs obtained in Agriculture across the ten years. The total number of PhDs. recorded in Agriculture for the 10 years is 5871. The lowest number of PhDs awarded in Agriculture across the ten years has been in the year 1998 (152, accounting for 2.6 percent of the PhDs awarded in 10 years) and the highest has been in the year 2002 (809, accounting for 13.8 percent of the total PhDs in 10 years). (Refer appendix I, table 3 for the percentage of PhDs awarded for each year as a proportion of the total PhDs). There has been a rapid growth in the number of PhDs from 152 in 1998 to 768 in 2000. Despite a small drop in numbers in 2001, there has been a further increase in numbers in 2002 (809 PhDs) after which there was a slow down in number of PhDs up to 2006. The year 2007 has witnessed a sharp fall in numbers with the graph coming close to the original period (352 PhDs in 2007). The growth and fall pattern may possibly reflect the declining emphasis on Agriculture in government policy among other reasons, as well as a decline in its share of the GDP.

** The data represents 31.2 percent of total PhDs awarded in the country, calculated up to 2005. Comparative data for 2006 and 2007 were unavailable.*

Further Nanda et al (2005) have stated that with greater demand for technical skills (60 percent) compared to soft skills (40 percent) by agro-industries, more number of students have found it profitable in the recent years to seek jobs with lower qualifications (such as Bachelors and Masters). Trends in Agricultural employment up to 2020, projected by the authors have shown that the private sector has increasingly become the largest employer in the agricultural sector, while the share of the academic sector has declined (refer appendix II, graph 1). With respect to supply and demand of agricultural manpower, their projection shows a tapering supply-demand gap towards 2020, from a gap of 27.1 percent in 2001 to a minimum of 5.93 percent in 2019 (refer appendix II, graph 2). The authors state that in addition to a modest growth in the government sectors that will provide employment to agricultural students, the private sector employers such as fertilizer, pesticide, seeds, agricultural machinery and processing industries will take-over the position of the government sector as major employers of agricultural human resource by 2007 and would account for nearly 42.1 per cent of employment by 2020 as against 24.6 per cent in the government sector. They correspondingly project a decrease in drop-out rates in Agriculture due to increased students' interest on account of better employability.

However, it is important for policy planners to keep in mind the need for qualified technical manpower with research capability which will be able to face the new challenges that will affect agricultural production and in turn India's economy. The need is for a research personnel base which will be able to engage with new areas of research in agriculture that can address the changing paradigm brought by such events as the as WTO regulations, climate change, population growth, new plant pests and diseases, etc.

Graph 3: Year wise Distribution of PhDs in Agriculture by gender*



** The data represents 31.2 percent of total PhDs awarded in the country, calculated up to 2005. Comparative data for 2006 and 2007 were unavailable.*

2. Gender-related Comparison of theTotal Number of PhDs Awarded in Agriculture

The difference in the number of PhDs. for men and women in Agriculture across 10 years is 3039. The number of women who have obtained a PhD. in Agriculture across the 10 years is 1416, while the number of men who have obtained a PhD. during the same period is 4455. In terms of percentages, 24.1percent of the total PhDs in Agriculture between 1998 to 2007 has been awarded to women while 75.9percent of the PhDs has been awarded to men.

Looking at the year-wise production of PhDs in Agriculture, it can be seen from the graph that the number of PhDs in Agriculture for women has been constantly lower than that for men. While the data for women shows that there has not been a substantial variation in the number of PhDs awarded for women across the years (the lowest number of PhDs being in the year 1998 with 31 PhDs, and the highest being in the year 2004, with 214 PhDs), for men, there is a substantial difference in the number of PhDs awarded across the years. The lowest number of PhDs was awarded in 1998 with 121 men receiving a PhD. in Agriculture. The highest number of PhDs has been awarded in 2002 with 627 men receiving PhDs. (Refer appendix I, table 3 for the percentage of PhDs awarded for each year as a proportion of the total PhDs awarded to men and women individually.) The trend indicates a sharp growth in the number of PhDs from 1998 to 2000 for men. From 2001 to 2006, the numbers have largely fluctuated around the 500 mark and there has been a sharp decline to 253 PhDs in 2007. For women the trend shows continuous but small yearly fluctuation in numbers with the numbers staying close to 180 for most years.

3. Sub-disciplinary Trends in Agriculture

A further analysis of the sub-disciplines in Agriculture that have received the highest share of PhDs shows Plant related sciences to be the most popular field of study in Agriculture (having 2900 PhDs, which amounts to 49.4 percent of total). Animal related sciences such as Veterinary Science, Dairy Science, Fisheries and Aqua-Culture, etc have received the second largest number of PhDs (1236, accounting for 21.1 percent of the total). (Refer appendix I, table 4 for the percentage of PhDs awarded for each sub-discipline as a proportion of the total PhDs in Agriculture). Plant and animal related fields, which form the main groups of study under Agriculture, comprise 70 percent of the total number of PhDs.

Table 4: Year-wise Distribution of PhDs Awarded in Sub-disciplines of Agriculture*

Sub-disciplines	Female	Male	Total
Agriculture	26	95	121
	21.5%	78.5%	100.0%
Agro - Chemistry	72	105	177
	40.7%	59.3%	100.0%
Plant Studies	635	2265	2900
	21.9%	78.1%	100.0%
Animal Studies	227	1009	1236
	18.4%	81.6%	100.0%
Agro - Social Sciences	170	362	532
	32.0%	68.0%	100.0%
Agro - Engineering and Technology	187	332	519
	36.0%	64.0%	100.0%
Agro - Genetics and Microbiology	80	207	287
	27.9%	72.1%	100.0%
Others	19	80	99
	19.19%	80.80%	100.0%
Total	1416	4455	5871
	24.1%	75.9%	100.0%

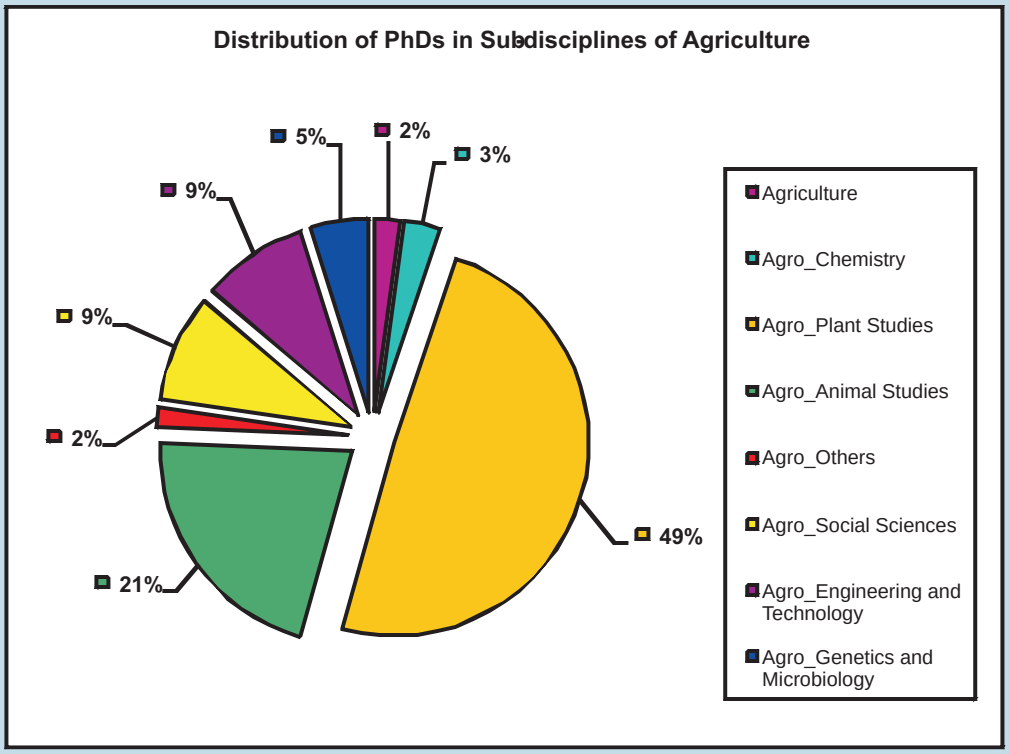
Fields that have received the least numbers include Environmental Studies, Agro-Physics and Agro-Chemistry. This may be due to the fact that research in interdisciplinary areas such as these is of recent origin, and universities and institutes may not yet be fully equipped with administrative facilities, faculty specializations or processes for interdisciplinary collaborations across departments. Similarly, universities and research institutes may not yet have provisions for registration of PhDs that are interdisciplinary in nature, as most university departments in the country are mainly single-discipline. However, the advent of PhDs in these disciplines indicates a need to develop mechanisms for research that draws from several disciplines. These provisions are important as interdisciplinary studies may provide a holistic understanding of real world problems. Therefore, developing alternate systems for management of interdisciplinary studies such as by setting up of 'Schools' or 'Centres' for interdisciplinary areas, of identifying a key Mother discipline, that can subsume several different sub-disciplines, etc. may be desirable.

Men and women have received the highest number of PhDs in Plant Related fields (2,265 PhDs for men which is 50.8 percent of total PhDs for men; women received 635 PhDs out of a total of 1416, which is 44.8 percent of the total for women). (Refer appendix I, table 4 for the percentage of PhDs awarded to men and women, individually, for each sub-discipline as a proportion of the total PhDs in Agriculture.)

In terms of gender representation within sub-disciplines, women are almost equally represented as men in Agricultural Chemistry (with 40.7 percent of the total 177 PhD in the field). Other sub-disciplines where women have received a higher proportion of PhDs include Agricultural Engineering and Technology and Agricultural Social Sciences.

** The data represents 31.2 percent of total PhDs awarded in the country, calculated up to 2005. Comparative data for 2006 and 2007 were unavailable*

Graph 4: Distribution of PhDs in Sub-disciplines of Agriculture*



B. Natural Sciences

Abrol (2007) has stated that Science in India has to undergo a paradigm shift, in order to establish a more direct and relevant relationship to the knowledge generated for the growth of a sustainable economy. However, it has largely been realized that members of the scientific community have failed to address this concern of Science for sustainable development through envisioning viable short-term, medium-term or long-term solutions. Declining enrollments in basic sciences and the general fall in academic quality of the university systems was also pointed out by Prime Minister Manmohan Singh as a concern that has implications for advancement in frontier researches in science. In planning for the long run, it would be important to analyze these pitfalls in Science education and research to rectify the scenario. Of prime importance is the need to analyze the PhD production, since it is a vital section that contributes to the research capability of the country and has a huge potential to contribute to its economy.

** The data represents 31.2 percent of total PhDs awarded in the country, calculated up to 2005. Comparative data for 2006 and 2007 were unavailable.*

1. A Year-wise Breakup of the Number of PhDs Awarded in Natural Sciences Across the Decade

Table 5: Year-wise Distribution of PhDs in Natural Sciences*

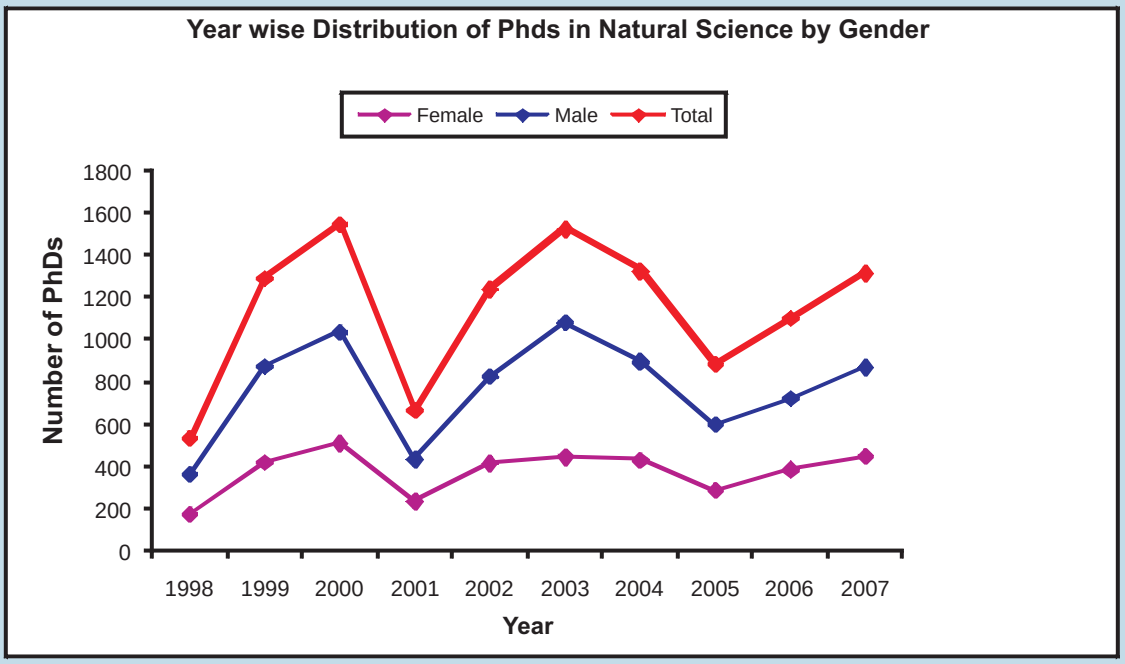
Year	Female	Male	Total
1998	174	361	535
	32.5%	67.5%	100.0%
1999	420	872	1292
	32.5%	67.5%	100.0%
2000	510	1038	1548
	32.9%	67.1%	100.0%
2001	236	432	668
	35.3%	64.7%	100.0%
2002	415	826	1241
	33.4%	66.6%	100.0%
2003	445	1080	1525
	29.2%	70.8%	100.0%
2004	432	896	1328
	32.5%	67.5%	100.0%
2005	290	598	888
	32.7%	67.3%	100.0%
2006	385	721	1106
	34.8%	65.2%	100.0%
2007	449	869	1318
	34.1%	65.9%	100.0%
Total	3756	7693	11449
	32.8%	67.2%	100.0%

Table 5 gives a break up of the year-wise award of PhDs in Natural Sciences from 1998-2007. The total number of PhDs awarded in the Natural Sciences across 10 years is 11,449, which is higher than for any other domain. The highest number of PhDs in the Natural Sciences has been awarded in the year 2000 with 1548 PhDs (13.5 percent of total; refer appendix I, table 5) and the lowest is in the year 1998 with 535 PhDs (4.7 percent of the total; refer appendix I, table 5).

The trend in PhDs awarded across the 10 years shows an increase in PhDs awarded in Natural Sciences from 1998 to 2000, followed by a sharp dip in the number of PhDs in 2001 and a subsequent increase from 2001 to 2003. From 2003, the number of PhDs has again dropped till 2005, which was followed by an increase in number of PhDs awarded between 2005 –2007.

** The data represents 24.0 percent of total PhDs awarded in the country, calculated up to 2005. Comparative data for 2006 and 2007 were unavailable.*

Graph 5: Year wise Distribution of PhDs in Natural Science by Gender*



2. Gender-related Comparison of the Total Number of PhDs Awarded Across the Decade

With respect to the number of PhDs awarded to men and women in Natural Sciences over the 10 years, it can be seen that there are more men in comparison to women with PhDs. The total number of PhDs awarded to women across the 10 years has been 3756 and the total number of PhDs awarded to men has been 7693. In terms of percentages, 32.8 % of the total number of PhDs has been awarded to women, while 67.2 % of PhDs has been awarded to men across the 10 years, in Natural Sciences.

From Table 5 it can be seen that men have received more number of PhDs in Natural Sciences than women across all 10 years. Men have received the highest number of PhDs in Natural Sciences in 2003 (1080, 14 percent of total PhDs to men; refer appendix I, table 5). The highest number of PhDs for women has been awarded in 2000 (510, 13.6 percent of the total PhDs to women; refer appendix I, table 5). For men and women the lowest number of PhDs has been awarded in the year 1998 (4.7 percent to men and 4.6 percent to women, of the total PhDs awarded to men and women, respectively; refer appendix I, table 5). The possible reason for this low number of PhDs in 1998 may be traceable to the problems of the database. It may also be due to the growth of the IT sector during the years 1995-2000, which may have significantly (though not conclusively) contributed to a reduction in the number of students opting for research.

Graph 5 above shows the trend in award of PhDs for men and women across the 10 years. From the graph, it can be seen that the trends are approximately similar for men and women. For both groups, there has been an increase in the numbers of PhDs awarded from 1998 to 2000. In 2001, there has been a fall in the number of

** The data represents 24.0 percent of total PhDs awarded in the country, calculated up to 2005. Comparative data for 2006 and 2007 were unavailable.*

PhDs awarded to men and women, with the percentage drop being slightly larger for men (58.4 percent drop) compared to women (53.7 percent drop). The difference in the proportion of PhDs awarded to men and women is also the least in the year 2001, with a difference of 29.4 percent. From 2001 – 2003 there has been an increase in the number of PhDs for both groups, but for women this increase has been lesser compared to men. From 2003-2005 there has been a decrease in the number of PhDs for both groups, followed by an increase in numbers up to 2007.

3. Sub-disciplinary Trends in Natural Science

Table 6: Year-wise Distribution of PhDs in Sub-disciplines of Natural Sciences*

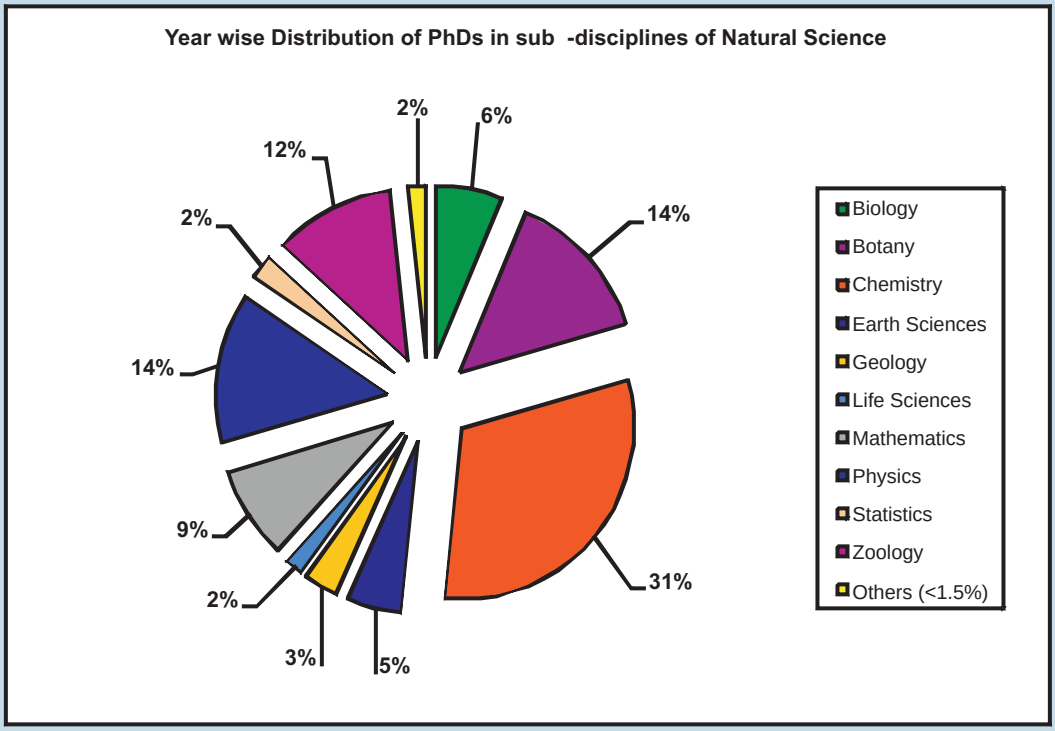
Sub-disciplines	Female	Male	Total
Biology	274	430	704
	38.9%	61.1%	100.0%
Botany	648	997	1645
	39.4%	60.6%	100.0%
Chemistry	1182	2374	3556
	33.2%	66.8%	100.0%
Earth Sciences	178	407	585
	30.4%	69.6%	100.0%
Geology	49	329	378
	13.0%	87.0%	100.0%
Life Sciences	109	86	195
	55.9%	44.1%	100.0%
Mathematics	251	744	995
	25.2%	74.8%	100.0%
Physics	394	1228	1622
	24.3%	75.7%	100.0%
Statistics	84	180	264
	31.8%	68.2%	100.0%
Zoology	525	784	1309
	40.1%	59.9%	100.0%
Others (<1.5%)	62	134	196
	31.63%	68.36%	100.0%
Total	3756	7693	11449
	32.8%	67.2%	100.0%

** The data represents 24.0 percent of total PhDs awarded in the country, calculated up to 2005. Comparative data for 2006 and 2007 were unavailable.*

An analysis of the sub-disciplines of Natural Sciences shows Chemistry having the largest number of PhDs in 10 years (3556, which is 31.1 percent of total; refer appendix I, table 6). The second largest number of PhDs has been awarded in Botany (1645, which is 14.4 percent of the total; refer appendix I, table 6), followed by Physics (1622, which is 14.2 percent of total). The disciplines that have received the least numbers include Atomic Energy, Astronomy and Environmental Sciences.

With respect to gender distribution, men have received more PhDs than women in all the sub-disciplines with the exception of Life Sciences (women received 55.9 percent of PhDs in the field). Women have received the least proportion of PhDs in Environmental Sciences (22.2 percent compared to 77.8 percent for men). (Atomic Energy has not been discussed as our database has a record of only one PhD in the field). Analyzing within groups data for women, it can be seen that women have the highest number of PhDs in Chemistry (1182, which is 31.5 percent of the total PhDs awarded to women; refer appendix I, table 6). The same is true for men as well with men receiving 2374 PhDs in Chemistry (30.9 percent of the total PhDs awarded to men; refer appendix I, table 6).

Graph 6: Distribution of PhDs in Sub-disciplines of Natural Sciences*



** The data represents 24.0 percent of total PhDs awarded in the country, calculated up to 2005. Comparative data for 2006 and 2007 were unavailable.*

C. Engineering and Technology

The widespread globalization of economies has led to new trends in Engineering, Technology and allied businesses. The world's largest businesses are looking at off-shore units which offer a combination of skilled workforce and economized overheads. India is in a strong position to optimize these opportunities. Market estimates have projected the Engineering Services Outsourcing (ESO) industry to achieve $55 billion in revenues by 2020. Indian technology companies are now doing a number of engineering jobs for global automotive and aerospace companies. A NASSCOM—Booz Allen Hamilton report has stated that in order for India to harness this potential, it must build on its talent pool which currently ranks average.

Analyzing the engineering education in the country, Banerjee and Muley (2008) have estimated the compound annual growth rate (CAGR) of Bachelor's degree in Engineering to be 12 percent while the CAGR for Master's in Engineering is estimated at 11.6 percent. Compared to this they report that doctorates in Engineering account for less than 1000 each year, with a growth rate of 8 percent only. For the period between 1985 –2005 the CAGR for doctorates has been a dismal 2.9 percent. The ratio of Engineering doctorates to graduates varies between 1 –3 percent. The authors have also reported that the number of Science doctorates affect the trends in Engineering research and development. Similarly, the Rao Committee Report (2002) highlighted this lacuna in the production of doctorates in Engineering and estimated that by 2008 an additional 10,000 doctorates would be required to staff the growing number of Engineering institutions across the country and meet the demand of quality faculty for Engineering education.

Thus an analysis of the Engineering doctorate production in India would be useful to inform policies and decisions in Engineering and Technological fields that can crucially affect India's growth potential.

1. A Year-wise Breakup of Number of PhDs Awarded in Engineering Across the Decade

The data presented in Table 7 analyzes the trends in doctorate degrees in Engineering.

The total number of PhDs awarded from 1998 to 2007 in Engineering is 3921. The least numbers of PhDs in Engineering is seen for the year 2001 with only 190 PhDs (which is 4.8 percent of the total; refer appendix I, table 7) and the highest number of PhDs is seen in 2007 with 685 (17.5 percent of total; refer appendix I, table 7). The annual trend in the number of PhDs indicates a growth in numbers in the last decade, particularly a greater rise in numbers from 2004 – 2007. This growth perhaps mirrors the coming of large MNC R&D units such as Texas Instruments, IBM, Motorola, Daimler-Benz, etc. It has been estimated that the Engineering Processes Outsourcing (EPO) in India will rise to 17.6 percent CAGR and reach US$ 20 billion by 2010 (as cited in Ingalsuo, 2009). This could perhaps signal a further growth in number of Engineering post-graduates, but also suggests a need for India to take positive steps in the direction of strengthening Engineering research.

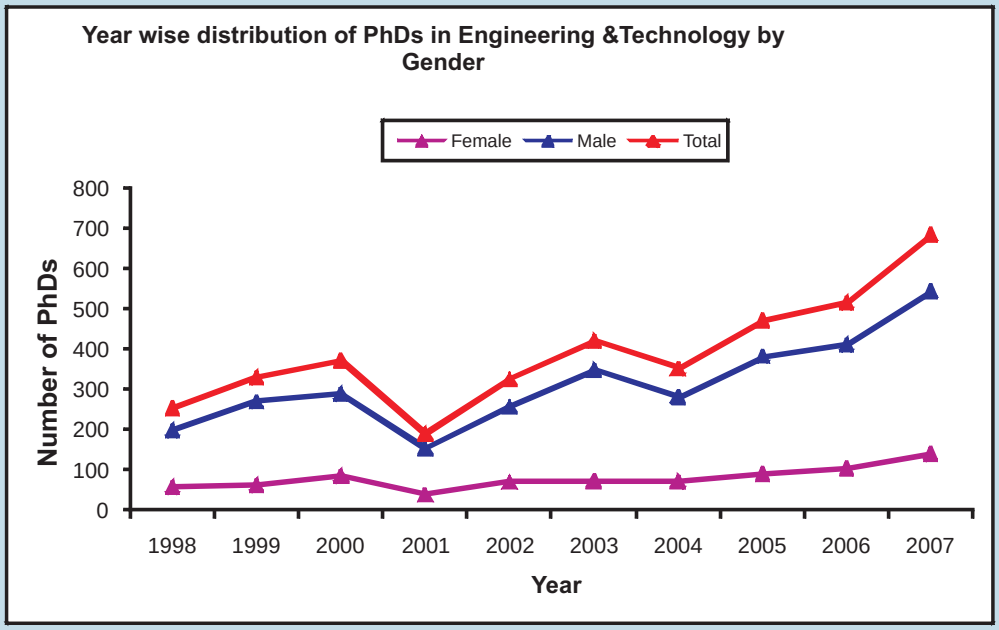
Table 7: Year wise Distribution of PhDs in Engineering & Technology*

Year	Female	Male	Total
1998	58	197	255
	22.7%	77.3%	100.0%
1999	62	268	330
	18.8%	81.2%	100.0%
2000	85	288	373
	22.8%	77.2%	100.0%
2001	39	151	190
	20.5%	79.5%	100.0%
2002	70	256	326
	21.5%	78.5%	100.0%
2003	73	348	421
	17.3%	82.7%	100.0%
2004	71	281	352
	20.2%	79.8%	100.0%
2005	91	382	473
	19.2%	80.8%	100.0%
2006	105	411	516
	20.3%	79.7%	100.0%
2007	140	545	685
	20.4%	79.6%	100.0%
Total	794	3127	3921
	20.2%	79.8%	100.0%

** The data represents 41.0 percent of total PhDs awarded in the country, calculated up to 2005. Comparative data for 2006 and 2007 were unavailable.*

With respect to the annual production of PhDs, it can be observed that the growth in numbers from the initial period to the terminal period of our study is 168 percent. This indicates that on an average, the annual rate of growth of PhDs is 16.8 percent. **It is important to analyze whether this growth rate will help India overcome the deficits in Engineering PhDs. Only two periods of decline in numbers are noticed – one during 2001 when the number of PhDs awarded is lower than for the initial period (190 in 2001 compared to 255 in 1998) and a small drop in numbers in 2004. The decline must be analyzed to understand whether they reflect a problem in the database or whether other factors influenced the research trends in Engineering and Technology prior to, during and after this period.**

Graph 7: Year wise Distribution of PhDs in Engineering by Gender*



2. Gender-related Comparison of Total Number of PhDs Awarded in Engineering Across the Decade

With respect to the proportion of Engineering PhDs awarded to men and women, it can be seen that men have received more than 77 percent of the total PhDs for all years. The total number of PhDs awarded to men in Engineering across the 10 years is 3127 (which is 79.8 per cent of the total) and 794 PhDs in Engineering have been awarded to women (which is 20.2 per cent of the total).

An analysis of Graph 7 above shows a higher rate of growth in Engineering PhDs for men compared to women. For women, the growth in numbers has been lower (14 percent yearly growth on an average) compared to men (17.7 percent yearly growth on an average). The gap between the number of PhDs awarded to men and women has thus progressively increased over the 10 years. This increasing gender gap is a reason for concern. The difference between the groups is least for the year 2000 (when women received 22.8 percent of the total PhDs,

** The data represents 41.0 percent of total PhDs awarded in the country, calculated up to 2005. Comparative data for 2006 and 2007 were unavailable.*

and men received 77.2 percent). The difference is highest for the year 2003, when women received only 17.3 percent of the PhDs, while men received 82.7 percent of the total PhDs.

Engineering, traditionally considered a male domain of study has witnessed smaller number of women students for long. However, the trends in the recent years are showing gradual improvements. According to Banerjee and Muley (2008), the number of women in Engineering increased from 16% in 1995 to 22% in 2001. In 2001 the number of women with a Masters degree in Engineering was 16% of the total number of M.tech/ M.E. awardees. At the doctoral level, the corresponding figure was 17%. In the US, women received 19.3% of the bachelor's, 22.5% of the Post-graduate, and 20.2% of the Doctorate degrees in 2006. Similarly, in the UK women received 14% of the Bachelor's and 20% of the post-graduate degrees in 2003-2004. Gender disparities in participation in Engineering and Allied Sciences are common worldwide. While the ratio of girls in Engineering in India is close to the ratio in the US and the UK, further attention must be given to increase the participation of women in Engineering, particularly at the doctoral level.

3. Sub-disciplinary Trends in Engineering and Technology

Table 8: Year-wise Distribution of PhDs in Sub-disciplines of Engineering & Technology*

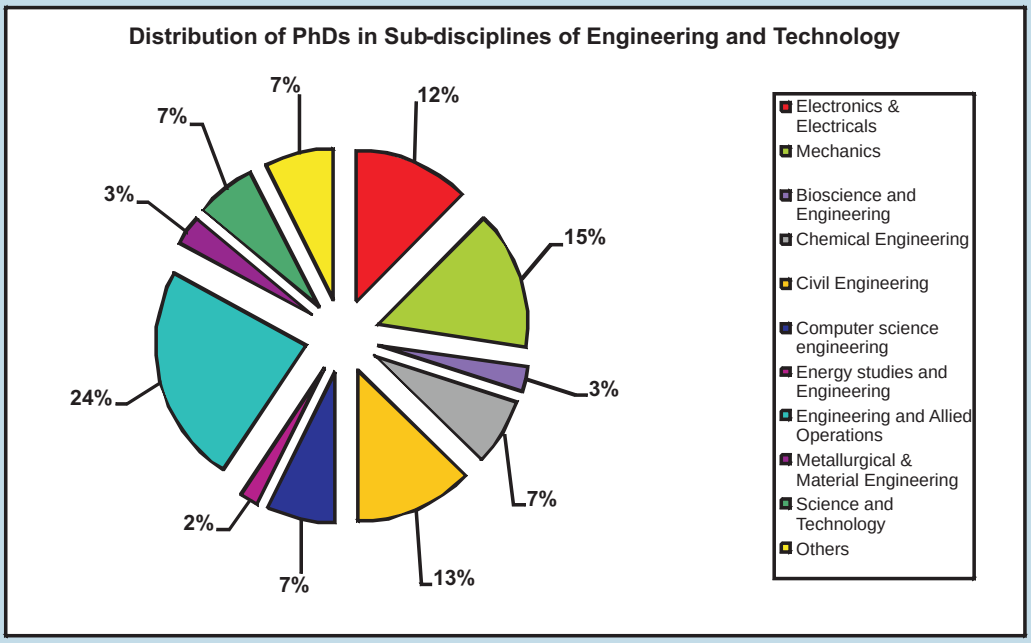
Sub -Disciplines	Female	Male	Total
Electronics & Electrical	109	378	487
	22.4%	77.6%	100.0%
Mechanical Engineering	23	563	586
	3.9%	96.1%	100.0%
Bioscience and Engineering	47	56	103
	45.6%	54.4%	100.0%
Chemical Engineering	81	203	284
	28.5%	71.5%	100.0%
Civil Engineering	63	438	501
	12.6%	87.4%	100.0%
Computer science engineering	60	224	284
	21.1%	78.9%	100.0%
Energy studies and Engineering	16	66	82
	19.5%	80.5%	100.0%
Engineering and Allied Operations	266	654	920
	28.9%	71.1%	100.0%
Metallurgical & Material Engineering	17	110	127
	13.4%	86.6%	100.0%
Science and Technology	62	193	255
	24.3%	75.7%	100.0%
Others	50	242	292
	17.12%	82.87%	100.0%
Total	794	3127	3921
	20.2%	79.8%	100.0%

** The data represents 41.0 percent of total PhDs awarded in the country, calculated up to 2005. Comparative data for 2006 and 2007 were unavailable.*

The largest number of PhDs in Engineering and Technology has been awarded under the broad category of Engineering and Allied Sciences (920 PhDs, which is 23.5 percent of the total; refer appendix I, table 8). With respect to singular fields, Mechanical Engineering and its applications have received the highest number of PhDs with 586 (amounting to 14.9 percent of the total; refer appendix I, table 8). Civil Engineering accounts for 12.8 percent of the total (refer appendix I, table 8) while Electronics and Electrical accounts for 12.4 percent (refer appendix I, table 8). Disciplines such as Architecture, Aerospace Engineering, Industrial Engineering, Energy and Metallurgical have the least number of PhDs.

Women have received the highest number of PhDs in the sub-discipline of Electronics and Electrical with a total of 109 PhDs (which is 13.7 percent of the total; refer appendix I, table 8). By contrast, men received the highest number of PhDs in Mechanical Engineering[2] (563, which is 18 percent of the total; refer appendix I, table 8), a discipline traditionally considered a male domain, and one which women are frequently dissuaded from taking because of the heavy physical labour involved in it. Both groups have recorded the least number of PhDs in Energy Studies (2 percent of the total PhDs for women and 2.1 percent of total PhDs for men; refer appendix I, table 8). However this trend could be due to several reasons such as Energy Studies being a new emerging interdisciplinary area of study, or its categorization into the Natural Science category and as mentioned earlier, inadequacy of research departments to meet the needs for interdisciplinary studies. Women are highly under-represented (having less than 25 percent of the total PhDs) in all disciplines except Biosciences and Engineering (women received 45.6 percent of the total PhDs in the field), and Chemical engineering (receiving 28. 5 percent of the total PhDs). Women are least represented in Mechanical Engineering (with only 3.9 percent of the total PhDs in the field).

Graph 8: Distribution of PhDs in Sub-disciplines of Engineering*



[2] *Engineering and Allied Sciences have not been considered in the discussion for women and men because the actual composition of the discipline is not known.*

** The data represents 41.0 percent of total PhDs awarded in the country, calculated up to 2005. Comparative data for 2006 and 2007 were unavailable.*

D. Medicine

India's position in becoming a world leader in medical and pharmaceutical advancements and developing a strong medical economy is a real possibility in the future due to several important advantages. Primary among these is a wide variety of ethnically and genetically diverse population for clinical testing and a valuable source of several traditional streams of medical knowledge that has the potential to provide solutions to new modern day diseases such as cancer and heart problems. The field of integrative medicine has emerged as a new area having the potential of bringing the best of both worlds – the West and the East. Thus, India has seen a robust 31 percent annual growth in the medical sector in the last four years. India has also become the biggest supplier of low-cost essential drugs to the developing world and has a share of nearly 25% in the overall generic space. Domestic generic companies such as Ranbaxy and Cipla have been recognized globally, not only for their low-cost medicines, but also of their ability to produce quality medicines. The Indian success in Medicine has been possible not only because of the population variance available for testing, and the low cost of R&D and manufacture, but also because of the availability of qualified technical human power with the strong advantage of having knowledge of the English language (Thatte, 2009). **However the Indian medical education and research system are in crisis today. This has been indicated even in the National Knowledge Commission report. Among other concerns, the outdated curriculum, lack of practical training for students, high cost of medical education making it an elitist system, and poor regulation and widespread corruption in medical education need urgent attention. It is important to reevaluate and revise the medical education and research systems in India, and compare them with global advancements in the field of medicine, if India is to retain its advantages in the field.**

1. A Year-wise Breakup of the Number of PhDs Awarded in Medicine Across the Decade

Table 9 shows the total number of PhDs awarded in Medicine for 10 years. The total number of PhDs awarded for 10 years is 3298. As in the case of Engineering, the number of PhDs in Medicine is far lower compared to other Science and Arts disciplines. This could be due to the professional nature of both courses, and the minimum industry requirements of only a post-graduation for employment. The number of students taking up medical research (as well as engineering research) may therefore be few. This trend may also be due to the high cost of medical and engineering education, large loans taken by families to avail these educational opportunities for their children in India and the urgency in repayment of these loans. A further deterrent could be the long years of study involved in these courses.

Table 9: Year-wise Distribution of PhDs in Medicine*

Year	Female	Male	Total
1998	97	144	241
	40.2%	59.8%	100.0%
1999	124	177	301
	41.2%	58.8%	100.0%
2000	124	231	355
	34.9%	65.1%	100.0%
2001	98	179	277
	35.4%	64.6%	100.0%
2002	140	238	378
	37.0%	63.0%	100.0%
2003	136	269	405
	33.6%	66.4%	100.0%
2004	132	288	420
	31.4%	68.6%	100.0%
2005	138	225	363
	38.0%	62.0%	100.0%
2006	149	248	397
	37.5%	62.5%	100.0%
2007	51	110	161
	31.7%	68.3%	100.0%
Total	1189	2109	3298
	36.1%	63.9%	100.0%

The highest number of PhDs in Medicine has been awarded in 2004 (420, which is 12.7 percent of the total) and the lowest in 2007 (161, which is 4.9 percent of the total) (refer appendix I, table 9). Reasons for the decline and the lower growth rate of medical education need to be analyzed to understand this low output of doctoral research. Some of the factors that have been identified are: the large mushrooming of medical colleges (refer appendix II, graph 3), especially private, which have led to a large scale production of medical graduates and specialized post-graduates, leading to a mismatch between demand and supply. Consequently students have now turned to foreign shores, especially to African and Gulf countries for more profitable careers, thus leaving fewer students back in India to pursue higher studies. Secondly, there has also been an explosion in two other medical-related industries that offer more rewarding opportunities – the pharmaceutical sector and the corporate hospitals and medical cities sector that are drawing large numbers of graduates and post-graduates.

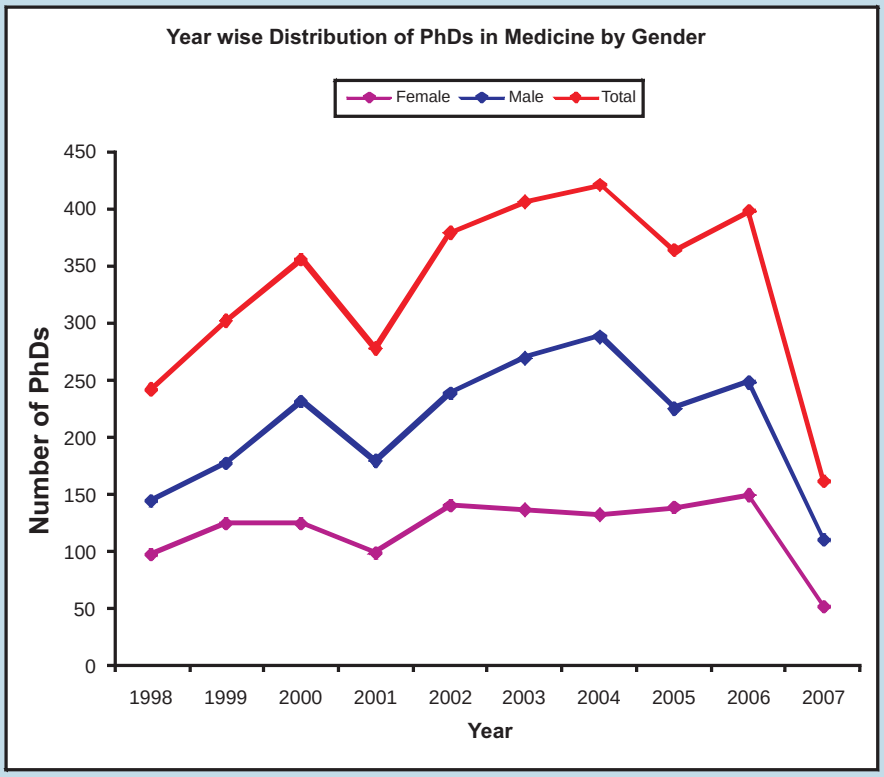
** Our data on medicine exceeds the data reported by secondary sources up to 2005.*

These two trends together have further stimulated the establishment of private colleges offering basic medical degrees, with the emphasis on training students for careers abroad, with no emphasis towards research due to the profitability of basic medical education, and the large number of students opting for these courses on account of the lucrative career options. Thus, while there are more than 270 medical colleges across the country, the number of health universities that are responsible for research and doctoral education in Medicine are only 7 as of 2005. Further, the number of health universities has increased at a much slower rate from 1 in 1986 to 7 in 2005 (a growth of 6 universities in 19 (Mandal, 2008).

The trends in the number of doctorates in Medicine show a decline from the initial to the terminal period. A decline of 33.2 percent has been recorded in 2007 from 1998. The trends show wide fluctuation in the numbers of PhDs awarded annually, with the numbers increasing and decreasing between the years. A growth in numbers has been recorded in the initial period between 1998 and 2000, followed by a decrease in 2001. From 2002 to 2004 there has once again been an increase in numbers followed by a decrease in the subsequent year, 2005. An increase in 2006 in the number of PhDs in Medicine has been followed by a large fall in numbers in 2007.

It would be important, while talking about the trends in professional disciplines such as Medicine and Engineering, to corroborate the data on the fields with the number of institutions that offer a research programme in these disciplines, as well as the added advantage (if any), of completing a PhD in these fields, to be able to make more insightful recommendations.

Graph 9: Year wise Distribution of PhDs in Medicine by Gender*



** Our data on medicine exceeds the data reported by secondary sources up to 2005.*

2. Gender-related Comparison of Total Number of PhDs Awarded Across the Decade

With respect to the gender-wise distribution of the total number of PhDs in medicine, the number of doctorates in Medicine awarded to men in the 10 years was 2109, which is 63.9 per cent of the total. The number of PhDs awarded to women is 1189, which is 36.1 per cent of the total. The difference between the number of PhDs awarded to women and men is least in Medicine, when compared to other science fields (namely Agriculture, Natural Science and Engineering). This is perhaps due to the fact that more women prefer Biological Sciences. More importantly, women have been accepted in the medical profession historically, since it has been largely associated with their traditional roles of caring and nurturing.

The highest number of PhDs for men was awarded in 2004 with 288 PhDs (13.7 percent of the total PhDs awarded to men), while the highest number for women was in 2006 with 149 PhDs (12.5 percent of the total for women). The least numbers in Medicine for both groups have been at the end of the 10-year period in 2007, with 110 (5.2 percent) and 51 (4.3 percent) PhDs for men and women respectively. (Refer appendix I, table 9 for details for a comparison of percentage of PhDs awarded each year).

The trends in PhDs awarded to men and women appear largely similar. Wide fluctuations and a non-linear trend are seen (refer to graph 9). The number of PhDs at the end of the 10-year period has declined for both groups as mentioned above. The percentage decline has been greater for women (47.4 percent) than for men (23.6 percent). The higher rate of decline in numbers for women, in a discipline that has traditionally seen greater participation by them indicates a need to understand the reasons for the declining numbers to develop early measures that will check this loss of talented women. The rising gender gap from the initial to the terminal is of serious concern, specifically the decline in women's participation at the doctoral level in 2000-2001, 2003-2004 and 2007. The largest growth in number of PhDs in Medicine across the study period has been from 2001 – 2004 for men. The period of growth has been longer for women compared to men (between 2001 and 2006). However, the percentage of growth (40.8 percent) has been much less for women (compared to 60.9 percent growth for men), despite the extended period.

E. Social Sciences

"We need to make sure that the Humanities and Social Sciences are considered to be no less important in building our future, a future on Science and Technology. This is because in the end, if all of the scientific problems of life were ever solved in an applied sense, the most important questions would remain unanswered."

-Brenda Nelson, Minister for Education, Australian government, 200).

The statement given above, states powerfully the role of Social Sciences and its importance to new world developments. In the light of newer challenges such as international trade and labour concerns, cyclical patterns of inflation and recession, government fiscal deficits, poverty, unemployment, new demands from weaker sections for more sustainable developments, religious tensions and communal violence, governments across the world are increasingly faced with the task of addressing national and international consequences of unplanned globalization, liberalization and scientific and technological developments. In the light of these trends, Social Science research and studies has become increasingly important, in order to provide solutions for the pressing social problems of the day. While several countries such as the UK, Australia, the US, etc have recognized these benefits and have turned towards strengthening their Social Science output, India still lags in reforms. **Poor funding and infrastructure, low status of Social Science research and poor job opportunities have led to a decline in interest among students in Social Science. Therefore an analysis of trends in Social Sciences will be useful in planning proactive policies for its revival.**

1. A Year-wise Breakup of the Number of PhDs Awarded in Social Sciences Across the Decade

Table 10: Year wise Distribution of PhDs in Social Sciences*

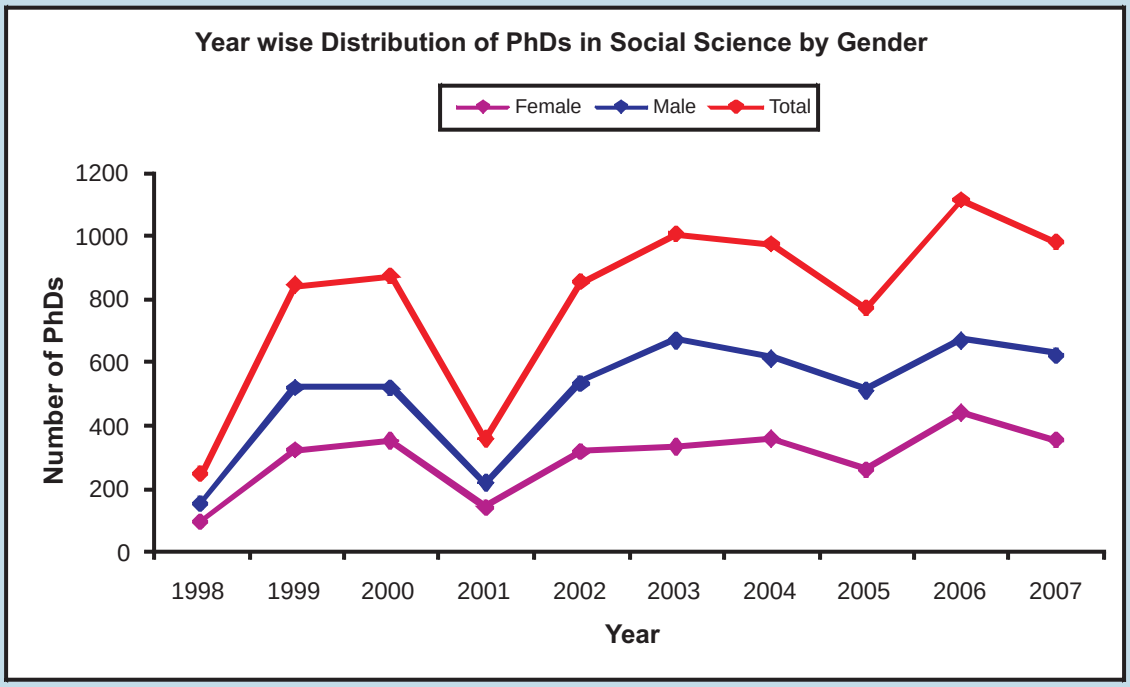
Year	Female	Male	Total
1998	94	152	246
	38.2%	61.8%	100.0%
1999	322	521	843
	38.2%	61.8%	100.0%
2000	352	520	872
	40.4%	59.6%	100.0%
2001	139	218	357
	38.9%	61.1%	100.0%
2002	319	535	854
	37.4%	62.6%	100.0%
2003	334	671	1005
	33.2%	66.8%	100.0%
2004	359	613	972
	36.9%	63.1%	100.0%
2005	259	511	770
	33.6%	66.4%	100.0%
2006	442	670	1112
	39.7%	60.3%	100.0%
2007	355	624	979
	36.3%	63.7%	100.0%
Total	2975	5035	8010
	37.1%	62.9%	100.0%

The total number of PhDs awarded in the Social Sciences for 10 years (from 1998-2007) is 8010. The highest number of PhDs in the Social Sciences has been awarded in the year 2006 with 1112 PhDs (13.9 %). The least number of PhDs in the Social Sciences has been awarded in the year 1998 with 246 PhDs (3.1 %) (Refer appendix I, table 10 for percentage of PhDs awarded yearly). From the initial to the terminal year there has been a huge growth in the number of PhDs awarded in Social Science. Yet, the growth rate of PhDs in the second half of the decade is lower than for the first half, which probably indicates a declining interest in Social Science research.

** The data represents 15.5 percent of the total Arts PhDs (i.e., Social Sciences and Humanities) reported by secondary up to 2005*

The total number of PhDs awarded at the end of the 10 year period has considerably increased since the initial years (with a growth of 30 percent per annum on an average). However the trends show wide annual fluctuations in the numbers awarded, as well as a non-linear growth pattern. There have been two periods of significant increase in the number of PhDs– the first being from 1998 to 1999, and the second being from 2001 to 2002. The number of PhDs drastically reduced in 2001, while the fall in numbers was smaller from 2003 to 2005 and in 2007.

Graph 10: Year Wise Distribution of PhDs in Social Science by Gender*



2. Gender-related Comparison of Total Number of PhDs Awarded Across the Decade

Men with a PhD in Social Sciences outnumber women as for every other discipline. However the difference in numbers awarded to the groups is less compared to all other disciplines with the exception of Humanities. The total number of PhDs awarded to men was 5035 (accounting for 62.9 percent of the total) and the total awarded to women was 2975 (accounting for 37.1 percent of the total). The gap between the number of PhDs awarded to men and women was also the least for 2006 (with women receiving 39.7 percent of the total PhDs and men receiving 60.3 percent of the total).

The least number of PhDs in Social Science for both groups was awarded in 1998 (3.2 percent and 3 percent of the total PhDs awarded to men and women respectively). The highest number of PhDs for men has been awarded in 2003 and 2006 (with 13.3 percent of the total PhDs to men), and the highest for women has been in 2006 (with 14.9 percent of the total PhDs awarded to women). (Refer appendix I, table 10 for the percentage of PhDs awarded to men and women).

** The data represents 15.5 percent of the total Arts PhDs (i.e., Social Sciences and Humanities) reported by secondary up to 2005*

The trends in PhDs for men and women appear largely similar with the exception of two periods - between 1999 and 2000, when women recorded a growth in numbers, while the graph for men shows a plateau; the second difference is for the period between 2003 and 2004, where men have recorded a decline in numbers, while women have recorded a growth. Despite these two positive trends for women, on the whole men have recorded a higher growth in numbers from the initial to the terminal period than women. In terms of individual years, it can be seen that the initial period of growth in numbers (from 1998-1999) has also been greater for men than women.

Similarly, men have recovered to show a higher number of PhDs in 2002 after a sharp fall in numbers in 2001, with the number of PhDs exceeding numbers recorded for all previous years. In the case of women, however, the sharp decline in numbers in 2001 has been followed by a smaller growth in 2002, with the numbers recorded for 2002 being below that for 1999 and 2000. The terminal year decline in numbers is also higher for women compared to men. The period between 2005 and 2006 is the only exception, when women have recorded a higher growth in numbers compared to men.

3. Sub-disciplinary Trends in Social Sciences

Table 11: Year wise Distribution of PhDs in Sub-disciplines of Social Science*

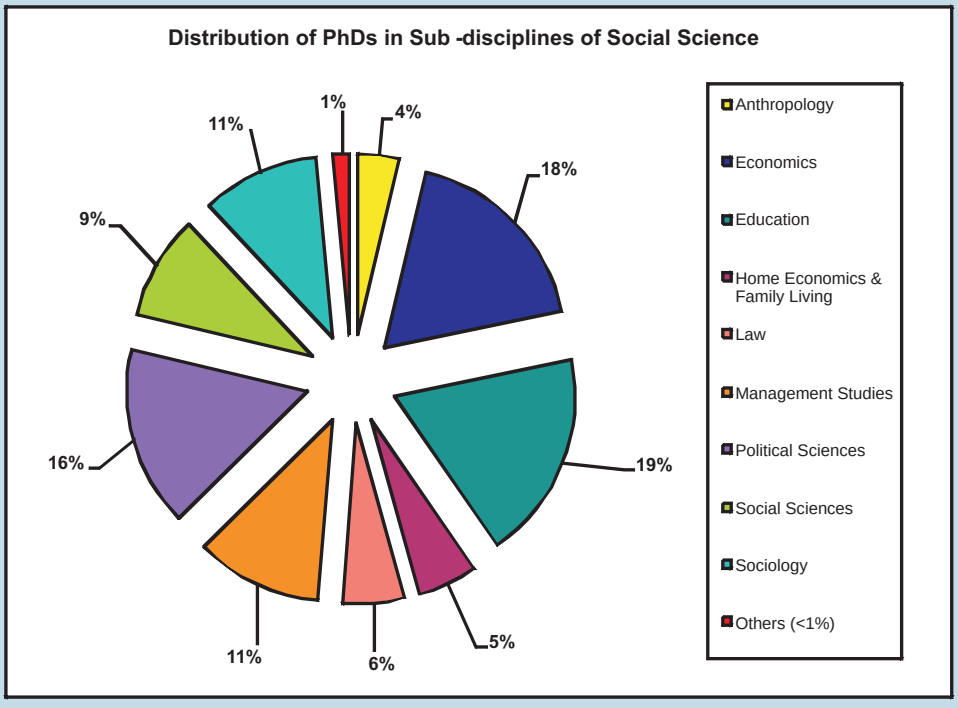
Sub Disciplines	Female	Male	Total
Anthropology	146	153	299
	48.8%	51.2%	100.0%
Economics	443	1000	1443
	30.7%	69.3%	100.0%
Education	582	909	1491
	39.0%	61.0%	100.0%
Home Economics & Family Living	364	63	427
	85.2%	14.8%	100.0%
Law	113	331	444
	25.5%	74.5%	100.0%
Management Studies	205	709	914
	22.4%	77.6%	100.0%
Political Sciences	467	820	1287
	36.3%	63.7%	100.0%
Social Sciences	272	469	741
	36.7%	63.3%	100.0%
Sociology	355	49 4	849
	41.8%	58.2%	100.0%
Others (<1%)	28	87	115
	24.34%	75.65%	100.0%
Total	2975	5035	8010
	37.1%	62.9%	100.0%

** The data represents 15.5 percent of the total Arts PhDs (i.e., Social Sciences and Humanities) reported by secondary up to 2005*

The highest number of PhDs under Social Sciences has been awarded in the field of Education (1491 PhDs, accounting for 18.6 percent of the total PhDs in Social Sciences). Economics with 1443 PhDs in the 10 years has received the second highest portion of PhDs (18 percent of the total). (Refer appendix I, table 11 for percentage of PhDs awarded for the various sub-disciplines of Social Science). Fields that have poor numbers include Cognitive Science, Regional Studies, Rural Development, Social Problems and Services, Public Administration, Communication, Journalism and Anthropology. While some of these disciplines may be of relatively recent origin, there is also a need to understand the administrative blocks to the promotion of these new areas that demonstrate a higher possibility to analyze interdisciplinary problems that reflect the real world, as mentioned earlier for the Sciences.

With respect to gender, men have received the highest number of PhDs in Economics with 1000 PhDs (19.9 percent of total PhDs awarded to men), while women have received highest number of PhDs in Education with 582 (19.6 percent of total PhDs awarded to women). (Refer appendix I, table 11 for percentage of PhDs awarded for the various sub-disciplines for men and women). Women have outnumbered men in terms of the proportion of PhDs received in Home Economics and Family Living (85.2 percent women compared to 14.8 percent men). However women's representation is absent in fields such as Regional Studies and Rural Development, and poor in Communication, Management Studies and Public Administration (below 25 percent). (Refer table 11 above, for percentage of PhDs awarded to men and women for each sub-discipline of Social Sciences). It is also important to link this lower representation of women in higher education in relatively higher lucrative fields such as Management and Law with their lower presence in careers in these fields. The predominance of men in these lucrative fields has been the pattern always.

Graph 11: Distribution of PhDs in Sub-disciplines of Social Sciences*



** The data represents 15.5 percent of the total Arts PhDs (i.e., Social Sciences and Humanities) reported by secondary up to 2005*

F. Humanities

Humanities accounts for the highest production of researchers after the Sciences. Yet knowledge about the research topics, number of researchers, their future occupational roles, and the contribution of research in Humanities to the larger society is largely absent, due to the lack of understanding of its relevance. The large body of research and practice in Humanities contributes to the preservation of our arts, literature, music, dance, drama and in the larger sense our tradition and culture that provide continuity to our present experiences and form the social threadwork that binds members of society collectively. Despite the centrality of their role to our present times, work in the Humanities is largely ignored. Present innovations in science and technology provide us a new opportunity to harness them to undertake tremendous work in the Humanities. For example new areas of research in decrypting, deciphering and decoding languages and script, using the latest advances in material science to preserve valuable artwork, manuscripts and monuments, applying computer simulations, animations and graphics to recreate ancient cities, lifestyles and living, harnessing satellite technology for archaeological findings, etc provides tremendous scope for protection, preservation and promotion of our socio-historical and cultural heritage. It is thus important to study the trends in Humanities education to make it more relevant to the present to prevent a loss of valuable data.

1. A Year-wise Breakup of Number of PhDs Awarded in Humanities Across the Decade

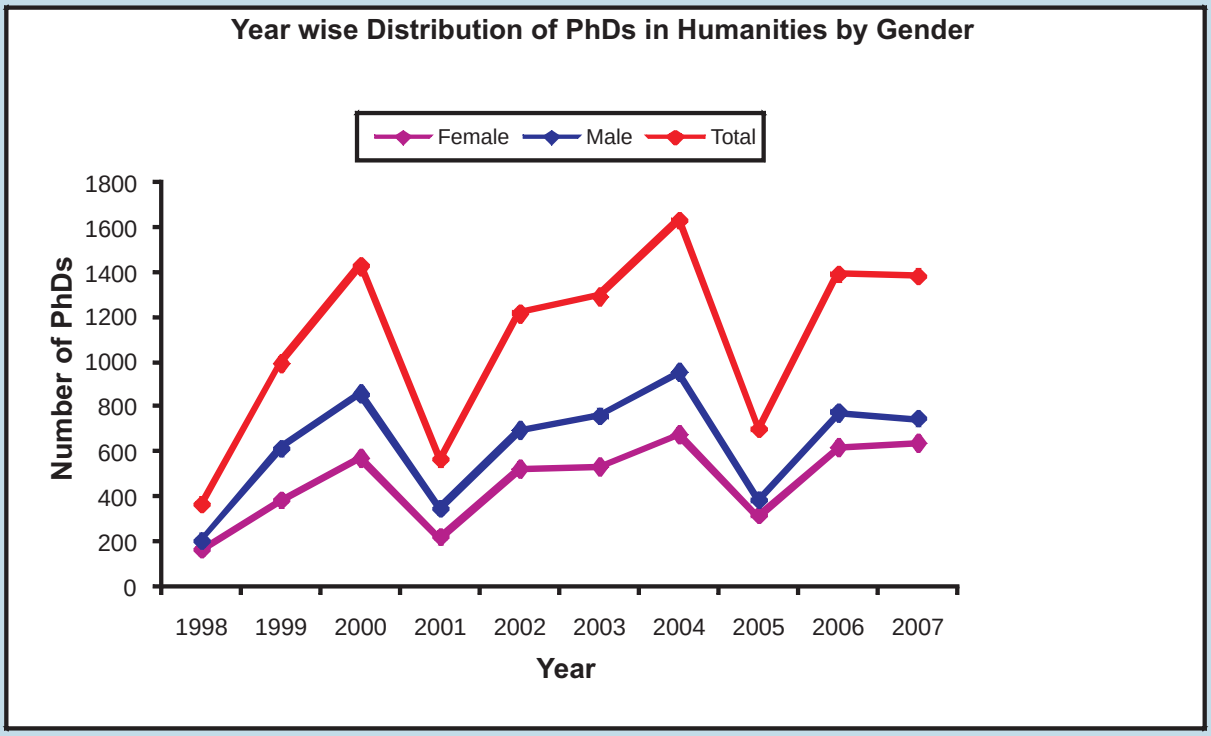
Year	Female	Male	Total
1998	162	203	365
	44.4%	55.6%	100.0%
1999	380	614	994
	38.2%	61.8%	100.0%
2000	570	858	1428
	39.9%	60.1%	100.0%
2001	217	348	565
	38.4%	61.6%	100.0%
2002	520	697	1217
	42.7%	57.3%	100.0%
2003	532	760	1292
	41.2%	58.8%	100.0%
2004	675	957	1632
	41.4%	58.6%	100.0%
2005	315	386	701
	44.9%	55.1%	100.0%
2006	616	775	1391
	44.3%	55.7%	100.0%
2007	636	749	1385
	45.9%	54.1%	100.0%
Total	4623	6347	10970
	42.1%	57.9%	100.0%

** The data represents 21.3 percent of the total Arts PhDs (i.e., Social Sciences and Humanities) reported by secondary up to 2005.*

The total number of PhDs awarded in the Humanities across 10 years is 10,970. Of these, the highest number was awarded in 2004 (1632 PhDs, 14.9 percent of total) and the least in 1998 (365, 3.3 percent PhDs). (Refer appendix I, table 12 for percentage of PhDs awarded yearly in Humanities).

In terms of annual trends, the number of PhDs has shown wide fluctuations. There has been a growth in numbers from 1998 to 2000 (from 361 to 1428). In 2001 the number of PhDs in Humanities has sharply declined to 525. From 2002 to 2004, there has been a large growth in the number of PhDs in Humanities (reaching 1632 in 2004), followed by a huge fall in 2005. The number of PhDs has risen in 2006 and remained constant up to 2007. This appears to be a positive trend and it may be important to convert this growth with efforts by various agencies to encourage research in these disciplines. It may also be necessary to correlate the employment potential of these doctorate holders at the National and International levels.

Graph 12: Year wise Distribution of PhDs in Humanities by Gender*



** The data represents 21.3 percent of the total Arts PhDs (i.e., Social Sciences and Humanities) reported by secondary up to 2005.*

2. Gender-related Comparison of Total Number of PhDs Awarded across the Decade

A healthy trend in the number of women with a PhD in Humanities is noticed in contrast to other disciplines. A total of 4623 PhDs in Humanities has been awarded to women for the 10 years (which 42.1 percent of the total). The number of PhDs awarded to men was 6347 (which is 57.9 percent of the total). The small gender gap may be an interesting area of enquiry.

The graph shows the differences in the number of PhDs awarded to men and women to be small for all years. The difference between the numbers awarded to men and women was the least for 2007 with 45.9 percent of the PhDs being awarded to women and 54.1 percent being awarded to men. The difference in the proportion of PhDs awarded is highest for 1999, with women receiving 38.2 percent of the PhDs compared to men who received 61.8 percent of the PhDs. For both men and women, the number of PhDs has increased from 1998 to 2000, with a higher growth for men; the numbers have fallen in 2001, with the percentage drop being slightly higher for women. From 2001 to 2004, both women and men have witnessed a growth in the number of PhDs. In 2005 the number of PhDs for both groups has dropped, with a greater drop for men than for women. There has been a small growth for both groups in 2006, with the numbers approximately remaining close to the previous year in 2007.

3. Sub-Disciplinary Trends in Humanities

Table 13: Year wise Distribution of PhDs in sub disciplines of Humanities*

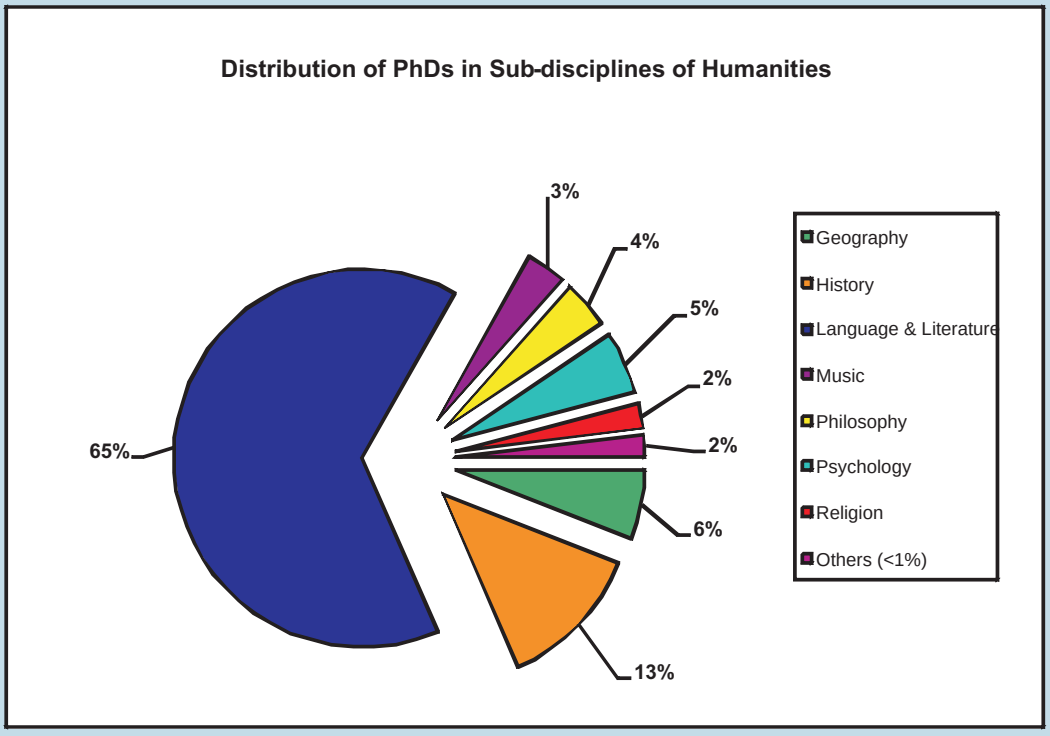
Sub Disciplines	Female	Male	Total
Geography	191	465	656
	29.1%	70.9%	100.0%
History	499	874	1373
	36.3%	63.7%	100.0%
Language & Literature	3057	4034	7091
	43.1%	56.9%	100.0%
Music	213	161	374
	57.0%	43.0%	100.0%
Philosophy	151	293	444
	34.0%	66.0%	100.0%
Psychology	342	244	586
	58.36%	41.63%	100.0%
Religion	63	174	237
	26.6%	73.4%	100.0%
Others (<1%)	107	102	209
	51.2%	48.8%	100.0%
Total	4623	6347	10970
	42.1%	57.9%	100.0%

** The data represents 21.3 percent of the total Arts PhDs (i.e., Social Sciences and Humanities) reported by secondary up to 2005.*

Among the sub-disciplines of Humanities, the largest share of PhDs has been awarded under Language and Literature (7091, accounting for 64.6 percent of the PhDs in Humanities.) History accounts for the second largest proportion of PhDs in Humanities (1373, which is 12.5 percent of the total). (For percentage of PhDs awarded to sub-disciplines of Humanities refer appendix I, table 13). Subjects that have received the least number of PhDs include Folklore, Psychology and Organizational Behavior, Theology, etc. For some of these disciplines such as Psychology and Organizational Behaviour, a substantial portion of research and doctorate programmes may have been conducted at medical universities, which have been difficult to access. Further, work in the area of Organizational Behaviour is also undertaken by Management schools that adopt a case study approach to the problem. It would be important to see what proportions of such research culminate into a PhD to understand the trends in these fields fully.

Women have received a significantly higher number of PhDs in Language and Literature (3057, which is 66.1 percent of the total Humanities PhDs awarded to women). Similarly men have also received a significantly higher number of PhDs in Language and Literature (4034, which is 63.6 percent of total). (For percentage of PhDs for sub-disciplines of Humanities, for men and women, refer appendix I, table 13). The proportion of PhDs awarded to women in disciplines such as Psychology and Organizational Behavior, Drawing and Painting, Fine Arts and Decorative Arts, and Music exceeds that for men. In disciplines such as Folklore and Theology, there are no women PhD holders in the study sample.

Graph 13: Distribution of PhDs in Sub-disciplines of Humanities*



** The data represents 21.3 percent of the total Arts PhDs (i.e., Social Sciences and Humanities) reported by secondary up to 2005.*

III. STATE/ ZONE WISE BREAK-UP

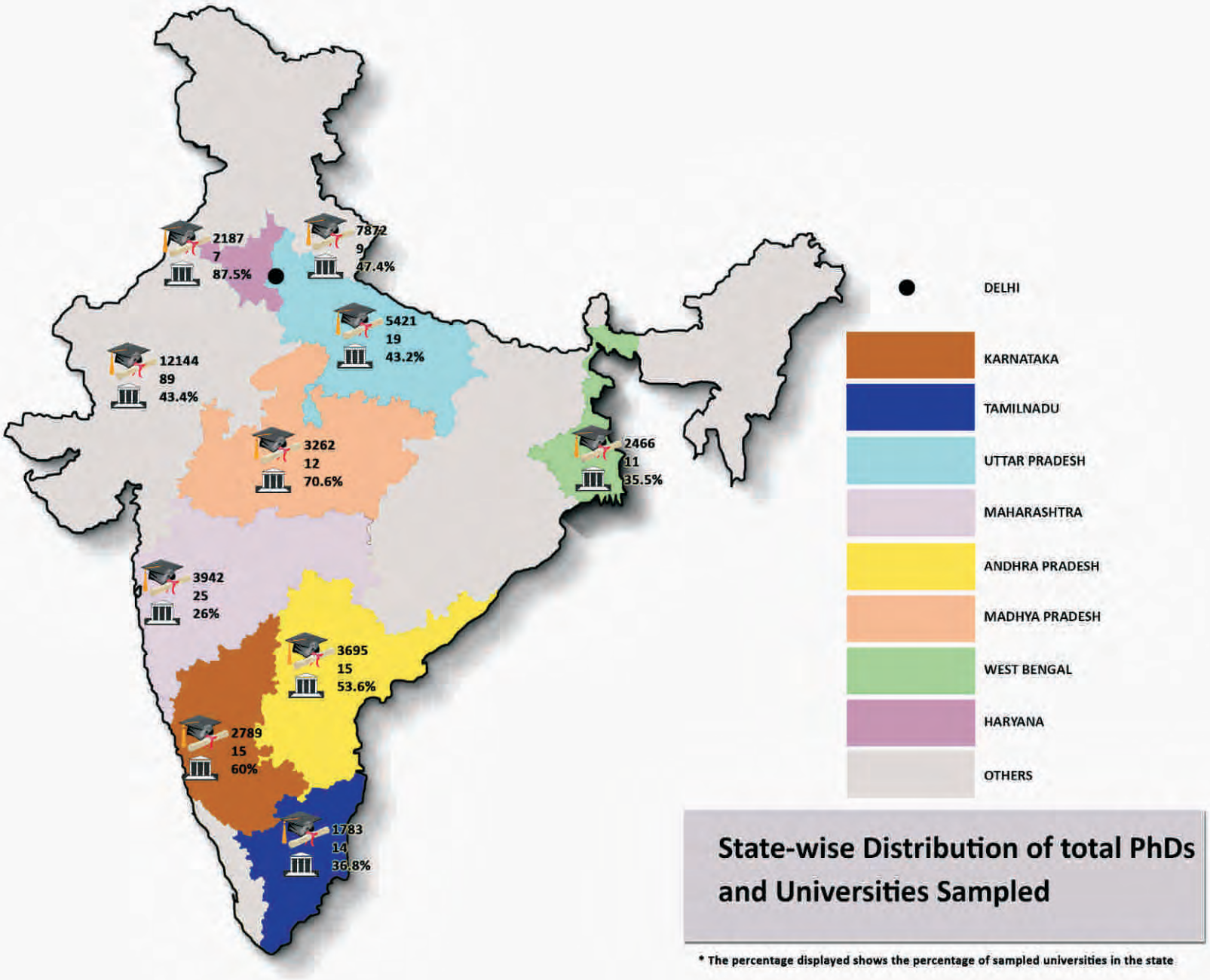
1. State-wise Distribution of PhDs Across 10 years.

Table 14: State-wise Distribution of total PhDs and Universities Sampled**

States	Female	Male	Total	Sampled number of Universities	Actual number of Universities	Percentage institutions Sampled
Andhra Pradesh	1173	2522	3695	15	28	53.6
	31.7%	68.3%	100.0%			
Haryana	805	1382	2187	07	8	87.5
	36.8%	63.2%	100.0%			
Karnataka	704	2085	2789	15	25	60.0
	25.2%	74.8%	100.0%			
Madhya Pradesh	1471	1791	3262	12	17	70.6
	45.1%	54.9%	100.0%			
Maharashtra	938	3004	3942	25	96	26.0
	23.8%	76.2%	100.0%			
New Delhi	2947	4925	7872	09	19	47.4
	37.4%	62.6%	100.0%			
Tamil Nadu	424	1359	1783	14	38	36.8
	23.8%	76.2%	100.0%			
Uttar Pradesh	1860	3561	5421	19	44	43.2
	34.3%	65.7%	100.0%			
West Bengal	600	1866	2466	11	31	35.5
	24.3%	75.7%	100.0%			
Others (<3.5%)	4375	7769	12144	89	205	43.4
	36%	64%	100.0%			
Total	15297	30264	45561	216	511	42.3
	33.6%	66.4%	100.0%			

The table above presents the distribution of PhDs across the states of India. For the purpose of facilitating analysis, states awarding the highest number of PhDs in the 10 years (i.e. states that have contributed to more than 3.5 percent of the total PhDs awarded) are shown in the table. (For a complete list of PhDs awarded across all states and union territories refer appendix I, table 14). The highest number of PhDs has been awarded in New Delhi (17.3 percent of total; refer appendix I, table 14). Delhi's contribution to the total PhD database is much higher compared to other states. The total number of universities and research institutes in Delhi is 19 of which 9 (47.4 percent) have been sampled.

*** The data represents 39.9 percent of the total data reported by secondary sources up to 2005.*



State-wise Distribution of total PhDs and Universities Sampled

* The percentage displayed shows the percentage of sampled universities in the state

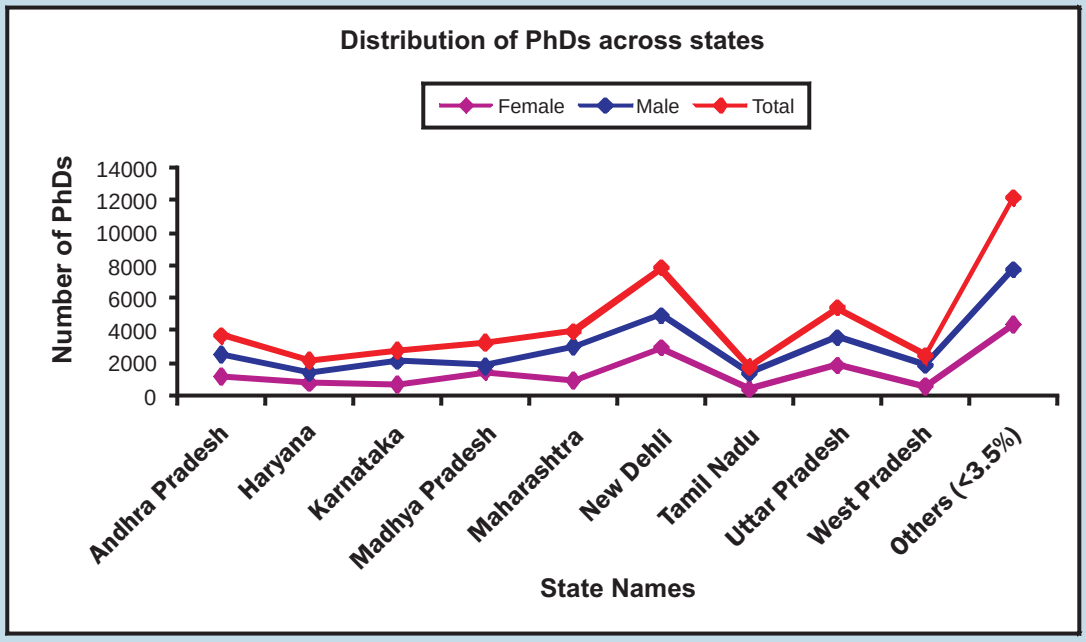
Despite the total number of research universities and institutions present and sampled being lesser than for other states such as Maharashtra (total of 96 institutions of which 25 were sampled), Uttar Pradesh (total of 44 with 19 sampled), Tamil Nadu (total of 38, with 14 sampled) and West Bengal (total 31 with 11 sampled), Delhi produces a considerably higher percent of PhDs than these other states. Factors such as history of higher education in Delhi, the history of institutions of higher education and research in Delhi, the reputation and quality of these institutes need to be further studied to understand the high rate of PhD production, and more importantly assess the quality of the PhDs. Further, the large-scale expansion of Delhi city, with the development of new suburban areas such as Noida, Greater Noida, Faridabad, Ghaziabad, etc. from where people travel daily into Delhi for education and work, could be another reason contributing the large number of PhDs. Delhi also attracts students and faculty from neighbouring states such as Haryana and Uttar Pradesh.

Uttar Pradesh has produced the second largest number of PhDs (5421, which is 11.9 percent of the total; refer appendix I, table 14). Despite Maharashtra having the highest number of universities and research institutions (96) in comparison to the other states, it contributes only 8.7 percent of the total PhDs. (However only 26 percent of the total universities and research institutions in Maharashtra have been sampled, and this could be a possible reason for the lower number of PhDs).

On the other hand, normalized data (Refer appendix I, table 15) for the states still shows Delhi performing significantly higher in terms of PhDs produces per institution (874.7 per university), followed by Haryana (312.4 per university) and Uttar Pradesh (285.3 per university). Tamil Nadu (with 127.4 PhDs per university) and Maharashtra (157.7 PhDs per university) still rank at the bottom (among the eight highest PhD producing states) with respect to the normalized data.

From table 14 above, it can also be seen that the highest proportion of Southern states (Andhra Pradesh, Karnataka and Tamil Nadu) are among the list of states contributing the highest number of PhDs (together they account for 18.1 percent of the PhDs). The state-wise trends described above indicate a need to re-examine the research performance capabilities and production of PhDs for individual states in terms of available infrastructure and resources, available man-power, nature of universities and institutions (e.g., central / state university) and quality parameters.

Graph 14: State wise Distribution of PhDs*



2. Gender Distribution of PhDs Across the States

With respect to the gender wise distribution of PhDs in individual states, women have received the highest proportion of PhDs in Madhya Pradesh (with 45.1 percent of the total, Refer Table 14 above). Similarly, Haryana also shows a smaller gender gap, with 36.8 percent of the total PhDs in the state going to women. States that have the largest gender differences in the number of PhDs awarded to women and men are Maharashtra and Tamil Nadu (23.8 percent PhDs were awarded to women in both states), West Bengal (with 24.3 percent PhDs to women) and Karnataka (25.2 percent PhDs to women). This is despite a higher proportion women's enrollment in higher education in these states such as 41.9 percent in Tamil Nadu, 40.6 percent in Karnataka and 38.2 percent in Maharashtra.

** The data represents 39.9 percent of the total data reported by secondary sources up to 2005.*

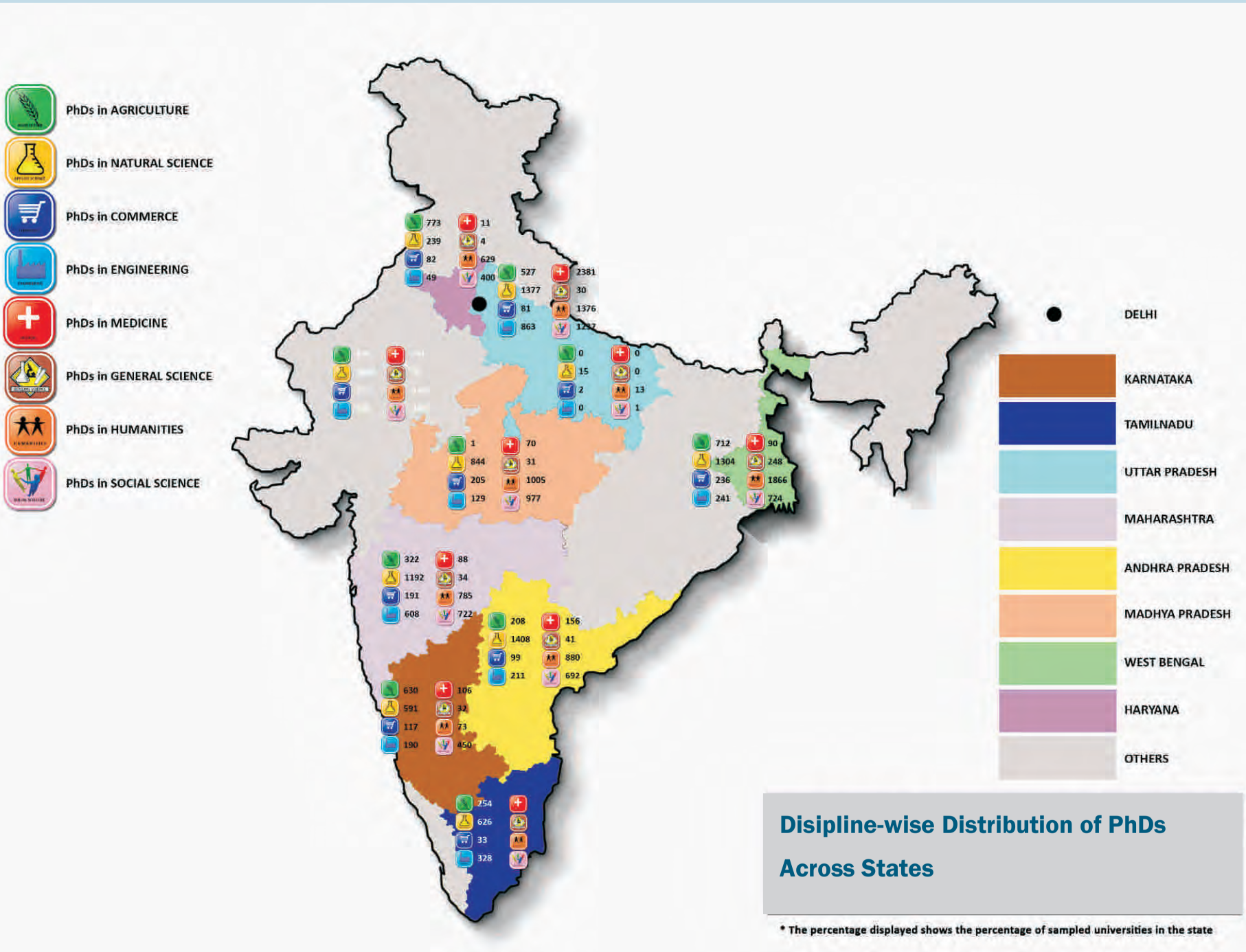
3. Discipline-wise Distribution of PhDs Across the States

Table 15: Discipline-wise Distribution of PhDs Across States*

State	Agricul-ture	Natural Science	Engineering & Technology	Medicine	Social Science	General Science	Human-ities	Comm-erce	Total
Andhra Pradesh	208	1408	211	156	692	41	880	99	3695
	3.5%	12.3%	5.4%	4.7%	8.6%	6.8%	8.0%	6.9%	8.1%
Haryana	773	239	49	11	400	4	629	82	2187
	13.2%	2.1%	1.2%	.3%	5.0%	.7%	5.7%	5.7%	4.8%
Karnataka	630	591	190	106	450	32	673	117	2789
	10.7%	5.2%	4.8%	3.2%	5.6%	5.3%	6.1%	8.1%	6.1%
Madhya Pradesh	1	844	129	70	977	31	1005	205	3262
	.0%	7.4%	3.3%	2.1%	12.2%	5.1%	9.2%	14.2%	7.2%
Maharashtra	322	1192	608	88	722	34	785	191	3942
	5.5%	10.4%	15.5%	2.7%	9.0%	5.6%	7.2%	13.3%	8.7%
New Delhi	527	1377	863	2381	1237	30	1376	81	7872
	9.0%	12.0%	22.0%	72.2%	15.4%	5.0%	12.5%	5.6%	17.3%
Tamil Nadu	254	626	328	26	272	70	174	33	1783
	4.3%	5.5%	8.4%	.8%	3.4%	11.6%	1.6%	2.3%	3.9%
Uttar Pradesh	0	15	0	0	1	0	13	2	31
	.0%	.1%	.0%	.0%	.0%	.0%	.1%	.1%	.1%
West Bengal	712	1304	241	90	724	248	1866	236	5421
	12.1%	11.4%	6.1%	2.7%	9.0%	41.1%	17.0%	16.4%	11.9%
Others	195	3044	598	341	2287	97	3170	327	12113
	3.3%	26.6%	15.3%	10.3%	28.6%	16.1%	28.9%	22.7%	26.6%
Total	5871	11449	3921	3298	8010	603	10970	1439	45561
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Despite the highest number of PhDs being awarded in New Delhi, it is interesting to note from Table 15 that Delhi has the highest percent of PhDs awarded only in Engineering & Technology (863, which is 22 percent of the total Engineering & Technology PhDs), Medicine (with a significant majority of 72.2 percent of the PhDs) and Social Science (15.4 percent PhDs). The highest proportion of Agricultural PhDs has been awarded in Haryana (with 13.2 percent of the PhDs). The highest number of Natural Science PhDs has been awarded in Andhra Pradesh (1408, 12.3 percent of the PhDs). West Bengal has the highest number of PhDs in Humanities (1866, 17 percent), General Science (248, 41.1 percent) and Commerce (236, 16.4 percent). However, the data with respect to disciplines needs to be analyzed in the light of the number of research institutions available for each discipline in the various states.

** The data represents 39.9 percent of the total data reported by secondary sources up to 2005.*



Disipline-wise Distribution of PhDs Across States

* The percentage displayed shows the percentage of sampled universities in the state

4. Zone-wise Distribution of PhDs Across Ten Years.

Table 16: Zonal Distribution of PhDs Across Ten Years.*

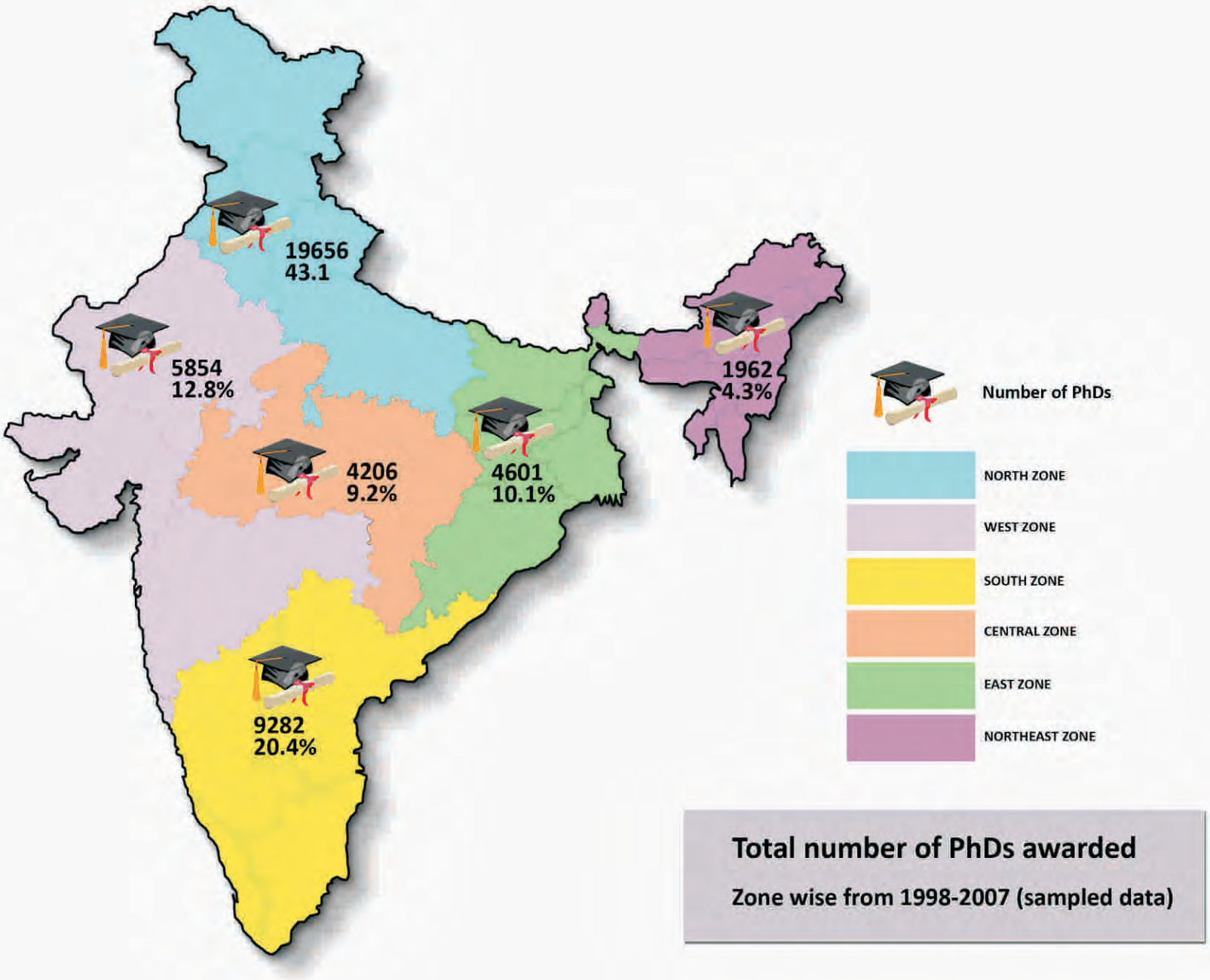
Zone	No. of PhDs	Percentage of Total PhDs	No. Of Universities sampled	Actual Number of Universities	Percent of Universities Sampled
South	9282	20.4	051	101	50.49
East	4601	10.1	035	083	42.16
West	5854	12.8	045	160	28.12
Central	4206	9.2	015	025	60.00
North East	1962	4.3	014	020	70.00
North	19656	43.1	056	121	46.28
Total	45561	100	216	510[6]	42.35

From the Table 16 it can be seen that the highest number of PhDs has been awarded in the North zone (accounting for 43.1 percent of the total data available). The number of PhDs awarded in the North zone is significantly higher when compared to the other 5 zones. This finding is significant in the light of the fact that the total number of institutions sampled in the North (56) and South (51) are almost equal (despite, a lower percentage of universities in the North sampled). In spite of this similarity in sampling, as well as actual number of institutions sampled the North accounts for more than double the number of PhDs as the South. Further analysis with respect to the research culture and efficiency in the two zones needs to be undertaken to optimize the production capacity of the country.

The North-East accounts for the least number of PhDs in the 10 years with only 4.3 percent of the total PhDs. However from the table it can be seen that the number of research institutions is least in the North-east (20), and hence the number of students having an opportunity to complete doctorates in the North-East may be low. The Central Zone shows the second lowest number of PhDs (9.2 percent of the total) in the 10 years followed by the East Zone (10.1 percent of the total). The East, which has a significantly higher number of Research institutions (83), of which 42.2 percent have been sampled, has contributed significantly lower.

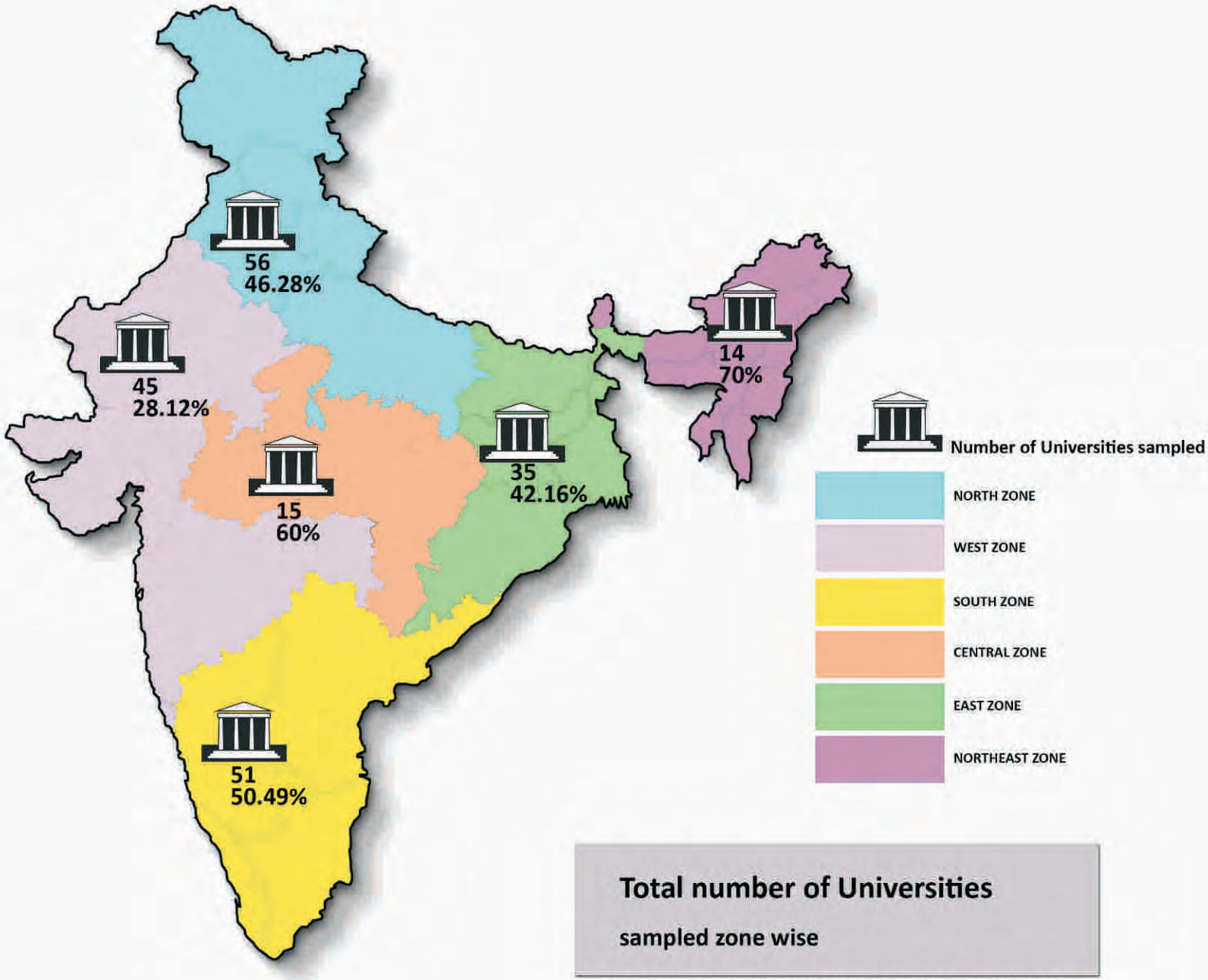
** The data represents 39.9 percent of the total data reported by secondary sources up to 2005, and covers 42.3 percent of the total PhD degree granting institutions in the country.*

[6] Of the total 511 universities in the country, 1 university in the Andaman and Nicobar Islands has not been considered for the zone-wise analysis of data as it does not fall within the six zones listed



Total number of PhDs awarded

Zone wise from 1998-2007 (sampled data)


56
46.28%
45
28.12%
15
60%
35
42.16%
14
70%
51
50.49%
Number of Universities sampled
NORTH ZONE
WEST ZONE
SOUTH ZONE
CENTRAL ZONE
EAST ZONE
NORTHEAST ZONE
Total number of Universities
sampled zone wise
* The percentage displayed shows the percentage of sampled universities in the Zone

5. Gender-wise Distribution of PhDs Awarded Across Zones for Ten Years

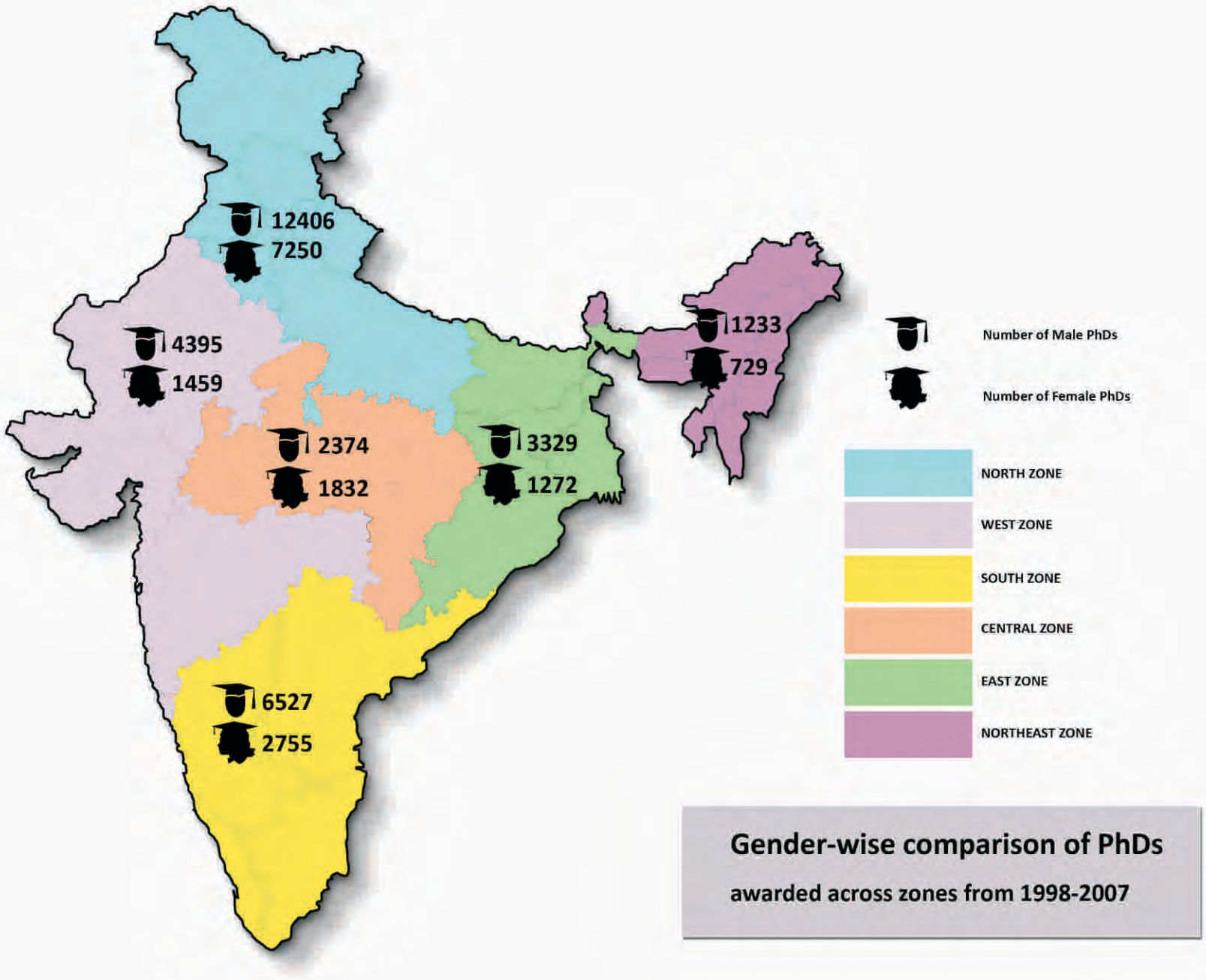
Table 17: Gender-wise Distribution of PhDs Across Zones for the Ten Years.*

Zone	Female	Male	Total
South	2755	6527	9282
	29.7%	70.3%	100.0%
East	1272	3329	4601
	27.6%	72.4%	100.0%
West	1459	4395	5854
	24.9%	75.1%	100.0%
Central	1832	2374	4206
	43.6%	56.4%	100.0%
North East	729	1233	1962
	37.2%	62.8%	100.0%
North	7250	12406	19656
	36.9%	63.1%	100.0%
Total	15297	30264	45561
	33.6%	66.4%	100.0%

The proportion of PhDs awarded to men and women varies from zone to zone. The regions with a higher proportion of women who have received PhDs include the Central zone (43.6 percent PhDs to women and 56.4 percent to men), North-East zone (37.2 percent PhDs to women and 62.8 percent to men) and the North zone (36.9 percent to women and 63.1 percent to men). The West zone has the lowest proportion of PhDs awarded to women (just 24.9 percent to women compared to 75.1 percent to men), followed by the East zone (27.6 percent to women and 72.4 percent to men) and South zone (29.7 percent women and 70.3 percent men).

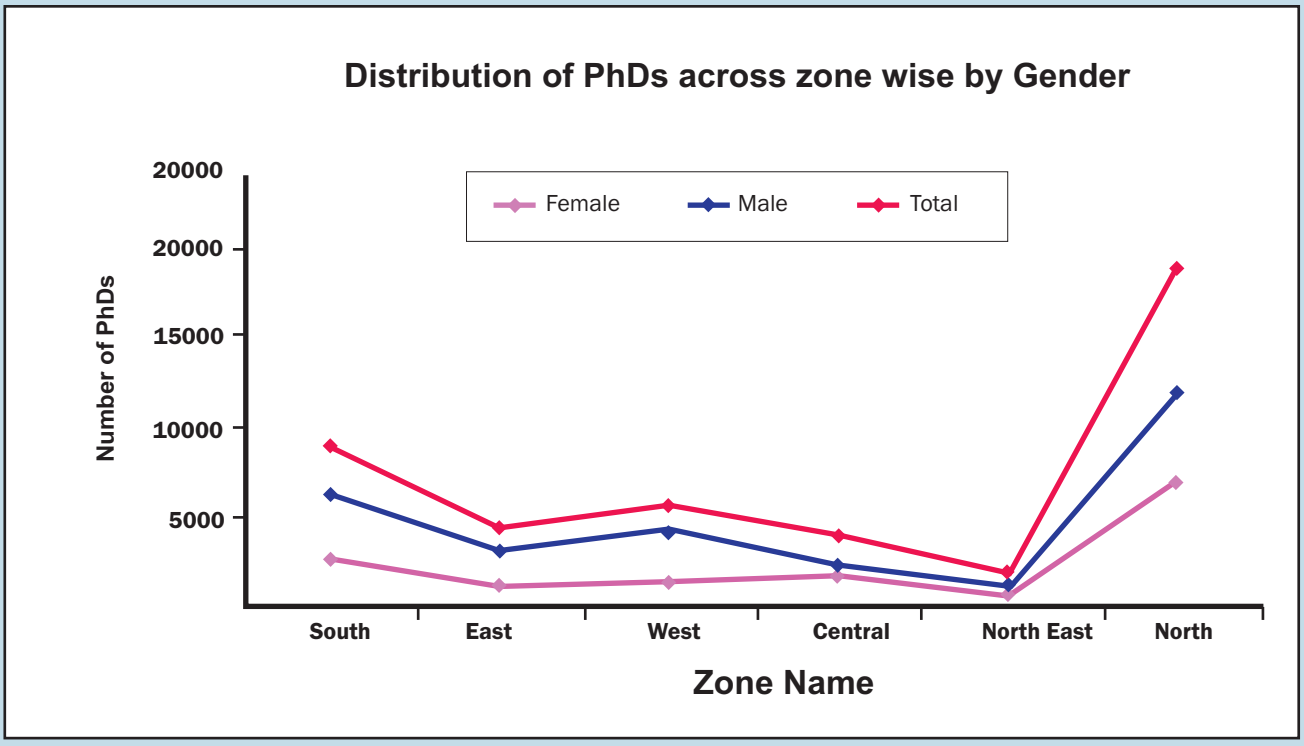
These figures are despite the higher enrollments for women in higher education in states such as Maharashtra (38.2 percent), Gujarat (43.7 percent) and Rajasthan (33 percent) in the West and Kerala (54.1 percent), Tamil Nadu (41.9 percent), Karnataka (40.6 percent) and Andhra Pradesh (37.3 percent) in the South . The data thus indicates a need to examine the research scenario to identify why women are less represented in these states and how changes may be brought about to encourage more participation of women in research.

** The data represents 39.9 percent of the total data reported by secondary sources up to 2005, and covers 42.3 percent of the total PhD degree granting institutions in the country.*


12406
7250
4395
1459
2374
1832
3329
1272
1233
729
6527
2755
Number of Male PhDs
Number of Female PhDs
NORTH ZONE
WEST ZONE
SOUTH ZONE
CENTRAL ZONE
EAST ZONE
NORTHEAST ZONE
Gender-wise comparison of PhDs
awarded across zones from 1998-2007

The data presented in this section highlights the need and importance of data on PhDs university/state/region-wise. Data of this nature is extremely crucial particularly at this point of time when the national government is looking at expansion. The need to address fair distribution cannot be further emphasized. The distribution of research capabilities that is by and large concentrated in certain metropolitan cities / states / regions needs to be redefined to ensure equity in the field of education.

Graph 15: Distribution of PhDs Across Zones, by Gender*



6. Discipline-wise distribution of PhDs across zones for 10 years

Across all disciplines, the highest number of PhDs has been awarded in the North zone, followed by the South. The least number of PhDs across disciplines has been awarded in the North-East zone. However these findings must be interpreted in the light of other data such as number of institutions available in the state and other socio-economic data for the states in the zone.

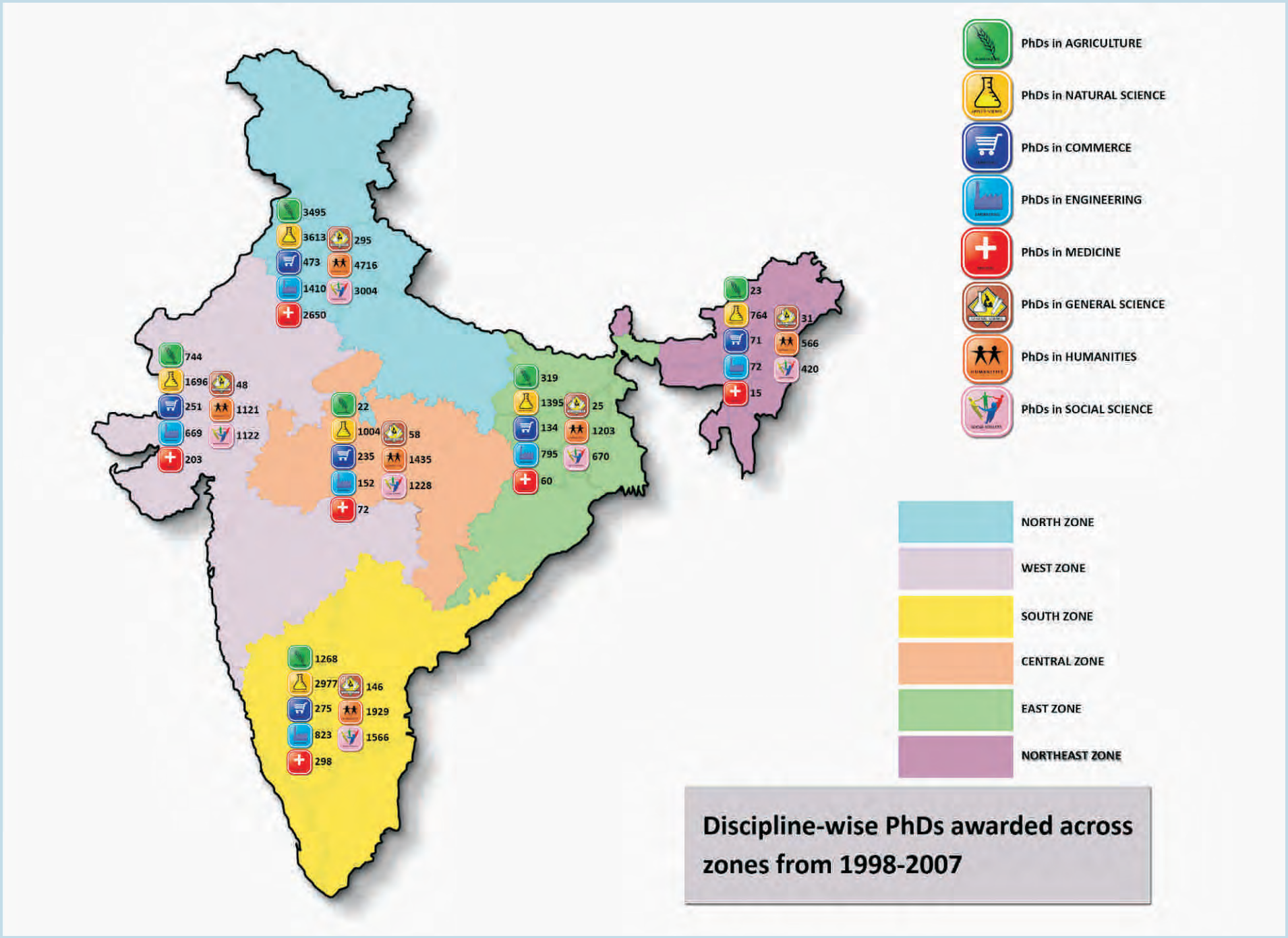
** The data represents 39.9 percent of the total data reported by secondary sources up to 2005, and covers 42.3 percent of the total PhD degree granting institutions in the country.*

Table 18: Discipline-wise Distribution of PhDs Across Zones for Ten Years*

Discipline	South	East	West	Central	North East	North	Total
Agriculture	1268	319	744	22	23	3495	5871
	21.6%	5.4%	12.7%	.4%	.4%	59.5%	100.0%
Natural Science	2977	1395	1696	1004	764	3613	11449
	26.0%	12.2%	14.8%	8.8%	6.7%	31.6%	100.0%
Engineering & Technology	823	795	669	152	72	1410	3921
	21.0%	20.3%	17.1%	3.9%	1.8%	36.0%	100.0%
Medicine	298	60	203	72	15	2650	3298
	9.0%	1.8%	6.2%	2.2%	.5%	80.4%	100.0%
Social Science	1566	670	1122	1228	420	3004	8010
	19.6%	8.4%	14.0%	15.3%	5.2%	37.5%	100.0%
General Science	146	25	48	58	31	295	603
	24.2%	4.1%	8.0%	9.6%	5.1%	48.9%	100.0%
Humanities	1929	1203	1121	1435	566	4716	10970
	17.6%	11.0%	10.2%	13.1%	5.2%	43.0%	100.0%
Commerce	275	134	251	235	71	473	1439
	19.1%	9.3%	17.4%	16.3%	4.9%	32.9%	100.0%
Total	9282	4601	5854	4206	1962	19656	45561
	20.1%	10.1%	12.8%	9.2%	4.3%	43.1%	100.0%

With respect to individual zones themselves, the highest number of PhDs in the South, East, West and North-East has been awarded in Natural Sciences (32.1 percent, 30.3 percent, 29 percent and 38.9 percent of the total PhDs for the zone respectively). The Central and north zones have the highest number of PhDs in Humanities (34.1 percent and 24 percent of total PhDs awarded in the zone, respectively). All zones with the exception of the Central and East zones have received the least number of PhDs in General Science. The Central Zone has received the lowest number of PhDs in Agriculture (22, which is 0.5 percent of the total PhDs in the Central Zone). This maybe due to a lower number of agricultural institutes in the zone compared to other zones. The East Zone has the lowest number of PhDs in Medicine (15, 0.8 percent of total PhDs in the zone). The East also shows low numbers in Agriculture (23, 1.2 percent of total).

** The data represents 39.9 percent of the total data reported by secondary sources up to 2005.*


PhDs in AGRICULTURE
PhDs in NATURAL SCIENCE
PhDs in COMMERCE
PhDs in ENGINEERING
PhDs in MEDICINE
PhDs in GENERAL SCIENCE
PhDs in HUMANITIES
PhDs in SOCIAL SCIENCE
3495
3613
295
473
4716
1410
3004
2650
744
1696
48
251
1121
669
1122
203
22
1004
58
235
1435
152
1228
72
319
1395
25
134
1203
795
670
60
23
764
31
71
566
72
420
15
1268
2977
146
275
1929
823
1566
298
NORTH ZONE
WEST ZONE
SOUTH ZONE
CENTRAL ZONE
EAST ZONE
NORTHEAST ZONE
Discipline-wise PhDs awarded across zones from 1998-2007

IV. COMPARISON OF TRENDS IN THE SCIENCES

1. A Year-wise Breakup of the Number of PhDs Awarded in Sub-categories of Science Across the Decade

Table 19: year-wise Distribution of PhDs in Sub-categories of Science*

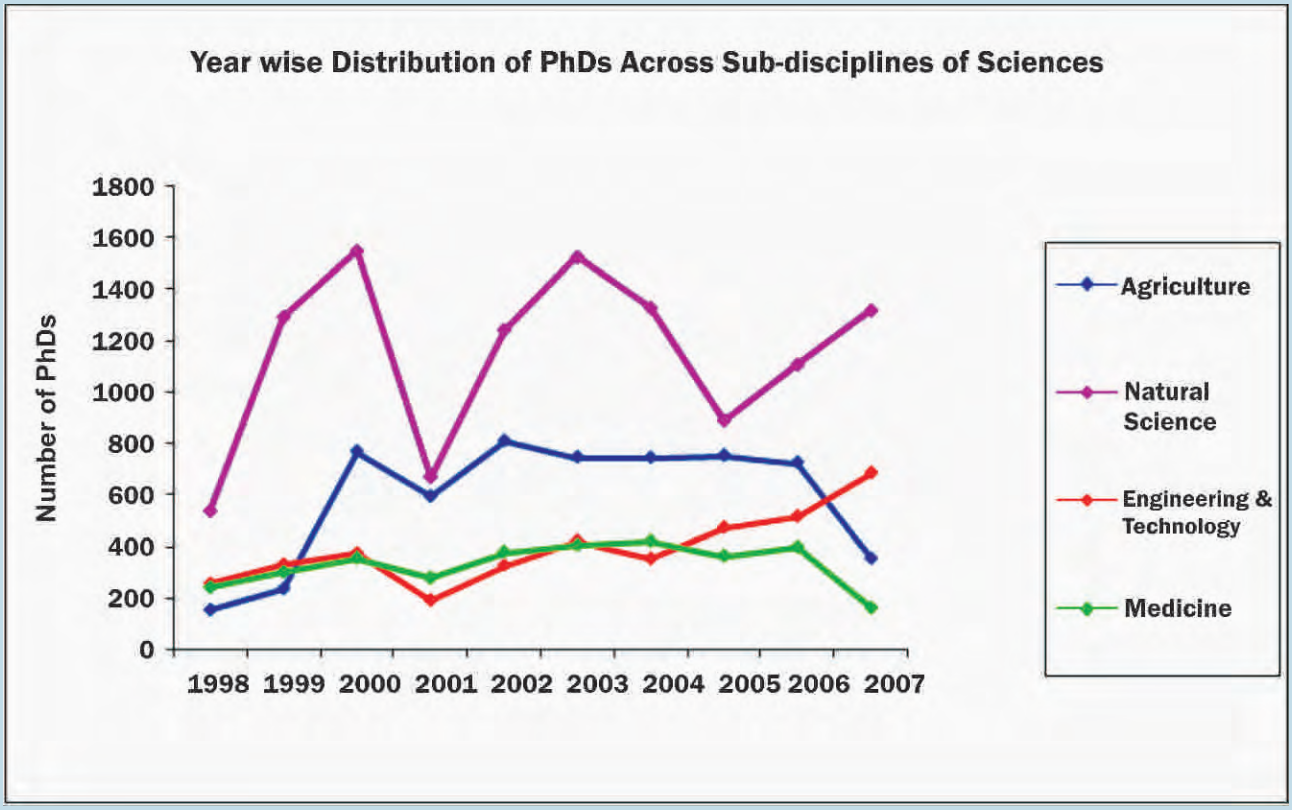
Year	Agriculture	Natural Science	Engineering & Technology	Medicine	Total
1998	152	535	255	241	1183
	12.8%	45.2%	21.6%	20.4%	100.0%
1999	234	1292	330	301	2157
	10.8%	59.9%	15.3%	14.0%	100.0%
2000	768	1548	373	355	3044
	25.2%	50.9%	12.3%	11.7%	100.0%
2001	592	668	190	277	1727
	34.3%	38.7%	11.0%	16.0%	100.0%
2002	809	1241	326	378	2754
	29.4%	45.1%	11.8%	13.7%	100.0%
2003	745	1525	421	405	3096
	24.1%	49.3%	13.6%	13.1%	100.0%
2004	743	1328	352	420	2843
	26.1%	46.7%	12.4%	14.8%	100.0%
2005	752	888	473	363	2476
	30.4%	35.9%	19.1%	14.7%	100.0%
2006	724	1106	516	397	2743
	26.4%	40.3%	18.8%	14.5%	100.0%
2007	352	1318	685	161	2516
	14.0%	52.4%	27.2%	6.4%	100.0%
Total	5871	11449	3921	3298	24539
	23.9%	46.7%	16.0%	13.4%	100.0%

The total number of PhDs for 10 years in the Sciences (which includes Natural Sciences, Engineering & Technology, Medicine and Agriculture) is 24,539. Of this, the highest proportion of PhDs has been awarded in Natural Sciences with 11,449 PhDs (46.7 percent of the total), followed by Agriculture which has 5871 PhDs (23.9 percent). Engineering and Technology and Medicine have a relatively modest number of PhDs in comparison (Engineering accounts for 16.1 percent while Medicine accounts for 13.4 percent).

** The data represents 24.0 percent of the total science PhDs, 31.2 percent of agricultural PhDs and 41 percent of Engineering PhDs reported by secondary sources up to 2005.*

Such low numbers in these disciplines may perhaps be due to the professional nature of the disciplines as well as higher incomes related with careers in the fields compared to research in the disciplines. This may also be related to the poor structure and management of the two disciplines in the country.

Graph 16: Year-wise Distribution of PhDs Across Sub-disciplines of Science*



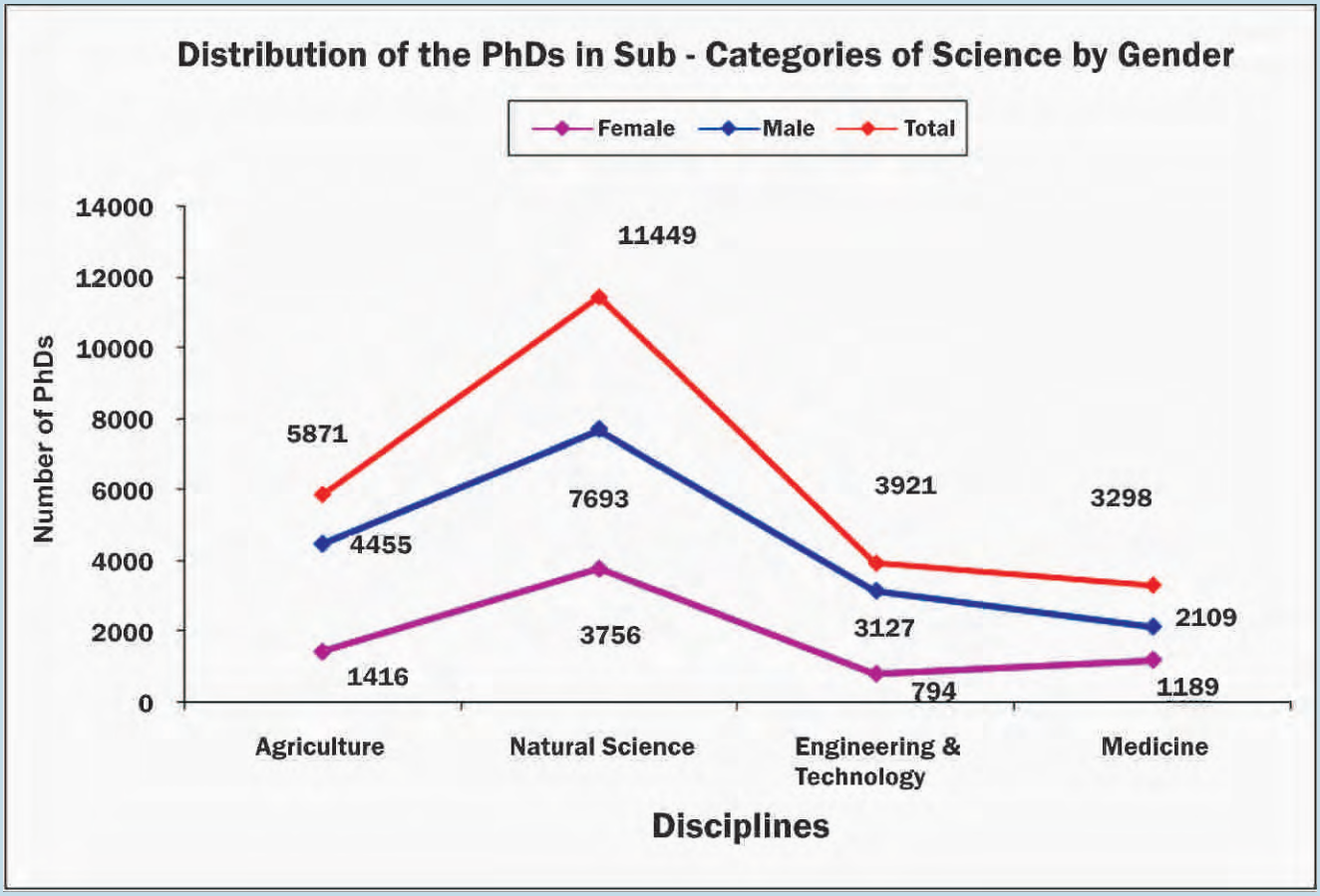
From Graph 16 it can be seen that the Natural Sciences have constantly received the highest number of PhDs across the 10 years. Agriculture which started at the lowest mark in 1998 has overtaken the other two science disciplines, namely Engineering and Technology and Medicine in the 10 years, though it has fallen below Engineering and Technology in the last two years. In comparison to the other disciplines, Medicine has shown the least growth. For the two disciplines, Natural Sciences and Agriculture, the least number of PhDs was awarded in the initial period in 1998 (4.7 percent of total and 2.6 percent of the total, respectively). For Engineering and Technology, the lowest number of PhDs was awarded in 2001 (4.8 percent of the total), perhaps mirroring the sudden growth of the IT, ITES, BPO and call centre industries which drew a large segment of the working-age population. It may also be related to the fact that during these years the income gap between the teaching faculty and IT industry was starkly high. The recruitment of faculty to universities by and large in the country has also relatively reduced. For Medicine, the least number of PhDs has been awarded in 2007 (4.9 percent of the total), which may be a result of the growth in bio-technology and other technology related biological and medical fields.

** The data represents 24.0 percent of the total science PhDs, 31.2 percent of agricultural PhDs and 41 percent of Engineering PhDs reported by secondary sources up to 2005.*

The highest number of PhDs for Natural Sciences was awarded in 2000 (13.5 percent of total); for Agriculture it was in 2002 (receiving 13.8 percent of total); Engineering and Technology which shows a rising trend in PhDs has received the highest numbers in 2007 (17.5 percent of total); and Medicine has received the highest numbers in 2004 (12.7 percent of total).

2. Gender-wise Distribution of PhDs awarded Across Sciences for Ten Years

Graph 17: Distribution of PhDs in Sub-Categories of Science by Gender*



An analysis of the gender distribution of PhDs in the science fields shows that men have received more PhDs (70.8 percent of Science PhDs) than women (29.2 percent of total) on the whole, as well as in all individual disciplines. The difference in the proportion of PhDs awarded to men and women is least for Medicine (36.1 percent to women and 63.9 percent to men), and the highest for Engineering and Technology (20.2 percent to women compared to 79.8 percent for men). This indicates that while impetus for women's participation in scientific research must be given for all disciplines, there is a far greater need to concentrate efforts in Engineering Education, which has traditionally also been considered a male domain, by examining the factors responsible in the realm of society, family and institutions.

** The data represents 24.0 percent of the total science PhDs, 31.2 percent of agricultural PhDs and 41 percent of Engineering PhDs reported by secondary sources up to 2005.*

3. Zone-wise Distribution of PhDs in Science

Table 20: Zone-wise Distribution of PhDs in Science*

Zones	Agriculture	Natural Science	Engineering & Technology	Medicine	Total
South	1268	2977	823	298	5366
	23.6%	55.5%	15.3%	5.6%	100.0%
East	319	1395	795	60	2569
	12.4%	54.3%	30.9%	2.3%	100.0%
West	744	1696	669	203	3312
	22.5%	51.2%	20.2%	6.1%	100.0%
Central	22	1004	152	72	1250
	1.8%	80.3%	12.2%	5.8%	100.0%
North East	23	764	72	15	874
	2.6%	87.4%	8.2%	1.7%	100.0%
North	3495	3613	1410	2650	11168
	31.3%	32.4%	12.6%	23.7%	100.0%
Total	5871	11449	3921	3298	24539
	23.9%	46.7%	16.0%	13.4%	100.0%

Across all disciplines of Science, the highest number of PhDs has been awarded in the North zone. The least number of PhDs in all disciplines except Agriculture has been awarded in the North-East zone. In Agriculture the least number of PhDs was awarded in the Central zone.

Medicine has received the least number of PhDs in all zones, with the exception of the North zone. The least number of PhDs in the North-zone has been awarded in Engineering and Technology (12.6 percent of the total Science PhDs). Across all the zones Natural Sciences have received the highest proportion of PhDs compared to the other disciplines. The gap between the Natural Sciences and other disciplines is least in the North Zone (32.4 percent PhDs in Natural Science compared to 31.3 percent in Agriculture and 23.7 percent in Medicine). The gap is the highest in the North-East which has 87.4 percent in Natural Science compared to 1.7 percent in Medicine, 2.6 percent in Agriculture, and 8.2 percent in Engineering and Technology. This suggests a need to examine the North-east zone in terms of the type of institutions available for higher studies.

** The data represents 24.0 percent of the total science PhDs, 31.2 percent of agricultural PhDs and 41 percent of Engineering PhDs reported by secondary sources up to 2005.*

V. COMPARISON OF TRENDS IN ARTS

1. A year-wise breakup of number of PhDs awarded in Sub-categories of Arts across the decade

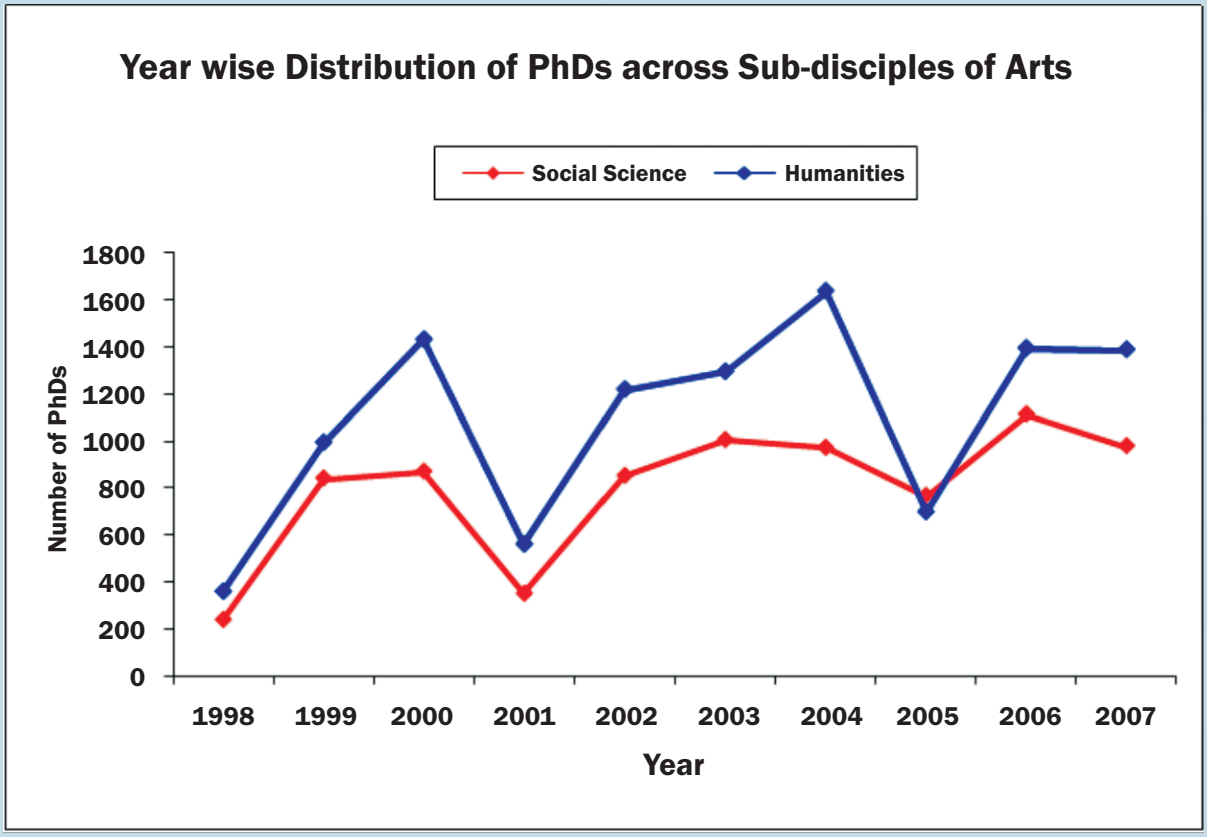
Table 21: Year-wise Distribution of PhDs in Sub-categories of Arts*

Year	Social Science	Humanities	Total
1998	246	365	611
	40.3%	59.7%	100.0%
1999	843	994	1837
	45.9%	54.1%	100.0%
2000	872	1428	2300
	37.9%	62.1%	100.0%
2001	357	565	922
	38.7%	61.3%	100.0%
2002	854	1217	2071
	41.2%	58.8%	100.0%
2003	1005	1292	2297
	43.8%	56.2%	100.0%
2004	972	1632	2604
	37.3%	62.7%	100.0%
2005	770	701	1471
	52.3%	47.7%	100.0%
2006	1112	1391	2503
	44.4%	55.6%	100.0%
2007	979	1385	2364
	41.4%	58.6%	100.0%
Total	8010	10970	18980
	42.2%	57.8%	100.0%

The total number of PhDs awarded under Social Sciences and Humanities is 18980. Humanities has a higher proportion of PhDs (10,970 which is 57.8 percent of the total), compared to Social Sciences (8010, which is 42.2 percent of total).

** The data represents 27.4 percent of the total Arts PhDs data reported by secondary sources up to 2005.*

Graph 18: Year-wise Distribution of PhDs across Sub-disciplines of Arts*

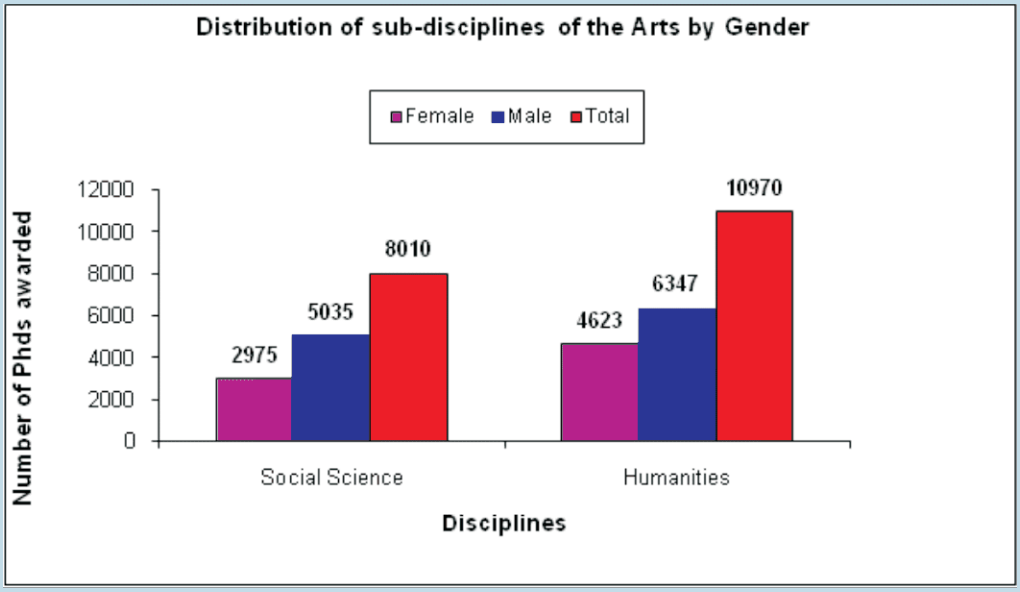


The annual number of PhDs has been constantly higher for Humanities in the Arts category, with the exception of 2005, when Social Sciences received marginally higher numbers (52.2 percent PhDs were awarded to Social Sciences while 47.7 percent of the total PhDs were awarded to Humanities for 2005). The difference in numbers for the two disciplines is the highest in 2004 (62.7 percent PhDs was awarded to Humanities compared to 37.3 percent to Social Sciences). For both disciplines the least number of PhDs was awarded in 1998 (3.1 percent of total for Social Science and 3.3 percent of total for Humanities). The highest proportion of PhDs was awarded in 2006 for Social Sciences (13.9 percent of total), and in 2004 for Humanities (14.9 percent of total). From the graph it can be seen that the fluctuations in the number of PhDs awarded has been greater for the Humanities in the 10 year period.

** The data represents 27.4 percent of the total Arts PhDs data reported by secondary sources up to 2005.*

2. Gender-wise Distribution of PhDs awarded in Arts for Ten Years

Graph 19: Distribution of PhDs in Sub-Categories of Arts by Gender*



A higher proportion of women have received a PhD in Humanities (42.1 percent) compared to Social Sciences (37.1 percent). It is interesting to see that even in subjects traditionally considered to be "for girls', men outdo women in the number of PhDs. Overall, the percentage of women with a PhD in Arts is 40 percent while, 60 percent men received a PhD in Arts.

3. Zone-wise Distribution of PhDs in Arts

Table 22: Zone wise Distribution of PhDs in Arts*

Zone	Social Science	Humanities	Total
South	1566	1929	3495
	44.8%	55.2%	100.0%
East	670	1203	1873
	35.8%	64.2%	100.0%
West	1122	1121	2243
	50.0%	50.0%	100.0%
Central	1228	1435	2663
	46.1%	53.9%	100.0%
North East	420	566	986
	42.6%	57.4%	100.0%
North	3004	4716	7720
	38.9%	61.1%	100.0%
Total	8010	10970	18980
	42.2%	57.8%	100.0%

** The data represents 27.4 percent of the total Arts PhDs data reported by secondary sources up to 2005.*

From the table it can be seen that the highest number of PhDs in both Social Sciences and Humanities has been awarded in the North (37.5 percent of total Social Science PhDs and 43.1 percent of Humanities PhDs), and the least in North-East (5.2 percent of Social Science and Humanities PhDs). With the exception of the Central Zone and West zone, all zones have received more number of PhDs in Humanities. In the West zone, there is not much difference between the two disciplines in terms of percentage of PhDs awarded (with a difference of only 1 PhD). The difference is the largest in the East zone (with 35.8 percent PhDs in Social Sciences compared to 64.2 percent in Humanities).

VI. COMPARISON OF SCIENCE AND ARTS

1. A Year-wise Breakup of Number of PhDs Awarded in Science & Arts Across the Decade

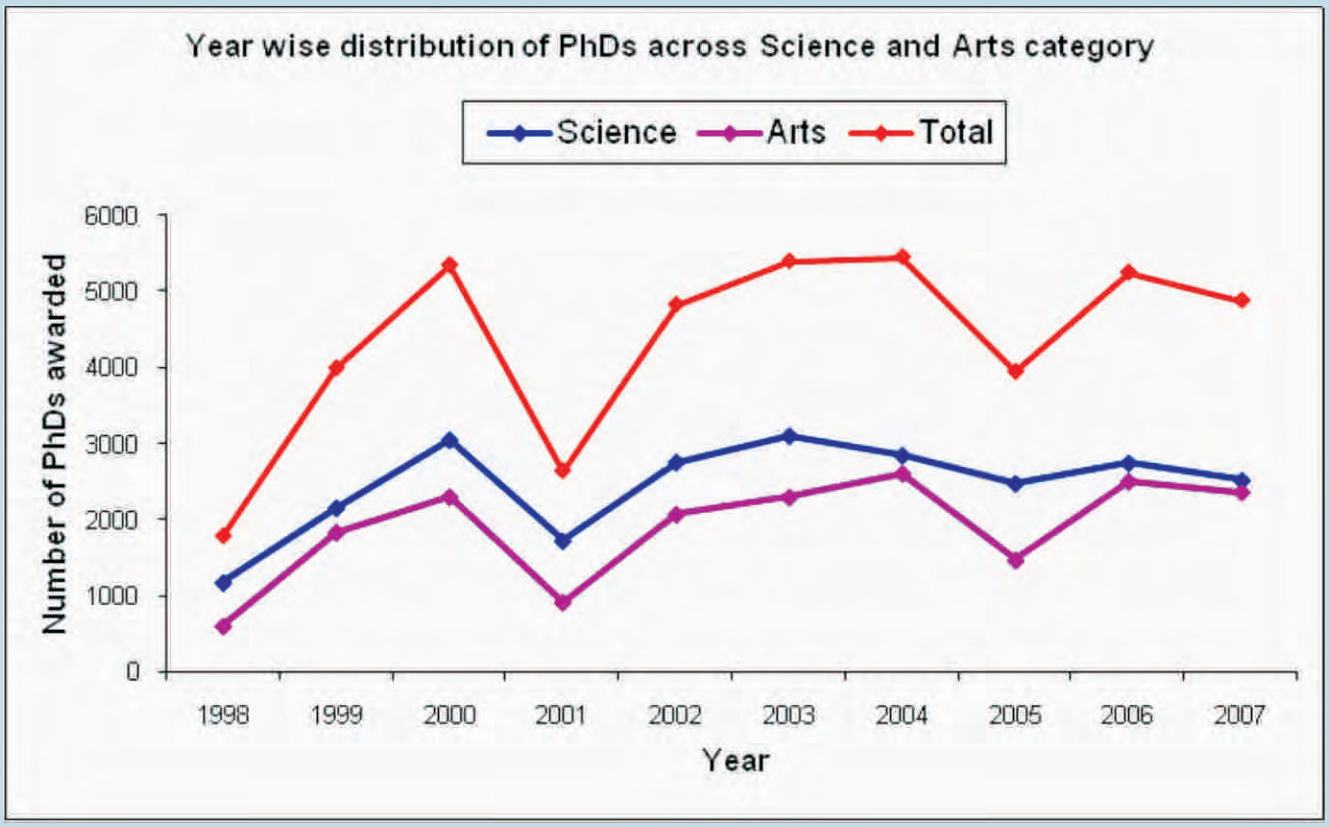
Table 23: Year-wise Distribution of PhDs in Science and Arts*

Year	Science	Arts	Total
1998	1183	611	1794
	65.9%	34.1%	100.0%
1999	2157	1837	3994
	54.0%	46.0%	100.0%
2000	3044	2300	5344
	57.0%	43.0%	100.0%
2001	1727	922	2649
	65.2%	34.8%	100.0%
2002	2754	2071	4825
	57.1%	42.9%	100.0%
2003	3096	2297	5393
	57.4%	42.6%	100.0%
2004	2843	2604	5447
	52.2%	47.8%	100.0%
2005	2476	1471	3947
	62.7%	37.3%	100.0%
2006	2743	2503	5246
	52.3%	47.7%	100.0%
2007	2516	2364	4880
	51.6%	48.4%	100.0%
Total	24539	18980	43519
	56.4%	43.6%	100.0%

** The data represents 24.0 percent of the total science PhDs and 27.4 percent of the total Arts PhDs data reported by secondary up to 2005.*

A comparison of all Science and Arts subjects shows the total number of PhDs in Sciences (24,539) to be higher than for Arts (18,980). Sciences account for 56.4 percent of the PhDs awarded in the 10 years, while the Arts disciplines account for 43.6 percent of the PhDs.

Graph 20: Year wise Distribution of PhDs in Science and Arts*

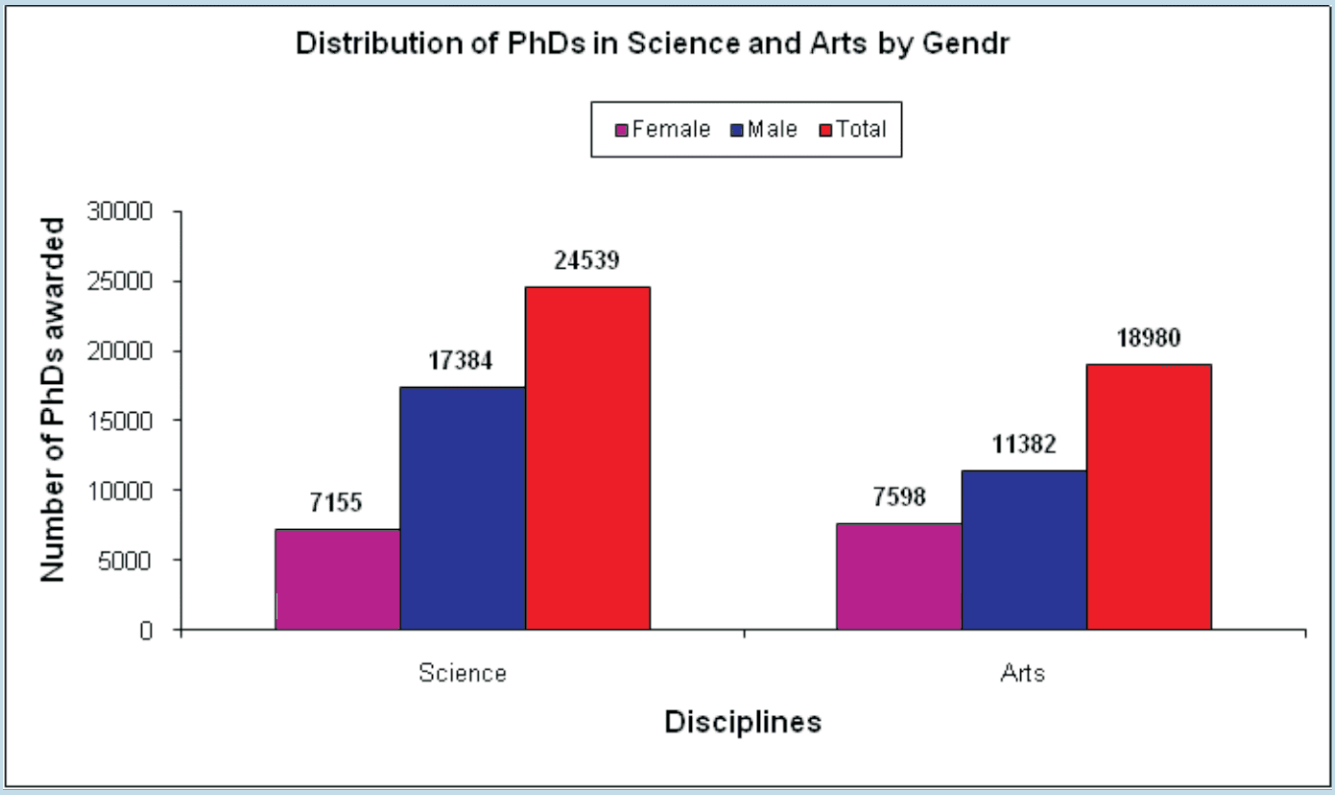


From Graph 20 it can be seen that the number of PhDs awarded in the Sciences has been constantly higher compared to that awarded for Arts. However the difference in annual numbers for the two groups has been small. The gap in numbers has increased from 2000 to 2003, reduced in 2004, and again increased in 2005. The gap has considerably reduced for 2006-2007, with the numbers coming very close to each other. The gap between the two disciplines is the least in 2007, with 48.4 percent of the total PhDs awarded in Arts and 51.7 percent in Science. The gap was the highest in 1998 with 34.1 percent PhDs awarded in Arts category and 65.9 percent in Science category.

** The data represents 24.0 percent of the total science PhDs and 27.4 percent of the total Arts PhDs data reported by secondary up to 2005.*

2. Gender-wise Distribution of PhDs Awarded Across Science & Arts for Ten Years

Graph 21: Distribution of PhDs in Science and Arts by Gender*



The ratio of women receiving a PhD in Arts is much higher (40 percent) when compared to Science (29.2 percent). This indicates a need to bring about a general balance in the practice of science. Awarding of PhDs is one step in the process of preparing qualified professionals in a field. More importantly, there is a need to examine how much of this is reflected in the employment scenario in the country. The distribution of faculty across universities and research institutes will be insightful. Similarly, the gender distribution of faculty across disciplines and universities will also add to the analysis. Data regarding availability, future demand for faculty, gender/disciplines/university/state-wise needs to be made available to undertake appropriate policies at the national level.

** The data represents 24.0 percent of the total science PhDs and 27.4 percent of the total Arts PhDs data reported by secondary up to 2005.*

3. Zone-wise Distribution of PhDs in Science and Arts

Table 24: Zone wise distribution of PhDs in Science and Arts*

Zone	Science	Arts	Total
South	5366	3495	8861
	60.6%	39.4%	100.0%
East	2569	1873	4442
	57.8%	42.2%	100.0%
West	3312	2243	5555
	59.6%	40.4%	100.0%
Central	1250	2663	3913
	31.9%	68.1%	100.0%
North East	874	986	1860
	47.0%	53.0%	100.0%
North	11168	7720	18888
	59.1%	40.9%	100.0%
Total	24539	18980	43519
	56.4%	43.6%	100.0%

The highest number of PhDs in Science and Arts has been awarded in the North zone (45.5 percent in Science and 40.7 percent in Arts) and the least in the North-East zone (3.6 percent in Science and 5.2 percent in Arts). (Refer appendix I, table 16 for details). More number of PhDs has been awarded in Science in all zones with the exception of the Central zone (68.1 percent of the total PhDs in the zone has been awarded in Arts) and the North East zone (53 percent of total has been awarded in Arts). The difference in the number of PhDs awarded is the least between the two disciplines in the North-East (a difference of 6 percent between the two disciplines) and highest in the South (21.2 percent difference with more PhDs in Science).

** The data represents 24.0 percent of the total science PhDs and 27.4 percent of the total Arts PhDs data reported by secondary up to 2005.*

RECOMMENDATIONS

The need for an analysis of the higher education scenario, particularly research and development capacity in India cannot be underscored enough.

Important lessons in how to stay competitive can be taken from countries such as the USA, UK, China and Australia, which despite a better performing higher education and research sector, periodically engage in critical self-evaluation to consolidate and retain their edge. For example, the U.S. Secretary of Education has set up a Commission on the Future of Higher Education in the United States as of September 2005 with an investment of US$ 134 billion over the next 10 years to be in the forefront in higher education and innovation. Innovations in financing of higher education, teaching and research and portable students' funding has helped the UK overcome the crisis of inadequate funding and failing accountability in its universities in recent times. Cost-sharing and cost-recovery reforms were introduced in China to stimulate growth in higher education (Agarwal, 2006). To bring about such systematic changes an in-depth knowledge of the performance of the higher education sector and a critical analysis of its functioning is required

India, despite an early advantage shows a considerable decline in performance in academic research and doctoral education output at present (Chatterjea & Mollik, 2006). The reasons for this are numerous, and include problems of inadequate resources and facilities for doctoral students, poor numbers of high-quality faculty required to advise students, poor financing of higher education, in particular doctoral education in India, etc. **In addition to these an important factor remains the lack of adequate current data on higher education and academic research that will be useful in steering India towards building academic research and R&D capacity.**

A preliminary attempt has been made through the **'Trends in Higher Education'** project, a **joint initiative** of **National-Institute of Advanced Studies (NIAS)** and **INFLIBNET,** funded by the **Tata Consultancy Services (TCS)**, to analyze the current PhD scenario in the country and provide a set of useful recommendations. The recommendations drawn from the findings of this study are given below.

1. Creation and Maintenance of a Comprehensive National level Database on PhDs: Data on higher education, particularly India's future available research capacity, measured in terms of the output of doctoral candidates, faculty available to advise students, institutions for doctoral education, their regional and state-wise spread, etc. are extremely important for planning. In the absence of such information, INFLIBNET and NIAS have attempted to create a network of institutions that provide information regarding doctoral degrees awarded annually.

a. This network needs to be strengthened, expanded and provided with the required mandate to access information from all degree granting institutions, including agricultural, technical and medical institutions, deemed universities, private and public sector institutions, etc., to have current data on the education scenario.

b. Such data needs to then be periodically subjected to analysis, to implement relevant policies that will help India maintain a competitive edge in research.

c. A single agency in charge of the database of annually awarded PhDs in the country, which can coordinate with all institutions, is necessary to avoid duplication of the data and differences in numbers reported. Such an agency should also become a nodal point of communication to all – policy makers, researchers, educationists, students, etc who may require access to such data for further analysis or reference.

d. There is an urgent need to create an awareness of the importance of this database to the nation. This should be linked to INFLIBNET, which has been set up by UGC and is the nodal agency for maintaining the bibliographic details of theses submitted by scholars in all universities of India. While it has been successful to a great extent in maintaining and updating national theses database, more efforts needs to be made to strengthen it and make it comprehensive.

e. **The PhD database can be strengthened using new enabling technologies to link individual institutional libraries with the national database.** This will facilitate access to information regarding research undertaken as well as allow access to electronic theses submitted to various universities in the country. This linkage of libraries which can provide access to individual theses is extremely important since such data is unavailable elsewhere in the country. **Since libraries receive a copy of all theses submitted at their institutions, they are in the best position to maintain an accurate record.** However, optimal use of technology and developing e-theses format requires adequate technology training for all university librarians.

f. This should be complemented by developing an online database of PhD students' profiles. Online submission of the students' profile details should be made mandatory by all universities. The information in the profile should include: a) name of the researcher, b) gender of researcher c) major discipline under which PhD was undertaken d) PhD Topic e) Advisor's name f)year of joining g) year of submission h) department, i) university which awarded the PhD j) State k) Current occupation l) part-time or full-time, etc. For ease of use, the online profile tracking system should have drop-down menus with multiple choices for selection of discipline, zone, state etc. This online profile must also have mirror sites in the North, East, South, West zones in different

the states and at INFLIBNET. This information needs to be publicized and done on a campaign mode with a defined time period of one year. The universities must be an integral part of this campaign.

2. Improving Productivity by Establishing Linkages between PhD Output and Changing Job Market: The total number of PhDs across the 10 years covered in the study is 45,561. The number of PhDs covered in the study is approximately 39.9 percent of the total PhDs awarded in the country (up to 2005). In terms of the actual PhD production in the country itself, only 0.25 of those enrolled at the graduate level enroll at the PhD level.

a. As a first step, it is important for policy planners in the country to study the occupational profiles of PhD holders and understand to what extent there exist a gap between demand for and supply of doctorates. Several reports and researches have documented the absence of the availability of highly trained faculty to address the student-teacher ratio in higher education. In addition to these requirements, it is important to understand to what extent this gap in PhD out-turn must be filled, and in what domains of knowledge.

b. In addition to the number of PhDs awarded, there is a need to analyze the production of PhDs in relation to the history of the university, the departments and the year of starting of the departments, number of faculty, infrastructural facilities available, etc.

c. Another important dimension will be the quality of PhDs in terms of its contribution to the body of knowledge through publications in journals and books, its forward and backward linkages to technology and society and its contribution to the contemporary knowledge production process. These are vital aspects and ways to record the same need to be developed. However, in the absence of numbers, which is the first step, such analysis will not be possible.

3. Improving Women's Representation in Research: In terms of gender differences, women's enrollment in higher education has grown from 10 percent in the 1950s to 38 percent as of 2006. At the PhD level, there has been a growth in women's enrollment numbers, from 30.05 percent in 1998-99 to 38.5 percent in 2003-2004. However the percentage of enrollments drops from 40 percent at the graduate level and 42 percent at the post-graduate level to 38 percent at the research level. Only 33.6 percent of the total PhDs awarded in the 10 years have been awarded to women.

This suggests a need to re-examine the doctoral education process, and improve provisions for women, that will allow their greater participation. The declining number of women in academic research indicates a loss of skilled / trained human power as well as the loss of diversity which can contribute to innovation in research. Since the period of doctoral education crucially clashes with women's age at marriage and family in India, special provisions such as part-time PhDs, more flexibility in terms of time period for completion, scholarships, etc may be useful in increasing their participation.

4.Ensuring Balanced Research Output Across Disciplines: Disciplinary analysis of PhDs reveals lower numbers in Agriculture (12.9 percent of the total PhDs), Engineering (8.6 percent of total PhDs) and Medicine (7.2 percent of total PhDs), which are important sectors that contribute to the growth in the economy.

a. It is important to analyze whether the current production of PhDs in these disciplines would be adequate to meet the demands in the field. New advances in these disciplines brought about by developments in Biotechnology, Material Science, Nano-Science, Neuroscience, Cognitive Science etc. demand more human power for research to make greater advancements and therefore it would be important to ensure the match between availability of researchers for new expansions in these various domains. .

b. More importantly, new forms of research agreements, policies and contracts may have to be drawn up in order to match the trends that are are currently popular in the various fields. For example, the professional nature of Engineering and Medical fields with higher economic prospects of careers in these fields compared to research in these disciplines, and the high cost of Engineering and Medical education may be probable deterrents for students. **Thus, to remain competitive higher educational, corporate and industrial policies must find new solutions, such as salary and job protection for the period of research, sabbaticals for PhD, higher remuneration or visibility, provisions to build important research networks, etc**.

c. A periodic assessment of research production of the various disciplines is important in order to match supply with demand. Trends among the various disciplines show differences in annual performance. While Natural Science recorded a higher number of PhDs during the initial period of the study (from 1998 – 2003), it has been taken over by the Humanities during the latter period (2006-2007). A sudden growth in Agriculture was seen from 2000, when it has overtaken other disciplines such as Engineering & Technology and Medicine. However the growth in Agriculture has tapered off towards the end of the period, with the numbers falling below Engineering & Technology in 2007. Disciplines that have consistently received lower number of PhDs are Engineering and Technology, Medicine, Commerce and General Science. **These trends indicate the importance of periodic assessments and current data on research productivity of the various disciplines, in order to match it to the present needs and demands, to stimulate disciplines that encounter adverse conditions through beneficial policies and keep track of international competition.**

d. There is a need to support and enhance research in newly emerging areas of study of interdisciplinary nature through new organizational arrangements and policies. Interdisciplinary research both in the Sciences as well as the Arts , in areas such as Agro-physics, Agro-chemistry, Energy studies, Cognitive Sciences, Regional Studies, Rural Development, etc. have immense potential to answer real world problems more holistically, due to the complex nature of these problems. **Research of interdisciplinary nature may also require special administrative and managerial provisions.** It is therefore important to provide support to these disciplines through academic and administrative mechanism at universities and research institutes that will facilitate research in these areas. These could include provisions for registering for PhDs of interdisciplinary nature, reorganization of departments into schools or centres on broad lines that will allow several different departments to collaborate with each other, allowing inter-university collaborations to draw on specialized faculty and resources for research, etc.

5 Improving Agricultural Productivity Through Research: The Agriculture PhD production in the country has

shown a gradual increase since 1998, but has declined considerably towards 2007 (from 152 in 1998 to 724 in 2006, but has dropped to 352 in 2007). While the decline may be traceable to problems with the database, a World Bank report has indicated that among other factors, lack of productivity- enhancement investment in areas such as research and extension are responsible for this decline.

a. This indicates the need is for a research personnel base which will be able to engage with new areas of research in agriculture that can address the changing paradigm brought by such events as the as WTO regulations, climate change, population growth, new plant pests and diseases, etc. It is, therefore, important for policy planners to keep in mind the need for qualified technical human power with research capacity to face the new challenges that will affect agricultural production, and in turn India's economy.

b. New emerging interdisciplinary areas of study are seen in agriculture also and require new mechanisms that can facilitate research in these fields and enhance agricultural productivity. These fields such as Environmental Studies, Agro-Physics and Agro-chemistry have, however, received the least number of PhDs under Agriculture such as. These areas being of recent origin, universities and institutes may not yet be fully equipped with administrative facilities, faculty specializations or processes for interdisciplinary collaborations across departments since they have the potential to more holistically address real world problems, by drawing from several disciplines.

6. Addressing Shortages of Trained Scientific Power in Engineering by Developing Mechanisms to Attract Students Towards Research: It has been estimated that the Engineering Processes Outsourcing (EPO) in India will rise to 17.6 percent CAGR and reach US$ 20 billion by 2010 (Ingalsuo, 2009). This could perhaps signal a further growth in the number of engineering post-graduates, but also suggests a need for India to take positive steps in the direction of strengthening engineering research. A positive trend of growth in number of PhDs in Engineering and Technology is seen from the study. However, in the light of Rao Committee report's (2002) predictions that India will face a shortage of an additional 10,000 doctorates by 2008, the current growth rate may still be inadequate.

a. Strengthening of research facilities in engineering, with more institutions and faculty other than select premier institutions such as IITs, engaging in research is needed if this scenario is to be corrected.

b. Gender difference in participation in research in Engineering shows a cause for concern and must be addressed if India must meet the shortage in trained human power in Engineering and Technology. Gender-wise study in Engineering shows a difference of more than 75 percent in award of PhDs between women and men. This may be due to traditional conceptions such as Engineering and Technology being considered male disciplines. To increase its research personnel base and overcome the estimated shortage of human power, it is important to undertake policies that will address these gender imbalances and develop a diverse and adequate manpower base.

7. Addressing the New Trends of Growing Gender Disparity in Medicine : Medicine (and allied bio-medical

fields that have traditionally seen a greater participation of women) has witnessed an increase in the gender gap in the number of PhDs awarded (from the difference in the proportion of PhDs awarded to women and men has increased from 17.6 percent in 1999 to 36.6 percent in 2007). While there has been an overall decrease in the number of PhDs in medicine in 2007, there has been a greater decline in numbers for women (47.4 percent decline) than for men (23.6 percent).

Absence or decline of women's presence in fields that they have historically shown larger participation in is a cause for serious concern. There is a need to re-examine these trends in order understand the factors that can reverse these trends at the earliest.

8. Retaining Interest in Humanities and Social Sciences : Despite the poor funding for research in Humanities and Social Sciences, the Humanities and Social Sciences have both received higher number of PhDs than all other disciplines, after Natural Science. This appears to be a positive trend and it may be important to convert this growth with efforts by various agencies to encourage research in these disciplines. Since these disciplines focus largely on the linkage of knowledge with society, they form an integral part of any research question and provide important directions for development. All real world problems are located within society and hence addressing the societal dimensions which is critical is possible only through research in Humanities and Social Sciences.

a. Thus, there is a need to analysis the number of institutions available state-wise for research in these areas, the number of faculty available to advise students, funds for research and the production of PhDs in these disciplines. Data of this nature needs to be systematically generated, subjected to analysis, documented and more importantly disseminated, in order to have a optimal and sustained growth of research capability across disciplines. It may also be necessary to correlate the employment potential of these doctorate holders at the National and International levels.

b. Quality of the PhDs produced in these disciplines need to be given attention. It is commonly perceived that the Humanities and Social Sciences do not require large funds since they mostly do not require laboratory and instrumentation facilities. Hence there is a large presence of Social Sciences and Humanities departments in the country across universities . However, This has resulted in inadequate funding for Humanities and Social Sciences research with universities receiving less than minimum support in terms of access to journals and books as well as support for field studies. Such trends impact the quality of the research undertaken and PhDs produced and is a matter of concern that needs to be addressed at the national level.

9. Increasing Scientific Research Capacity Across all Science Domains: . Trends in the Sciences have shown a large difference between the number of PhDs produced in Natural Sciences on the one hand and in Agriculture, Medicine and Engineering and Technology on the other. The smaller number of students opting for research in the latter disciplines, maybe due to the professional nature of the courses, and the minimum industry requirements of post-graduation for employment. These trends may also be a result of the high cost of medical and engineering education, large loans taken by families to avail these educational opportunities and

the urgency in repayment of these loans.

In order for India to remain on par with international research capacities and contribute to research in new emerging fields such as Biotechnology, Nanotechnology, Genetic Engineering, Human Genetics, Neurosciences, etc., it is important to ensure adequate research human power in these fields. It is also important to match job requirements, skills, qualifications and educational outcomes of completing a doctorate degree in these fields. Similar analysis needs to be made of the advantages, professionally and monetarily to be gained by higher level of education in these professional courses.

10. Bringing Gender Equity in Science Research and Higher Education: Women's participation in all fields of science is significantly lower, compared to men's. The difference in the proportion of PhDs awarded to men and women is least for Medicine (36.1 percent to women and 63.9 percent to men), and the highest for Engineering and Technology (20.2 percent to women compared to 79.8 percent for men).

Women compose one half of the potential workforce and their critical absence from fields such as Engineering and Technology and Agriculture indicate a larger loss for the country's innovation climate and research capacity. Hence it will be crucial to attract talented and qualified women to research through attractive schemes, as well as by facilitating their participation in research by understanding women's dual responsibilities and timing. While some efforts in the Sciences have been undertaken by national agencies such as Department of Science and Technology (DST), Department of Biotechnology (DBT) and University Grants Commission (UGC), it is important to broaden these provisions to other fields such as Agriculture and Engineering and Technology also.

11. Need to Balance Distribution of Research Capabilities Across Zones and States: Large differences are observed in the spread of PhDs across the various regions of the country. The highest number of PhDs has been awarded in the North zone, which is significantly higher than for other zones. This difference needs to be carefully analyzed because even with the number of institutions sampled in the North (56) and South (51) being almost equal North accounts for more than double the number of PhDs as the South. Further, East despite having a higher number of institutions (86 of which 42.2 percent were sampled), has contributed only 10.1 percent of the total PhDs in 10 years (compared to 43.1 percent by the North).

a. Further analysis with respect to the research culture, research performance capabilities, quality and efficiency in these different zones needs to be undertaken to optimize the PhD out-turn of the country.

b. The new developments in the North-East higher education and research scenario requires attention. North-East has the lowest number of PhDs compared to all zones (4.3 percent of the total). It also has significantly lower number of research universities and institutions compared to the other zones (20). Further the difference in PhDs produced in the different disciplines of Science is large. Of the total number of 874 Science PhDs awarded in the North-East, 87.4 percent is in Natural Sciences compared to 1.7 percent in Medicine, 2.6 percent in Agriculture, and 8.2 percent in Engineering and Technology).

The history of institutions of higher education in the North-East and growth in the number of institutions,

students and researchers is a recent phenomenon. **It is important for policy planners to recognize these new developments in the region and support the growth of research and academic culture by setting up new institutions, policies, fellowships and other such provisions to encourage the growing research culture, while also balancing out the vast differences in the research across disciplines.**

b. More importantly data on state-wise distribution of PHDs is required, since all policies and planning is undertaken at the state level. However such data is largely lacking. State-wise data for disciplinary trends in PhDs, number of institutes available for research in particular disciplines, university/ research institute-wise number of degrees awarded, gender-distribution of PhDs in different disciplines, availability of jobs within the state for doctorate degree holders, economic sectors emphasized by the state government in relation to the PhDs awarded, etc is largely absent. Data sampled for the project itself shows large differences in states' production of PhDs. A total of 8 states (of 28) and 1 union territory (of 7) have produced approximately 73.4 percent of the data. Thus, individual state's PhD output needs to be analyzed further, with respect to the number of institutions and faculty available for research as well as governmental policies, to bring about a more balanced growth among the states.

c. A gender-wise distribution of PhDs across the different zones shows a cause for concern in the South, East and West zones (less than 30 percent of the PhDs are awarded to women).

Despite a high rate of enrollment of women in higher education in states such as Maharashtra, Tamil Nadu, West Bengal and Karnataka, and other states in the West and South (Refer appendixII, table 1) gender disparity is higher among these states and zones at the PhD. level. It will be important to study the factors responsible for this gender disparity at the doctorate level despite the greater participation of women in higher education in these states .

d. In order to fully understand the regional differences in doctoral education it is important to have data on PhDs by university, states, and region. Data of this nature is extremely crucial to address fair distribution and equity in higher education. The distribution of research capabilities has by and large been concentrated in certain metropolitan cities / states / regions so far. However, such data needed for planning has been altogether absent or limited thus far, and it would be important for national agencies to focus attention and resources in collecting and analyzing data of this nature.

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APPENDIX

APPENDIX I: Within Group (i.e., Column-wise) Percentages of PhDs Awarded Across the 10 years

Table 1: Column-wise Percentage of Total PhDs Awarded to Men and Women Across 10 years

Year	Female	Male	Total
1998	644	1258	1902
	4.2%	4.2%	4.2%
1999	1426	2799	4225
	9.3%	9.2%	9.3%
2000	1854	3672	5526
	12.1%	12.1%	12.1%
2001	880	1845	2725
	5.8%	6.1%	6.0%
2002	1711	3352	5063
	11.2%	11.1%	11.1%
2003	1769	3958	5727
	11.6%	13.1%	12.6%
2004	1949	3729	5678
	12.7%	12.3%	12.5%
2005	1325	2810	4135
	8.7%	9.3%	9.1%
2006	1946	3522	5468
	12.7%	11.6%	12.0%
2007	1793	3319	5112
	11.7%	11.0%	11.2%
Total	15297	30264	45561
	100.0%	100.0%	100.0%

Table 2: Column-wise Percentage of Total PhDs Awarded in Various Disciplines Across 10 years

Year	Agriculture	Natural Science	Engineering & Technology	Medicine	Social Science	General Science	Humanities	Commerce	Total
1998	152	535	255	241	246	70	365	38	1902
	2.6%	4.7%	6.5%	7.3%	3.1%	11.6%	3.3%	2.6%	4.2%
1999	234	1292	330	301	843	96	994	135	4225
	4.0%	11.3%	8.4%	9.1%	10.5%	15.9%	9.1%	9.4%	9.3%
2000	768	1548	373	355	872	44	1428	138	5526
	13.1%	13.5%	9.5%	10.8%	10.9%	7.3%	13.0%	9.6%	12.1%
2001	592	668	190	277	357	35	565	41	2725
	10.1%	5.8%	4.8%	8.4%	4.5%	5.8%	5.2%	2.8%	6.0%
2002	809	1241	326	378	854	71	1217	167	5063
	13.8%	10.8%	8.3%	11.5%	10.7%	11.8%	11.1%	11.6%	11.1%
2003	745	1525	421	405	1005	85	1292	249	5727
	12.7%	13.3%	10.7%	12.3%	12.5%	14.1%	11.8%	17.3%	12.6%
2004	743	1328	352	420	972	36	1632	195	5678
	12.7%	11.6%	9.0%	12.7%	12.1%	6.0%	14.9%	13.6%	12.5%
2005	752	888	473	363	770	59	701	129	4135
	12.8%	7.8%	12.1%	11.0%	9.6%	9.8%	6.4%	9.0%	9.1%
2006	724	1106	516	397	1112	51	1391	171	5468
	12.3%	9.7%	13.2%	12.0%	13.9%	8.5%	12.7%	11.9%	12.0%
2007	352	1318	685	161	979	56	1385	176	5112
	6.0%	11.5%	17.5%	4.9%	12.2%	9.3%	12.6%	12.2%	11.2%
Total	5871	11449	3921	3298	8010	603	10970	1439	45561
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 3: Column-wise Percentage of Total PhDs Awarded in Agriculture Across 10 years

Year	Female	Male	Total
1998	31	121	152
	2.2%	2.7%	2.6%
1999	47	187	234
	3.3%	4.2%	4.0%
2000	172	596	768
	12.1%	13.4%	13.1%
2001	132	460	592
	9.3%	10.3%	10.1%
2002	182	627	809
	12.9%	14.1%	13.8%
2003	167	578	745
	11.8%	13.0%	12.7%
2004	214	529	743
	15.1%	11.9%	12.7%
2005	186	566	752
	13.1%	12.7%	12.8%
2006	186	538	724
	13.1%	12.1%	12.3%
2007	99	253	352
	7.0%	5.7%	6.0%
Total	1416	4455	5871
	100.0%	100.0%	100.0%

Table 4: Column-wise Percentage of PhDs Awarded in Sub-Disciplines of Agriculture Across 10 years

Sub Disciplines	Female	Male	Total
Agriculture	26	95	121
	1.8%	2.1%	2.1%
Agro Chemistry	72	105	177
	5.1%	2.4%	3.0%
Agro Plant Studies	635	2265	2900
	44.8%	50.8%	49.4%
Agro Animal Studies	227	1009	1236
	16.0%	22.6%	21.1%
Agro Social Sciences	170	362	532
	12.0%	8.1%	9.1%
Agro Engineering and Technology	187	332	519
	13.2%	7.5%	8.8%
Agro Genetics and Microbiology	80	207	287
	5.6%	4.6%	4.9%
Agro Others	19	80	99
	1.3%	1.8%	1.7%
Total	1416	4455	5871
	100.0%	100.0%	100.0%

Table 5: Column-wise Percentage of Total PhDs Awarded in Natural Sciences Across 10 years

Year	Female	Male	Total
1998	174	361	535
	4.6%	4.7%	4.7%
1999	420	872	1292
	11.2%	11.3%	11.3%
2000	510	1038	1548
	13.6%	13.5%	13.5%
2001	236	432	668
	6.3%	5.6%	5.8%
2002	415	826	1241
	11.0%	10.7%	10.8%
2003	445	1080	1525
	11.8%	14.0%	13.3%
2004	432	896	1328
	11.5%	11.6%	11.6%
2005	290	598	888
	7.7%	7.8%	7.8%
2006	385	721	1106
	10.3%	9.4%	9.7%
2007	449	869	1318
	12.0%	11.3%	11.5%
Total	3756	7693	11449
	100.0%	100.0%	100.0%

Table 6: Column-wise Percentage of PhDs Awarded in Sub-Disciplines of Natural Sciences Across 10 years

Sub Disciplines	Female	Male	Total
Biology	274	430	704
	7.3%	5.6%	6.1%
Botany	648	997	1645
	17.3%	13.0%	14.4%
Chemistry	1182	2374	3556
	31.5%	30.9%	31.1%
Earth Sciences	178	407	585
	4.7%	5.3%	5.1%
Geology	49	329	378
	1.3%	4.3%	3.3%
Life Sciences	109	86	195
	2.9%	1.1%	1.7%
Mathematics	251	744	995
	6.7%	9.7%	8.7%
Physics	394	1228	1622
	10.5%	16.0%	14.2%
Science	37	55	92
	1.0%	.7%	.8%
Statistics	86	186	272
	2.3%	2.4%	2.4%
Zoology	525	784	1309
	14.0%	10.2%	11.4%
Others (<1.0%)	23	73	96
	0.7%	0.9%	0.9%
Total	3756	7693	11449
	100.0%	100.0%	100.0%

Table 7: Column-wise Percentage of Total PhDs Awarded in Engineering & Technology Across 10 years

Year	Female	Male	Total
1998	58	197	255
	7.3%	6.3%	6.5%
1999	62	268	330
	7.8%	8.6%	8.4%
2000	85	288	373
	10.7%	9.2%	9.5%
2001	39	151	190
	4.9%	4.8%	4.8%
2002	70	256	326
	8.8%	8.2%	8.3%
2003	73	348	421
	9.2%	11.1%	10.7%
2004	71	281	352
	8.9%	9.0%	9.0%
2005	91	382	473
	11.5%	12.2%	12.1%
2006	105	411	516
	13.2%	13.1%	13.2%
2007	140	545	685
	17.6%	17.4%	17.5%
Total	794	3127	3921
	100.0%	100.0%	100.0%

Table 8: Column-wise Percentage of PhDs Awarded in Sub-Disciplines of Engineering & Technology Across 10 years

Sub Disciplines	Female	Male	Total
Electronic & Electrical Engineering	109	378	487
	13.7%	12.1%	12.4%
Mechanical Engineering	23	563	586
	2.9%	18.0%	14.9%
Architecture	9	25	34
	1.1%	.8%	.9%
Bioscience and Engineering	47	56	103
	5.9%	1.8%	2.6%
Chemical Engineering	81	203	284
	10.2%	6.5%	7.2%
Civil Engineering	63	438	501
	7.9%	14.0%	12.8%
Computer science engineering	60	224	284
	7.6%	7.2%	7.2%
Energy studies and Engineering	16	66	82
	2.0%	2.1%	2.1%
Engineering and Allied Operations	266	654	920
	33.5%	20.9%	23.5%
Industrial Engineering	9	60	69
	1.1%	1.9%	1.8%
Metallurgical & Material Engineering	17	110	127
	2.1%	3.5%	3.2%
Science and Technology	62	193	255
	7.8%	6.2%	6.5%
Others	32	157	189
	4.0%	5.0%	4.8%
Total	794	3127	3921
	100.0%	100.0%	100.0%

Table 9: Column-wise Percentage of Total PhDs Awarded in Medicine Across 10 years

Year	Female	Male	Total
1998	97	144	241
	8.2%	6.8%	7.3%
1999	124	177	301
	10.4%	8.4%	9.1%
2000	124	231	355
	10.4%	11.0%	10.8%
2001	98	179	277
	8.2%	8.5%	8.4%
2002	140	238	378
	11.8%	11.3%	11.5%
2003	136	269	405
	11.4%	12.8%	12.3%
2004	132	288	420
	11.1%	13.7%	12.7%
2005	138	225	363
	11.6%	10.7%	11.0%
2006	149	248	397
	12.5%	11.8%	12.0%
2007	51	110	161
	4.3%	5.2%	4.9%
Total	1189	2109	3298
	100.0%	100.0%	100.0%

Table 10: Column-wise Percentage of Total PhDs Awarded in Social Sciences Across 10 years

Year	Female	Male	Total
1998	94	152	246
	3.2%	3.0%	3.1%
1999	322	521	843
	10.8%	10.3%	10.5%
2000	352	520	872
	11.8%	10.3%	10.9%
2001	139	218	357
	4.7%	4.3%	4.5%
2002	319	535	854
	10.7%	10.6%	10.7%
2003	334	671	1005
	11.2%	13.3%	12.5%
2004	359	613	972
	12.1%	12.2%	12.1%
2005	259	511	770
	8.7%	10.1%	9.6%
2006	442	670	1112
	14.9%	13.3%	13.9%
2007	355	624	979
	11.9%	12.4%	12.2%
Total	2975	5035	8010
	100.0%	100.0%	100.0%

Table 11: Column-wise Percentage of PhDs Awarded in Sub-Disciplines of Social Sciences Across 10 years

Sub Disciplines	Female	Male	Total
Anthropology	146	153	299
	4.9%	3.0%	3.7%
Economics	443	1000	1443
	14.9%	19.9%	18.0%
Education	582	909	1491
	19.6%	18.1%	18.6%
Home Economics & Family Living	364	63	427
	12.2%	1.3%	5.3%
Law	113	331	444
	3.8%	6.6%	5.5%
Management Studies	205	709	914
	6.9%	14.1%	11.4%
Political Sciences	467	820	1287
	15.7%	16.3%	16.1%
Social Sciences	272	469	741
	9.1%	9.3%	9.3%
Sociology	355	494	849
	11.9%	9.8%	10.6%
Others (<1%)	28	87	115
	0.9%	1.8%	1.4%
Total	2975	5035	8010
	100.0%	100.0%	100.0%

Table 12: Column-wise Percentage of Total PhDs Awarded in Humanities Across 10 years

Year	Female	Male	Total
1998	162	203	365
	3.5%	3.2%	3.3%
1999	380	614	994
	8.2%	9.7%	9.1%
2000	570	858	1428
	12.3%	13.5%	13.0%
2001	217	348	565
	4.7%	5.5%	5.2%
2002	520	697	1217
	11.2%	11.0%	11.1%
2003	532	760	1292
	11.5%	12.0%	11.8%
2004	675	957	1632
	14.6%	15.1%	14.9%
2005	315	386	701
	6.8%	6.1%	6.4%
2006	616	775	1391
	13.3%	12.2%	12.7%
2007	636	749	1385
	13.8%	11.8%	12.6%
Total	4623	6347	10970
	100.0%	100.0%	100.0%

Table 13: Column-wise Percentage of PhDs Awarded in Sub-Disciplines of Humanities Across 10 years

Sub Disciplines	Female	Male	Total
Geography	191	465	656
	4.1%	7.3%	6.0%
History	499	874	1373
	10.8%	13.8%	12.5%
Language & Literature	3057	4034	7091
	66.1%	63.6%	64.6%
Music	213	161	374
	4.6%	2.5%	3.4%
Philosophy	151	293	444
	3.3%	4.6%	4.0%
Psychology	342	244	586
	7.4%	3.9%	5.3%
Religion	63	174	237
	1.4%	2.7%	2.2%
Others (<1%)	107	102	209
	2.3%	1.6%	1.8%
Total	4623	6347	10970
	100.0%	100.0%	100.0%

States	Female	Male	Total
Andhra Pradesh	1173	2522	3695
	7.7%	8.3%	8.1%
Arunachal Pradesh	14	37	51
	.1%	.1%	.1%
Assam	375	684	1059
	2.5%	2.3%	2.3%
Bihar	200	622	822
	1.3%	2.1%	1.8%
Chandigarh	330	366	696
	2.2%	1.2%	1.5%
Chattisgarh	361	583	944
	2.4%	1.9%	2.1%
Goa	0	1	1
	.0%	.0%	.0%
Gujarat	301	887	1188
	2.0%	2.9%	2.6%
Haryana	805	1382	2187
	5.3%	4.6%	4.8%
Himachal Pradesh	278	488	766
	1.8%	1.6%	1.7%
Jammu & Kashmir	132	251	383
	.9%	.8%	.8%
Jharkhand	97	234	331
	.6%	.8%	.7%
Karnataka	704	2085	2789
	4.6%	6.9%	6.1%
Kerala	454	561	1015
	3.0%	1.9%	2.2%
Madhya Pradesh	1471	1791	3262
	9.6%	5.9%	7.2%
Maharashtra	938	3004	3942
	6.1%	9.9%	8.7%
Manipur	138	200	338
	.9%	.7%	.7%
Meghalaya	174	259	433
	1.1%	.9%	1.0%
Mizoram	8	12	20
	.1%	.0%	.0%
Nagaland	11	15	26
	.1%	.0%	.1%
New Delhi	2947	4925	7872
	19.3%	16.3%	17.3%
Orissa	375	607	982
	2.5%	2.0%	2.2%
Punjab	587	727	1314
	3.8%	2.4%	2.9%
Rajasthan	220	503	723
	1.4%	1.7%	1.6%
Sikkim	1	3	4
	.0%	.0%	.0%
Tamil Nadu	424	1359	1783
	2.8%	4.5%	3.9%
Tripura	8	23	31
	.1%	.1%	.1%
Uttar Pradesh	1860	3561	5421
	12.2%	11.8%	11.9%
Uttarakhand	311	706	1017
	2.0%	2.3%	2.2%
West Bengal	600	1866	2466
	3.9%	6.2%	5.4%
Total	15297	30264	45561
	100.0%	100.0%	100.0%

Table 14: Column-wise Percentage of PhDs Awarded Across States and Union Territories of India

Table 15: Normalized Data for State-wise PhDs Produced

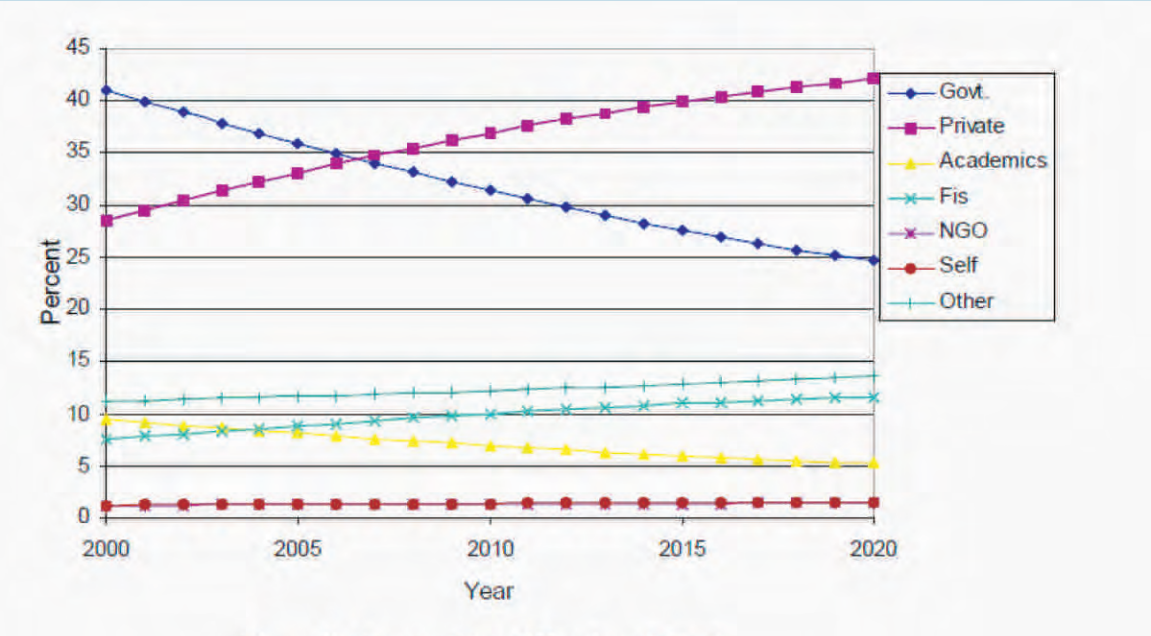
States	Total	Sampled number of universities	Normalized Data
Andhra Pradesh	3695	15	246.3
Haryana	2187	7	312.4
Karnataka	2789	15	185.9
Madhya Pradesh	3262	12	271.8
Maharashtra	3942	25	157.7
New Delhi	7872	9	874.7
Tamil Nadu	1783	14	127.4
Uttar Pradesh	5421	19	285.3
West Bengal	2466	11	224.2
Others (<3.5%)	12144	89	136.5
Total	45561	216	210.9

Table 16: Column-wise Percentage for PhDs Awarded Across Zones in Science and Arts

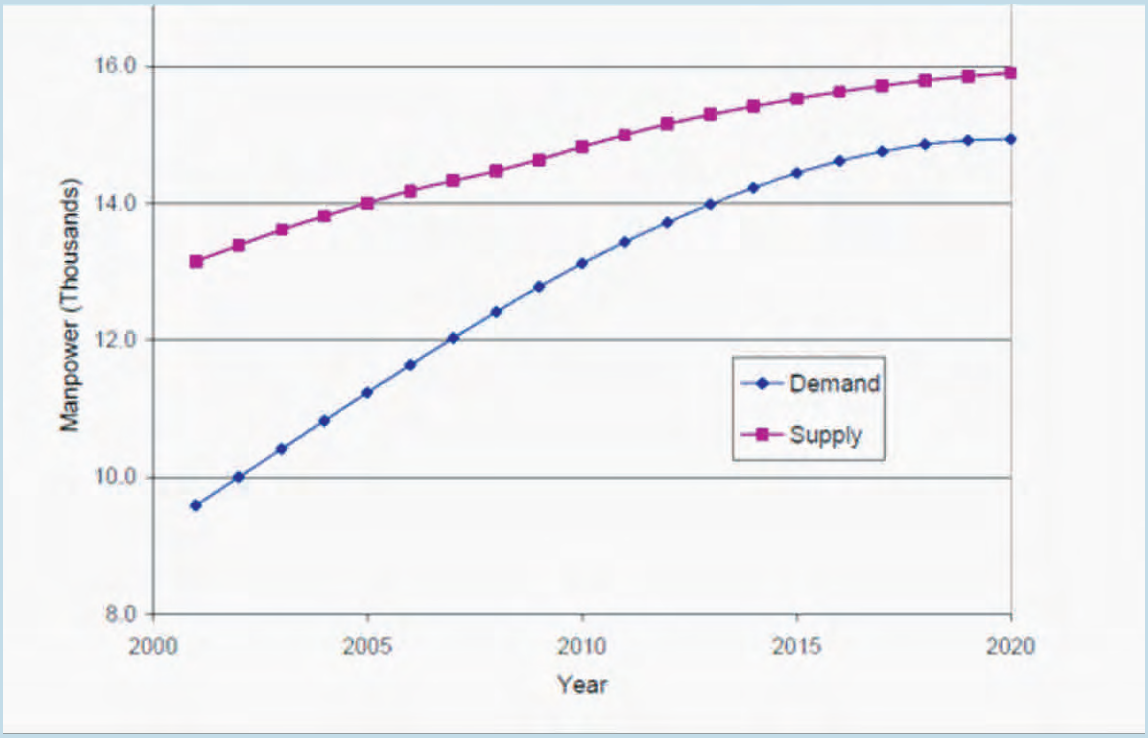
Zone	Science	Arts
South	5366	3495
	21.9%	18.4%
East	2569	1873
	10.5%	9.9%
West	3312	2243
	13.5%	11.8%
Central	1250	2663
	5.1%	14.0%
North East	874	986
	3.6%	2.1%
North	11168	7720
	45.5%	40.7%
Total	24539	18980
	56.4%	43.6%

APPENDIX II: Secondary Data used for Analysis

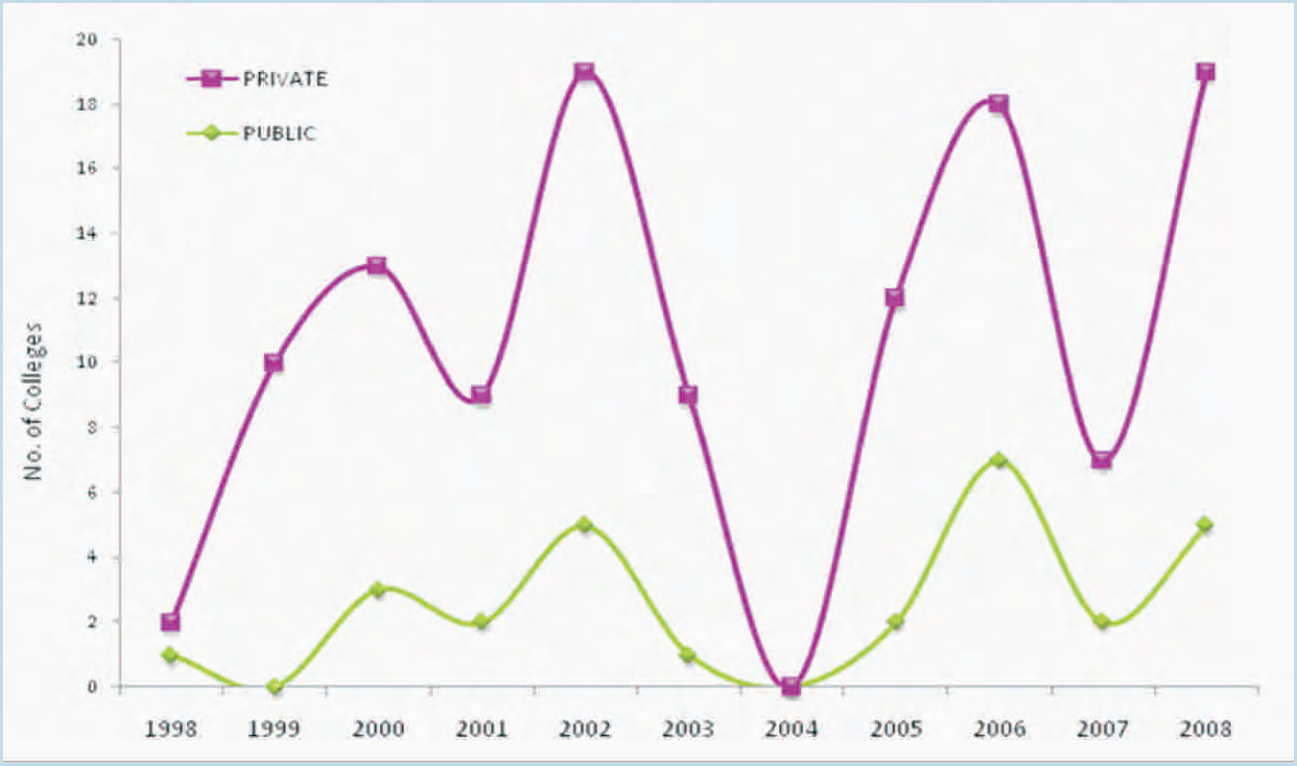
Graph 1: Trends in Agricultural Employment (Source Nanda et al., 2005)



Graph 2: Projection of Supply and Demand of Agricultural Manpower (Source: Nanda et al., 2005).



Graph 3: Trend of Introduction of new Medical Colleges since 1998



Source: Mandal, K. (2008). Medical Manpower in India: An Overview. In 'Indian Science and Technology: 2008. S&T Human Resources'. http://www.nistads.res.in/indiasnt2008/t1humanresources/t1hr11.htm. Accessed: 5 Feb, 2010, 9:50 am

Table 1: Women's Enrollments in Higher Education

States	Percentage enrollment in higher education (2005-2006)	Percentage enrollment in PhDs (2004-2006)	Gender Parity Index in higher education (2004-2005)
Haryana	43.5	43.8	0.91
Madhya Pradesh	32.1	44.4	0.71
Maharashtra	38.2	33.8	0.76
Tamil Nadu	41.9	56.3	0.75
West Bengal	35.7	49.7	0.60
Karnataka	40.6	31.8	0.79

Adapted from Indiastat.com (www.indiastat.com). Accessed 17 Feb, 2010, 11:30 am.

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