

Contribution of higher education and higher educational institutions, research institutions of India in the development of Science and technology

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Abstract: In this article, we intend to review the role and importance of higher education, higher educational & research institutions in India in the advancement of science and technology that plays an important role in the development of countries and individuals. The article also highlights the recent contributions made by some higher educational and research institutions such as IIT's, ICAR, IISER etc. to the development of technology.

Keywords: Science, Technology, Higher education, Human development.

Introduction:

¹Education is the backbone of all developing countries and good quality education is a sign of a bright future for a country. ²Higher education shapes the future citizens of the nation through its holistic development. ³Higher education provides job market demands; critical thinking fosters democracy, social mobility and prepares for the future. In India, higher education is at tertiary level of education, and basically leads to award of an academic degree, after primary and secondary education. Higher education provides different types of degrees, diplomas or certificate degrees of higher studies along with research activity. A higher educa-

tional institution includes universities, colleges and various professional schools. The usual entrance age for higher education is about 18. Primary education is free and compulsory as per right to education act 2002, but higher education is optional. Higher education in India is administered by state as well as central government because education is included in the concurrent list of Indian constitution. On the basis of management, universities are classified into central universities, state universities, private universities and deemed universities. ⁹As per data of 4 March 2022 in India, there are a total 1026 universities including national institutes. Amongst them, 54 central universities, 443 state universities, 126 deemed universities and 403 private universities. The regulatory framework includes oversight of the entire higher education ecosystem through the University Grants Commission (UGC), the All India Council for Technical Education (AICTE), finally the NAAC and NIRF, and finally the NAAC and NIRF oversee university accreditation.

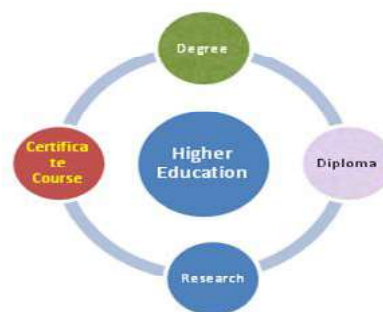


Fig: Higher education system

Research, technology and higher education

⁵Research and development is inseparable part of higher education. The process of research is ongoing simultaneously with the teaching and learning process. ⁸Most of the knowledge in higher education is based on practical experience and, therefore, it is mostly applied in nature. Higher education develops thinking ability and creativity of human brain. If we connect higher education with technology, then the process of improving and sharing of knowl-

edge is fast. For example, when world suffered from corona virus covid-19 during the year 2020 to 2021 and at that period of global pandemic, higher education was hampered and at that time, most of the technology is used to continue the process of teaching, so technology plays an important role in the higher education. Most of the distance-learning educational degrees and diplomas conducted by universities through online and virtual platforms.



Fig: Apex Bodies in higher education that regulates research in India.

(1) Council of Scientific and Industrial Research (CSIR), (2) Indian Council for Social Science Research (ICSSR)

3) Indian council of medical research (ICMR), 4) Indian Council of Agricultural Research (ICAR)

5) Tata Institute of Fundamental Research (TIFR)) Contributions of National Institutions in development

¹⁾ **Recent top ten innovation of IIT'S in india**

In recent periods, Indian IIT's has contributed to the development of various sectors of science and technology through innovations. Some achievements of these institutes are discussed briefly below.

a) Passive solar water wall

⁶Group of researchers of IITs developed a new air cooling systems which can be replacing domestic air conditioners. In a new developed air conditioners their unusual cooling system revolves around a rectangular water tank fitted into a wall its very high surface area allows maximum interaction between the air and the tank walls, thus helping it cool air rapidly. The advantages of newly developed air condi-

tioners is that, it minimize about 50 percent of electricity consumption, reduces carbon emission and CFCs emission in the environment.

b) Smart cane

⁶Some professor of IIT and social entrepreneurs jointly developed smart cane for visually challenged peoples. Advanced features of smart cane is it is foldable, light weight, high diagnostic capability any above the knee obstruction from a distance of 3 meters. It can reduce probability of injuries to the visually challenged peoples in India. India will get maximum benefits of this innovation because India is a home to the largest population of visually challenged people in the world.

c) Water for plastic machine

⁶Large number of cities in India is continuously facing the problems of garbage and especially pollution of plastic. To solve this problem, some state governments have banned use of plastic bags, but do not provide a permanent solution for plastic waste. Recently, two former IIT-Bombay students, Anurag Meena and Satyendra Meena, have collaborated with a Chandigarh-based start-up to build a machine named 'Swachch Machine' that lets you get rid of your plastic waste and get clean drinking water. The special feature of this machine is that every recyclable waste plastic item one puts inside the machine will be rewarded with a digital value token that can be exchanged for 300 ml of clean drinking water. It designed and developed in just 95 days. It can provide cool water as well as normal temperature water. One of the most interesting features of this machine is it reduces the waste to one-sixth of its size.

d) Dirt detector:

⁶IIT-Kharagpur researchers have developed an inexpensive device based on a pollution sensor. The device is equipped with an intelligent hygiene monitor that can record the levels of ammonia, sulfur dioxide, carbon monoxide, carbon dioxide, volatile organic compounds and particulate matter with the help of

sensors. It also sends online alerts to stakeholders via the cloud when forecast thresholds are exceeded, indicating the condition of the room and the need for cleaning. This can help maintain hygiene in public places that only occasionally clean, such as toilets, hospitals, canteens, parks, train stations, and airports.

e) Solar powered cold storage:

In India every year, farmers lose over thirty percent of their harvest due to insufficient infrastructure and storage facilities like warehouses. Some alumni of IIT Kharagpur developed solar power cold storage and it will be helpful to the farmers to store and preserve their product against natural calamities like heavy rainfall, cloud bursting etc. and also against market risk. It is more effective for the product to which tends to spoil quickly, such as spinach, tomatoes, or capsicum these products can now be stored for up to 21 days. Some advanced technologies are used in this solar power cold storage including the control of temperature from mobile phones by selecting the product that they want to store. The storage unit then automatically regulates the required temperature. In cloudy days specifically in rainy season when there is no sun, the facility is equipped with chemical batteries that maintain temperatures up to 30 hours.

f) Intelligent Street light:

⁶A group of students at IIT Madras has developed a sensor-based smart lighting system that saves huge amounts of money and electricity consumption for lighting metropolitan areas. This ensures that the street lights only work at full brightness when they detect vehicle movement. When the road is empty, the lights dim by about 30% thanks to sensors and cloud networks. The project has been piloted on the IIT Madras campus in various locations and the results have been positive. The service life of the system is 15 years.

2) Recent Achievement of ICAR

⁷The Indian Council of Agricultural Re-

search plays an important role in science-leading the growth and development of agriculture in India. They have developed a number of technologies in farming sector and contributed to the Indian economy and human development. Some recent achievements of ICAR mentioned here briefly.

a) Food security and nutrition:

⁷As per the demand of growing population in India, food security and nutrition is the big challenge. To face this challenge and farmers' welfare, the Indian Council of Agricultural Research has taken a number of initiatives and some of them are mentioned below.

• **Field crop:**

⁷Between 2014 and 2021, ICAR launched 1575 high-yielding varieties of crops. All these varieties have been registered on the bulletin board to increase the income of farmers.

• **Pulses Revolution:**

⁷ICAR has acted as a catalyst by providing farmers with high-quality, prolific variety seeds, resulting in an increase in legume production by 6.5 million tonnes and a decrease in imports by 5 million tonnes over the past seven years. 18223.61 million in 2019-2020.

• **Sugar Revolution:** ⁷The improved variety by ICAR Co 0238 were the prime contributor to the sugar revolution which result cumulative increase sugarcane production 2565.5 million tons during 2014-2021

• **Horticulture crop:** ⁷New and improved varieties and hybrids of horticultural crops have played vital role in augmentation the production of fruits and vegetables for nutrition and income security.

b) Agriculture genomic for genetic resources and gene discovery

ICAR has developed genomic resources for 16 different commodities, including complete genome sequences of 2 crops, 2 fish, 1 insect, 10 microorganisms and 1 pathogen.

c) Genome editing for productivity and stress

resilience

ICAR has developed genome editing, a precision mutagenesis tool for improving crop genes. By editing four different genes, we developed the transgene-free genome-edited rice giant cultivar MUT1010 with increased yield and stress tolerance.

d) Genetic modification of crops with new traits

⁷Recently ICAR developed Genetic modification of crops with new traits For imparting resistance to the devastating insect pod borer in pigeonpea, transgenic lines expressing two different Bt genes were developed and advanced to the event selection trial stage. Bioassay using the pod borer insect revealed high level of resistance in the transgenic plants as compared to non-transgenic wild type plants. E) Animal sciences, indigenous Breeds, Health and Nutrition: For the conservation and development of indigenous breed ICAR taken initiatives for description of non-described breeds and their registration is the primary activity. As a result 2007-14 197 breeds of animal and birds were gazette notified. This shall strengthen the protection and provide IPR safety to our breeds.

d) Fishery technology for blue revolution

⁷Fish breeding and seed production technologies were developed by ICAR for 25 species of food fishes during 2014-21 which resulted in fish production and raised the income of the fish growers in the country. G) Natural resources management and climate resilient agriculture: During 2014-21, ICAR developed the land resource inventories of 314 blocks for effective agricultural land use plans. Land resource inventory also developed for 27 aspirational districts in 8 states. The soil health scheme was rolled out as a national priority. ICAR developed a machine for coating seeds with different microorganism. ICAR designed and developed mini pan evaporimeter. ICAR developed soil biological health kit based on substrate induced respiration. ICAR developed granular mineral fertil-

izers using low-grade rock-phosphate and feldspar, as an alternative to conventional P and K fertilizers. ICAR developed an android platform-based mobile app for agroforesters based on the package of practices of 25 promising agroforestry tree species.

Current status of Higher educational institutions in India**1) NIRF Rankings of higher educational institutes of India**

³The Ministry of Education and the Government of India NIRF publish separate annual rankings for Universities, Colleges, Research Institutions, Engineering, Pharmacy, Medicine, Dentistry, Administration, Law and Architecture, as well as overall rankings for all higher education institutions. It is based on different parameters for different institutions. The full rating parameters are listed below.

Different heads of parameters for overall ranking**a) ³Teaching Learning and Resources (TLR)**

- Student strength including doctoral students (SS)
- Faculty-Student ratio (FSR)
- Combined metric for faculty with Ph.D or equivalent experiences (FQE)
- Financial resources and their utilization (FRU)

b) Research and Professional practice (RP)

- Combined metric for publications (PU)
- Combined metric for quality publications (QP)
- IPR and patents published and granted (IPR)
- Footprint of projects and professional practices (FPPP)

c) ³Graduation Outcomes (GO)

- Metric for university examinations (GUE)
- Metric for number of Ph.D students graduates (GPHD)

d) ³Outreach and Inclusivity (OI)

- Percentage of students from other states/countries i.e region diversity (RD)
- Percentage of women (WD)
- Economically and socially challenged students (ESCS)

· Facilities for physically challenged students (PCS)

· Perception Ranking (PR)

e) ³Peer Perception

· Academic peers and employers (PR)

Table: ³ Overall NIRF 2022 ranking of top 20 institutes.

Rank as per NIRF	Name of Institutes	Rank as per NIRF	Name of Institutes
1	Indian Institute of Technology Madras, Chennai	11	Banaras Hindu University, Varanasi
2	Indian Institute of Science, Bengaluru	12	Jadavpur University, Kolkata
3	Indian Institute of Technology, Bombay, Mumbai	13	Jamia Millia Islamia, New Delhi
4	Indian Institute of Technology, Delhi	14	Indian Institutes of Technology Hyderabad
5	Indian Institute of Technology Kanpur, Kanpur	15	Calcutta University, Kolkata
6	Indian Institute of Technology, Kharagpur	16	Amrita Vishwa Vidyapeeth, Coimbatore
7	Indian Institute of Technology, Roorkee	17	Manipal Academy of Higher Education, Manipal
8	Indian Institute of Technology, Guwahati	18	Vellore Institute of Technology, Vellore
9	All India Institute of Medical Sciences, Delhi	19	Aligarh Muslim University, Aligarh
10	Jawahar Lal Nehru University, Delhi	20	University of Hyderabad

2022 rankings of Indian scientific institutes, universities and colleges released by Nature Index.

⁴The Nature index is released every year on the basis of institutional research performances. The research institutions are listed on the basis of count and share of institutions or country's publication output in 82 natural science journals between December 1 to November 30 of year and selection for listing done by an independent panel of leading scientists in their fields. For listing purpose nature index recognizes some other factors taken in to consideration like research quality and institutional performance.

⁴As per research output for India published between 1 April 2021 to 31 March 2022 tracked by nature index, Count 1881, and share is 1204.73. Subject wise count and share respectively are Chemistry Count-757, Share-615.79, Physical Science Count-833, Share-437.52, Life Sciences count-253, share-119.78 and Earth & Environmental Sciences count-136, share-65.88.

Table: ⁴Top ten institutions from India by share

(Source: <https://www.nature.com/nature-index/country-outputs/India#topten>)

Sr No	Institutions	Count	Share
1	Indian Institute of Science (IISc)	198	95.11
2	Homi Bhabha National Institute (HBNi)	216	72.39
3	Indian Institute of Technology Bombay (IIT Bombay)	167	62.03
4	Council of Scientific and Industrial Research (CSIR)	141	61.96
5	Tata Institute of Fundamental Research (TIFR)	198	52.97
6	Indian Institute of Science Education and Research Kolkata (IISER, Kolkata)	66	44.54
7	Indian Association for the Cultivation of Science (IACS)	106	41.77
8	Indian Institute of Technology Madras (IIT Madras)	156	41.51
9	Indian Institute of Technology Kanpur (IIT Kanpur)	82	40.82
10	Indian Institute of Science Education and Research Pune (IISER Pune)	117	40.33

Conclusion:

Indian higher educational and research institutions play a vital role in the development of technology through innovations in various fields and contribute to the development of different sectors. As per the above study,, Indian institutions globally perform satisfactorily. The innovations of these institutions also contribute to the Indian economy and, therefore, it is required to pay more attention to higher education for research and development. It needs to invest more of GDP of country in higher educational and research to perform best.

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