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RESEARCH PAPER

Fostering scientific excellence in Indian universities: analyzing the impact and future prospects of DST's PURSE program

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Abstract
The "Promotion of University Research and Scientific Excellence (PURSE)" program provide financial support to persuade top-tier research facilities in universities. The program aims to improve research infrastructure, foster interdisciplinary collaboration, and boost universities scientific output. This paper explores PURSE's strategic approach to fostering research excellence in Indian universities, highlighting its significant contribution to enhance scientific capabilities and to facilitate progress in science and technology, resulting in substantial improvements in R&D outcomes. Key metrics such as average publications per year, H-index, I-10 index, and DST-acknowledged publications were analyzed before and after the implementation of PURSE support. The PURSE program has significantly improved university rankings, boosted research output, and fostered innovation within universities, thereby augmenting India's global competitiveness and undertaking societal issues. The program's long-term benefits include knowledge creation, economic development, and societal well-being. Future funding agencies can use this study's findings to design research schemes for further scientific advancement.

Keywords DST · PURSE · Universities · Infrastructure · Research · Publications · India

Introduction

India stands as a historical epicenter for knowledge and a reservoir of wisdom. Achievers spanning natural and material sciences, applied sciences, social sciences, medicine, literature, engineering, technology, and the arts have earned global acclaim, leaving an enduring legacy through their remarkable achievements. The higher education landscape in India is in a state of continuous and transformative evolution. Indian research and development (R&D) reaching milestone achievements in recent years, for example the Make in India program provides support in this sector (Chaudhary and Pandey 2023). These challenges stem from the rapidly shifting global terrain, the rise of disruptive technologies linked to the impending fourth industrial revolution, the globalization of higher education, noteworthy scientific progress worldwide, global rankings of higher education institutions. While progress has been made, addressing these emerging issues is crucial to ensure the ongoing growth and adaptability of the higher education sector in India. It's heartening to observe that Indian universities are actively preparing to embrace the changing times.

As India progresses with its higher education system, it is becoming more and more apparent that innovative strategies are required to keep the country's universities vibrant, adaptable, and competitive worldwide. This can be done only by strengthening research activities in Indian universities. In India, UGC highlights the "Quality Mandate" to encourage high-quality research and the conception of innovative knowledge by faculty members of the universities, a good infrastructure is necessary for active research, which in turn exposes students to good research methods and practices (Quality Mandate for Higher Education Institutions in India, Secretary, University Grants Commission, and February, 2021). In India, the research funding is supported by 12

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government agencies. Figure 1 represents the trend of financing over 30 years by various Indian funding agencies. It was observed that 84.4% of the R&D disbursement was given by 12 major central government funding agencies. For the year 2020–21 the expenditure incurred by Defense Research and Development (DRDO), Department of Space (DOS), Indian Council of Agricultural Research (ICAR) and Department of Atomic Energy (DAE) are 31%, 18%, 12% and 11% respectively however, Council of Scientific & Industrial Research (CSIR), Department of Science and Technology (DST), Department of Biotechnology (DBT) and Indian Council of Medical Research (ICMR) share 8,7,5 and 3% of funding respectively (Fig. 1a). The rest of the other ministries, like the Ministry of Electronics and Information Technology (MEITY), Military Engineering Services (MES), Ministry of New & Renewable Energy (MNRE) and Ministry of Environment and Forests (MoEFCC) confer equal to or below 2%. Figure 2b shows the year-wise expenditure of major funding agencies in crores (cr.). Among 12 major funding agencies, the average last five-year (2015–16 to 2020–21) expenditure was highest for DRDO (15,362.79 cr.), lowest for MNRE (42.425 cr.), whereas DST (3470.81 cr.) holds sixth position (DST research and development statistics 2022–23).

As per National Science Foundation (NSF) data, 50% of the world's S&T publications are shared by four countries: China (22.77%), United States (15.5%), India (5%) and Germany (3.72%). India ranked 3rd with a total 149,213 publications of S & T in 2020. The compound annual growth rate for publication in India is 9% (White 2021).

Enhancing the quality of our research projects demands a substantial reinforcement of our research infrastructure. A pivotal step toward this objective involves establishing and cultivating research centers and institutes within universities

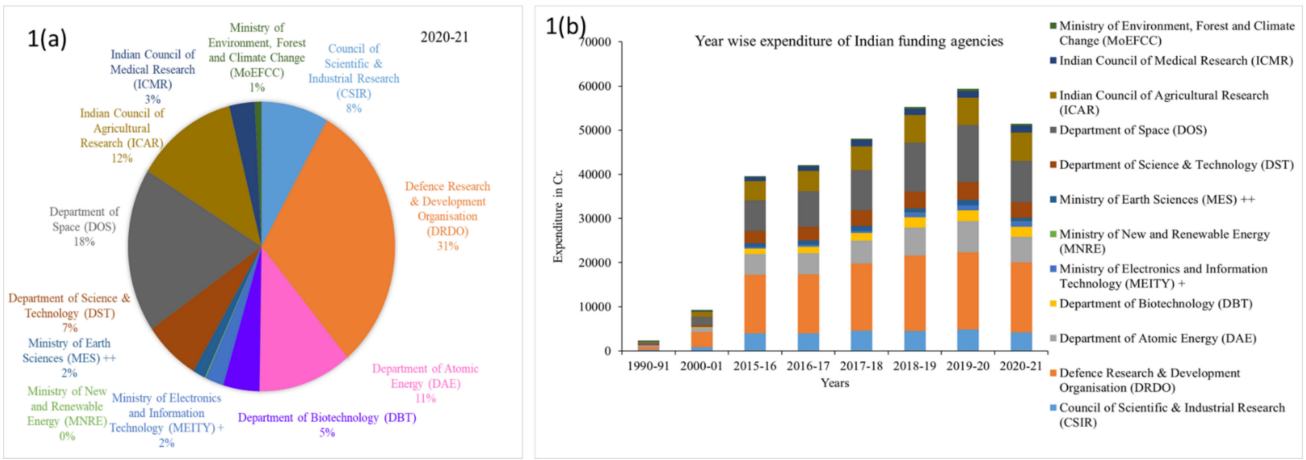


Fig. 1 **a** R&D funds disbursement by Indian funding agencies for FY 2020–21, **b** Year wise expenditure of Indian funding agencies. (Data Source: DST research and development statistics 2022–23)

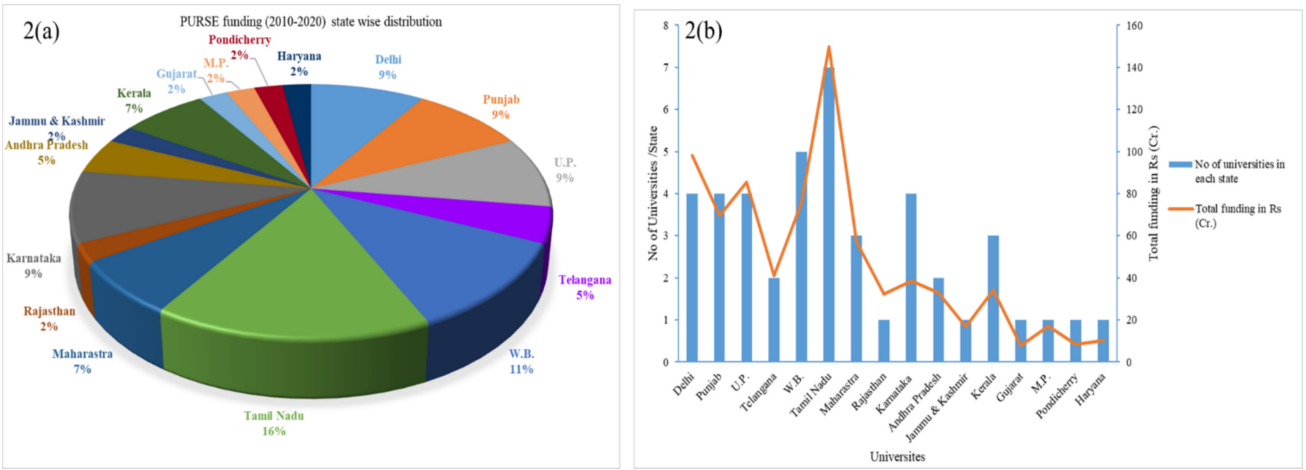


Fig. 2 **a** Pie-chart of PURSE funding (2010–2020) state-wise distribution, **b** State-wise total universities *vs* total funding during 2010–2020

capable of conducting cutting-edge research. These facilities necessitate a highly skilled staff and state-of-the-art equipment essential for pushing the boundaries of research. In order to fulfill its fundamental mission of advancing science, the nation must furnish the research community with advanced and powerful tools, ensuring that research endeavors maintain a leading position globally. These tools encompass major research facilities, mid-scale instrumentation, and advanced computational and data resources. It is imperative to prepare the next generation of the workforce to develop, maintain, and utilize such infrastructure, as these facilities serve as training grounds for the scientists and engineers of tomorrow. Consequently, the creation of a robust research infrastructure emerges as a fundamental requirement. The "Promotion of University Research and Scientific Excellence (PURSE)," a distinctive initiative of the DST exclusively designed for universities since its inception in 2009, aligns seamlessly with this objective. This scheme offers crucial infrastructure support to universities, encompassing both basic and cutting- edge equipment, as well as assistance for lab renovation, networking/computational support, equipment maintenance, and networking resources. Under the PURSE program, various equipments are supported, including but not limited to Ion Chromatograph, DNA Sequencers, Scanning Probe Microscope, Oligonucleotide Synthesizer, Molecular Imaging System, High- Resolution Powder/Single crystal X-ray Diffractometer, NMR, Mass Spectrometer, Plasma Deposition Etching System, Universal Testing Machines (UTMs), Electron Microprobe Analyzer, High-Resolution Microscopes, Confocal Microscope, Field Emission Scanning Electron Microscope, High-Resolution Transmission Electron Microscope, Scanning Tunneling Microscope, Vacuum Melting Furnace, High-Resolution Mass Spectrometer, and more. These facilities are indispensable for research across diverse scientific domains, empowering researchers to explore new frontiers, test hypotheses, and make ground breaking discoveries. The availability of such advanced facilities plays a crucial role in translating scientific breakthroughs into practical applications and the development of new industries, subsequently generating employment, encouraging the creation of innovative products and services, and contributing to overall economic growth. Recognizing the impact of this unique project on the scientific landscape is pivotal for shaping future policy decisions related to public funding in science and technology.

Methodology

PURSE program university selection process

Based on the research report from the National Institute of Science, Technology and Development Studies (NISTADS) titled "Status of India in Science and Technology," the publication output in the Scopus International Database for the periods 1996–2006 and 1998–2008, a total of 50 universities with h-index values ranging from 56 to 26 were identified for support (Banerjee 2008). The support ranged from Rs 6.0 Crores to Rs 30.0 Crores. The selection criteria included universities' performance during the specified periods. Utilizing a "performance-linked" investment model specifically designed for universities, the initial 14 universities (Phase I) were subsequently considered for support under the PURSE program (Phase I B). This served as an incentive for maintaining impressive growth rates in overall publications and the h-index. The second set comprised 30 universities (Phase II A), which were further considered for support under the PURSE program (Phase II B). Six new universities were added to this set, replacing six from Phase II A. Under the PURSE program, universities were granted flexibility in expenditure types and equipment selection. The universities received varying levels of support based on their revised h-index values. It is worth noting that the criteria and quantum of grants were revised in 2016, as detailed in Table 1.

Bibliometric studies

A comprehensive bibliometric analysis of publications emanating from universities supported by the PURSE program was conducted through the SCOPUS database. The papers were systematically categorized through keyword searches specifically targeting DST and /PURSE/DST-PURSE. The resulting publication records, along with the I-10 index and H-index rankings, were meticulously documented and subjected to thorough analysis. This examination aimed to provide insights into the scholarly output and impact of Indian universities benefiting from PURSE support, shedding light on their research influence and standing in the academic landscape (Table 2).

Table 1 Criteria for support in the PURSE program

Initial h-Index (2008–2015)	Revised h index (2016-onward)	Research grant for 4 years
More than 50	More than70	Rs 30.0 Cr
40–49	60–69	Rs 15.0 Cr
30–39	50–59	Rs 9.0 Cr
26–29	45–49	Rs 6.0 Cr

Table 2 Universities benefited from 2009–2017: inclusions in phase I and phase II programs

PHASE-I A (Study Period of H indexfor selection 1996–2006)	PHASE-I B (Study Period of H indexfor selection 2000–2010)	PHASE-II A (Study Period of H indexfor selection 1998–2008)	PHASE-II B (Study Period of H index for selection 2002–2012
University of Delhi, New Delhi	Punjab University, Punjab	University of Calcutta, Kolkata	Annamalai University, Tamil Nadu
University of Hyderabad, Hyderabad	University of Delhi, New Delhi	Annamalai University, Tamil Nadu	Bharathidasan University, Tamil Nadu
University of Punjab, Chandigarh	Banaras Hindu University, Uttar Pradesh	Bharathidasan University, Tamil Nadu	Bharathiar University, Tamil Nadu
University of Pune, Maharashtra	University of Hyderabad, Hyderabad	Bharathiar University, Tamil Nadu	Guru Nanak Dev University, Punjab
Jadavpur University, Kolkata	Jadavpur University, Kolkata	University of Burdwan, West Bengal	Sri Venkateswara University, Andhra Pradesh
Banaras Hindu University, Uttar Pradesh	Anna University, Tamil Nadu	Guru Nanak Dev University, Punjab	University of Jammu, Jammu & Kashmir
University of Madras, Tamil Nadu	University of Pune, Maharashtra	Sri Venkateshwar University, Andhra Pradesh	University of Calcutta, Kolkata
University of Bombay, Maharashtra	University of Madras, Tamil Nadu	Mahatma Gandhi University, Kerala	Cochin University of Science and Technology, Kerala
Jawaharlal Nehru University, New Delhi	Aligarh Muslim university, Uttar Pradesh	University of Jammu, Jammu & Kashmir	Dr. Harisingh Gour University, Madhya Pradesh
Anna University, Tamil Nadu	University Of Rajasthan, Rajasthan	Cochin University of Science and Technology, Kerala	Shivaji University, Maharashtra
Karnataka University, Karnataka	Jawaharlal Nehru University, New Delhi	MS University of Baroda, Gujarat	Punjab Agriculture University, Punjab
Aligarh Muslim University, Uttar Pradesh	University Of Mumbai, Maharashtra	Shivaji University, Maharashtra	Mahatma Gandhi University, Kerala
University Of Rajasthan, Rajasthan	Karnataka university, Karnataka	Utkal University, Odisha #	University of Mysore, Karnataka
Andhra University, Andhra Pradesh	Andhra University, Andhra Pradesh	Madurai Kamaraj University, Tamil Nadu	M.S University of Baroda, Gujarat
# These Universities are not supported in Phase II-B		University of Kerala, Kerala	University of Lucknow, Uttar Pradesh
***New universities added in Phase II-B**		Osmania University, Telangana	Madurai Kamaraj University, Tamil Nadu
		Dr Harisingh Gour university, Madhya Pradesh	University of Kerala, Kerala
		Mangalore university, Karnataka	Osmania University, Telangana
		University of Kalyani, West Bengal	Pondicherry University, Pondicherry
		University of Mysore, karnataka	University of Burdwan, West Bengal
		University of Lucknow, Uttar pradesh #	Mangalore University, Karnataka
		Pondicherry University, Pondicherry	Bangalore University, Karnataka
		CCS Haryana Agricultural University, Haryana	University of Kalyani, West Bengal
		Bangalore University, Karnataka	Alagappa University, Tamil Nadu
		Punjab Agricultural University, Punjab	Jamia Hamdard University, New Delhi *
		University Of Agricultural Sciences, Karnatak #	Punjabi University, Punjab*
		Alagappa University, Tamil Nadu	Visva-Bharati University, West Bengal*
		Sardar Patel University, Gujarat #	University of Allahabad, Uttar pradesh *

Table 2 (continued)

PHASE-I A (Study Period of H indexfor selection 1996–2006)	PHASE-I B (Study Period of H indexfor selection 2000–2010)	PHASE-II A (Study Period of H indexfor selection 1998–2008)	PHASE-II B (Study Period of H index for selection 2002–2012
		North Eastern Hill University, Meghalaya#	Jamia Millia Islamia, New Delhi*

Results

Distribution across regions and the grants offered within the PURSE program

Between 2009 and 2020, the PURSE program provided support to a total of 50 universities across diverse states, incurring a combined cost of 796.6 crore (Fig. 2b). This initiative has proven advantageous for universities in 13 states and three union territories (Fig. 2a). The breakdown of state and central universities across different states is as follows: Tamil Nadu: Seven state universities, West Bengal: One central university and four state universities, Uttar Pradesh: Two central universities and three state universities, Punjab: Four state universities, Karnataka: Four state universities, Maharashtra: Three state universities, Delhi: Three central universities and one state university, Kerala: Three state universities, Andhra Pradesh: Two state universities, Jammu and Kashmir: One state university, Telangana: Two state universities, Madhya Pradesh: One central university, Pondicherry: One central university, Haryana: One state university, Rajasthan: One state university, Gujarat: One state university, Fig. 2a illustrates the state-wise distribution of total funds from 2010 to 2020. These observations indicate a reasonably equitable distribution of beneficiaries throughout the country. Nevertheless, it is evident that several states have not been included in the list, highlighting the need for targeted initiatives or special drives aimed at supporting universities in these omitted regions.

Bibliometric studies on DST acknowledged publications

In this investigation, the Scopus database was utilized to identify the quantity of papers published between 2010 and 2023. The objective was to ascertain the institutions receiving funding from the DST and their acknowledgment of the funding agency in their published articles. A year-wise trend analysis revealed that, in recent years, institutions have increasingly acknowledged research funding agencies compared to earlier periods, as evident from the number of papers published during these years. Conducting a bibliometric study with specific conditions and filters aimed at evaluating the impact of funding on the research output of institutions, the search query included "DST" or "Department of Science and Technology," and a funding type filter was applied for "DST" or "Department of Science and Technology", Further examination of the data showed that out of 130,700 documents, 6228 were from IISC, Bangalore, followed by 4306 from AcSIR, 4160 from IIT Madras, 4115 from IIT Bombay, and 3792 from IIT Delhi. Additionally, institutions such as Jadavpur University, Panjab University, University of Hyderabad, University of Calcutta, Jawaharlal Nehru University, Aligarh Muslim University, Bharathidasan University, and Anna University supported by the PURSE initiative also contributed a substantial number of documents during this period. These documents include 110,233 research articles, 7679 review articles, 10,394 conference papers and 1184 book chapters as major components. Out of these, 11% of papers were from the Engineering domain, 14% were from chemistry, 13% were from physics, 3.6% were from medical, 4.1% were from computer science, 8.4% were from biochemistry, 13% were from material science and 4.2% were from agriculture etc. (Fig. 3).

Bibliometric analysis across different time periods specifically for universities that have benefited from the PURSE program

Following the implementation of the PURSE initiative, there has been a significant expansion in the infrastructure facilities of numerous public and private universities. It is anticipated that this improvement in infrastructure will lead to substantial growth in the quality of publications and collaborations. This study aims to analyze the impact of the DST-PURSE scheme on Indian researchers, focusing on their publications. The study comprises two phases of PURSE funding:

- PURSE Phase I A & IB: Ten years before and during the implementation of the project. (2004–2014) After 4 years of the project's implementation (2015–2019)
- PURSE Phase IIA & II B: 11 years before and during the implementation of the project. (2006–2017) After 5 years of the project's implementation (2018–2023)

The institutions selected for Phase IA were the top 14 universities based on their output in the Scopus database, as listed in the CSIR-NISTADS policy document (Banerjee 2008). Observing that the same institutions maintained

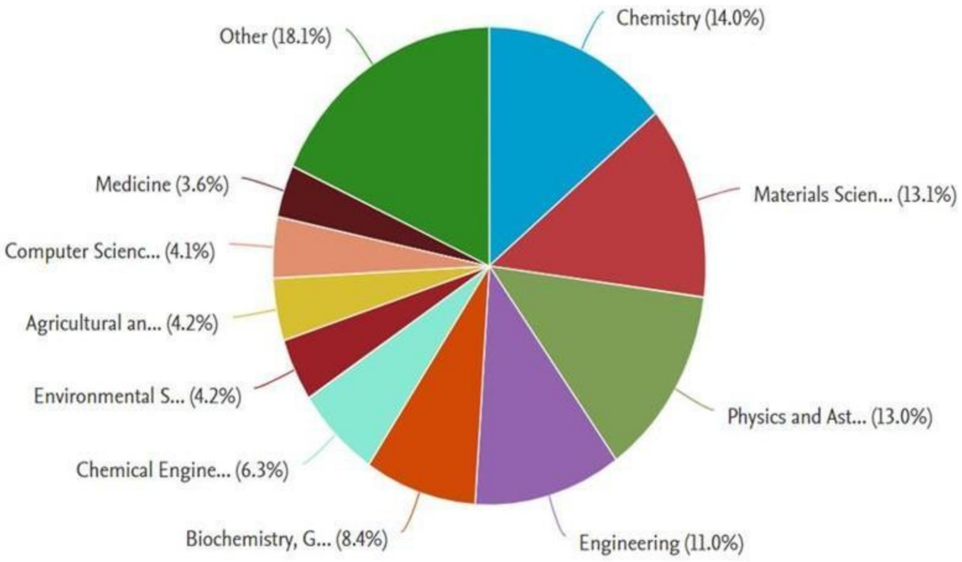


Fig. 3 Distribution of DST acknowledged papers under different subject areas

top positions after the first phase, it was decided during the next phase that institutions previously benefiting from PURSE funding were ineligible for support under Phase II. This decision allowed other institutions to benefit from the scheme. The PURSE Phase–IA funding significantly enhanced university performance in terms of total publications, and DST-acknowledged publications continued to rise even five years after project completion. Among the 13 universities, three showed a ≥ 1.2-fold increase in average publications/year, and six demonstrated a ≥ 2-fold increase in average DST-acknowledged publications/year after completing the funding period. However, no significant change was noted in H-index and I-10 index (Fig. 4).

Figure 5 illustrates the results of the PURSE Phase IIA & II B funding. Among the 30 universities, three have improved their publication records with a ≥ 1.5-fold increase in average publications/year after the conclusion of the funding period. Five years post PURSE-II B funding, six universities exhibited a 1.2-fold rise in the average I-10 index/year, and nine universities demonstrated a ≥ 5-fold increase in average DST-acknowledged publications/year. However, no significant fold change rise was observed for the H-index.

Insights into regional problem-solving capabilities of universities supported by the PURSE program

Within this initiative, universities are encouraged to engage in research addressing national priorities, including areas such as advanced manufacturing, waste management and processing, clean energy, water, and the Startup India initiative. Emphasis is placed on research that demonstrates positive impact and adopts an interdisciplinary approach to qualify for funding.

PURSE funding has led to significant achievements in solar cell development, bio-fortified wheat variety, nutraceutical pesticide-resistant crops and vegetables, in vivo electrophysiology technique brain function study in rodents, and selective ion detection in water (Chaudhary et al. 2024) The universities demonstrated their distinctive areas of focus and steadfast commitment to advancing knowledge and sustainable solutions within their respective fields during the scientific event "Vishwavidyalaya Anusandhan Utsav-2023," organized by the Department of Science and Technology. The event served as a platform to showcase the potential of universities that received PURSE funding. Noteworthy research achievements in specific areas of focus were presented during the event, as outlined in Table 3 (Shivaprasad and Pandey 2023). Patents play a vital role in bolstering economic development through the encouragement of innovation, facilitation of economic growth, and establishment of a framework for safeguarding intellectual property. Sri Venketeswara University, Tirupati, has successfully acquired approximately five patents with the assistance of PURSE support. These patents cover diverse processes, including the creation of dehydrated fruit bars from prickly pear fruits, the production of blended fruit squash incorporating Prickly Pear (*Opuntia ficus-indica* and *Opuntia dillenii*) fruits and lemon juice, the generation of Alcohol (Naturo-Hol) from *Agave albomarginata*, the manufacturing of Conditioned Graded and Packed (CGP) Sand, and research in Computer-aided molecular docking, physicochemical, and ADMET properties of novel bromopyrimidine analogues as potential anti-cancer agents. Countries that increase the level of patenting also witness a concomitant increase in economic growth (Hasan and Tucci 2010).

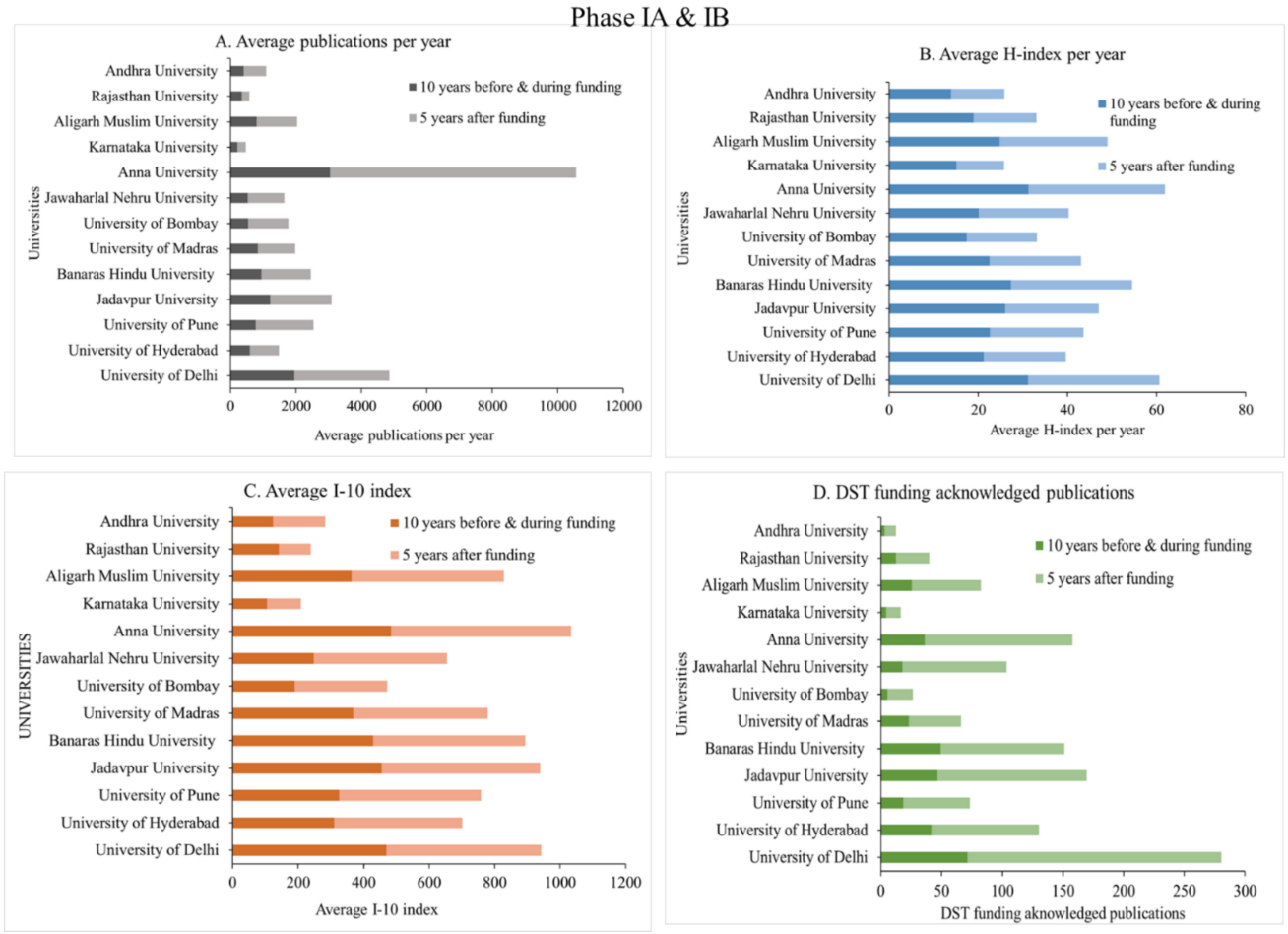


Fig. 4 Outcome of Purse Phase 1 A & Phase I B funding: **a** Average publication per year, **b** Average H-index per year, **c** Average I-10 index per year and **d** Average DST funding acknowledged publications

Discussion

Globally, science, technology and innovation are growing very fast. In this challenging scientific environment, research funding is crucial. Particularly, in India, the research and innovation in science and engineering (S&E) are evolving to achieve capacity building in various scientific areas. R&D funding agencies of GoI play an active role in supporting the Indian research ecosystem. The 12 major central funding agencies in India provide funds in their respective domains, and during the last five years (2015–16 to 2020–21), their expenditure on R&D has grown substantially. Globally, research funding agencies are interested in making research data and outcomes of the projects available online. The Indian research funding agencies are also progressing in this direction of data sharing and accessibility for funded projects (Manu and Gala 2020).

The PURSE program, under DST, enhances research quality by identifying and initiating high-quality research area in universities or institutes, leading to increased quality publications from host universities.

The H-index and I-10 index are determined by individual faculty performance and can affect the overall University ranking in one way. Since we have a limitation of 5 years after funding data, we can't precisely conclude the universities' performances based on H-index and I-10 index. In upcoming years, the ranking based on the H-index and I-10 index is anticipated to increase.

Indian universities must ready themselves to harness the momentum expected from the National Education Policy 2020 (National Educational Policy 2020), which places a greater emphasis on research in most institutions. One of the crucial goals of NEP 2020 is to transform all higher education institutions into multidisciplinary institutions by 2040 for the proper use of infrastructure and resources by thousands of students (Year-End Review - 2022: Department of Science & Technology, Ministry of Science and Technology). Establishing Anusandhan—National Research Foundation (A-NRF) aims to fund outstanding peer-reviewed

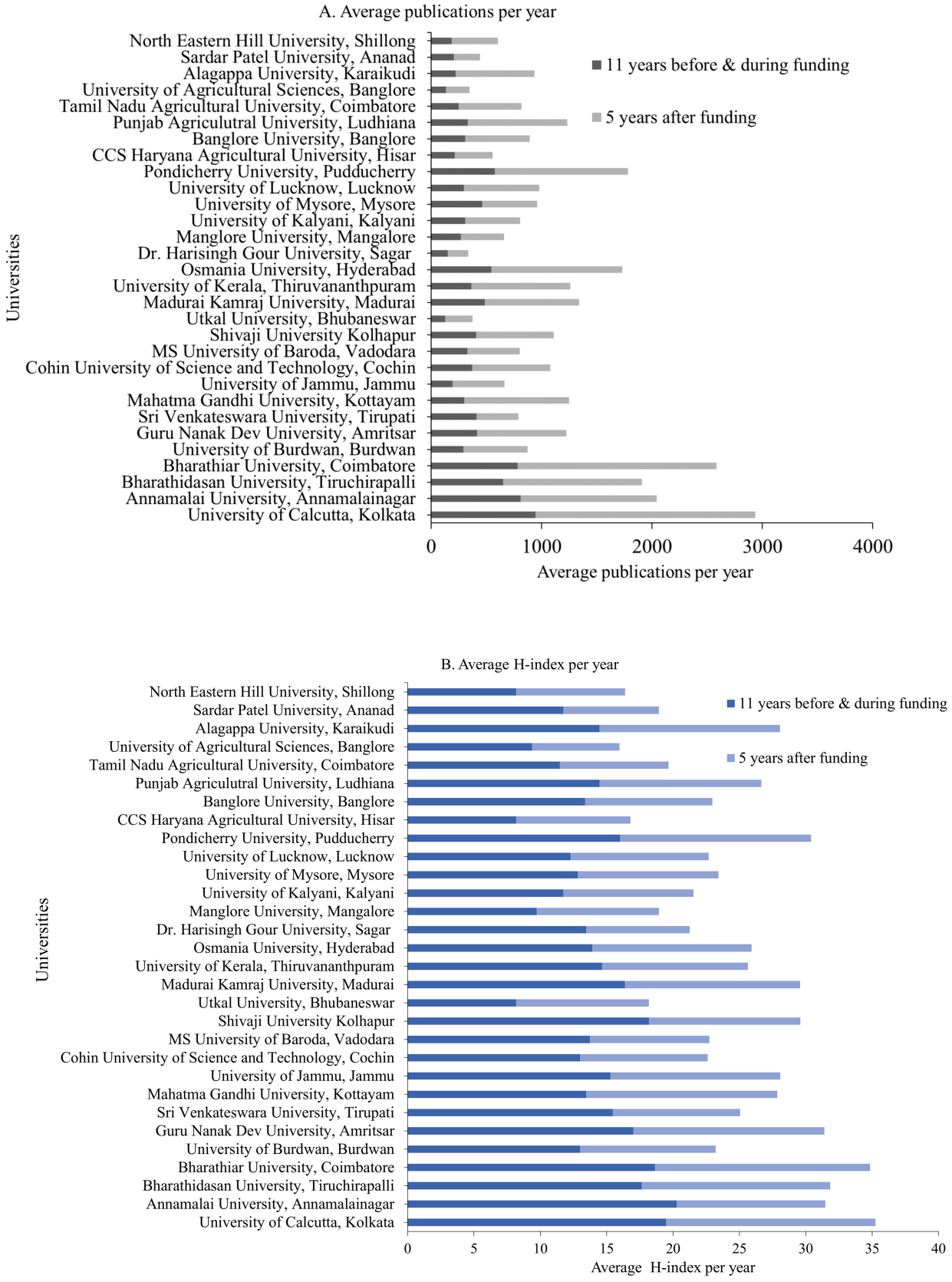
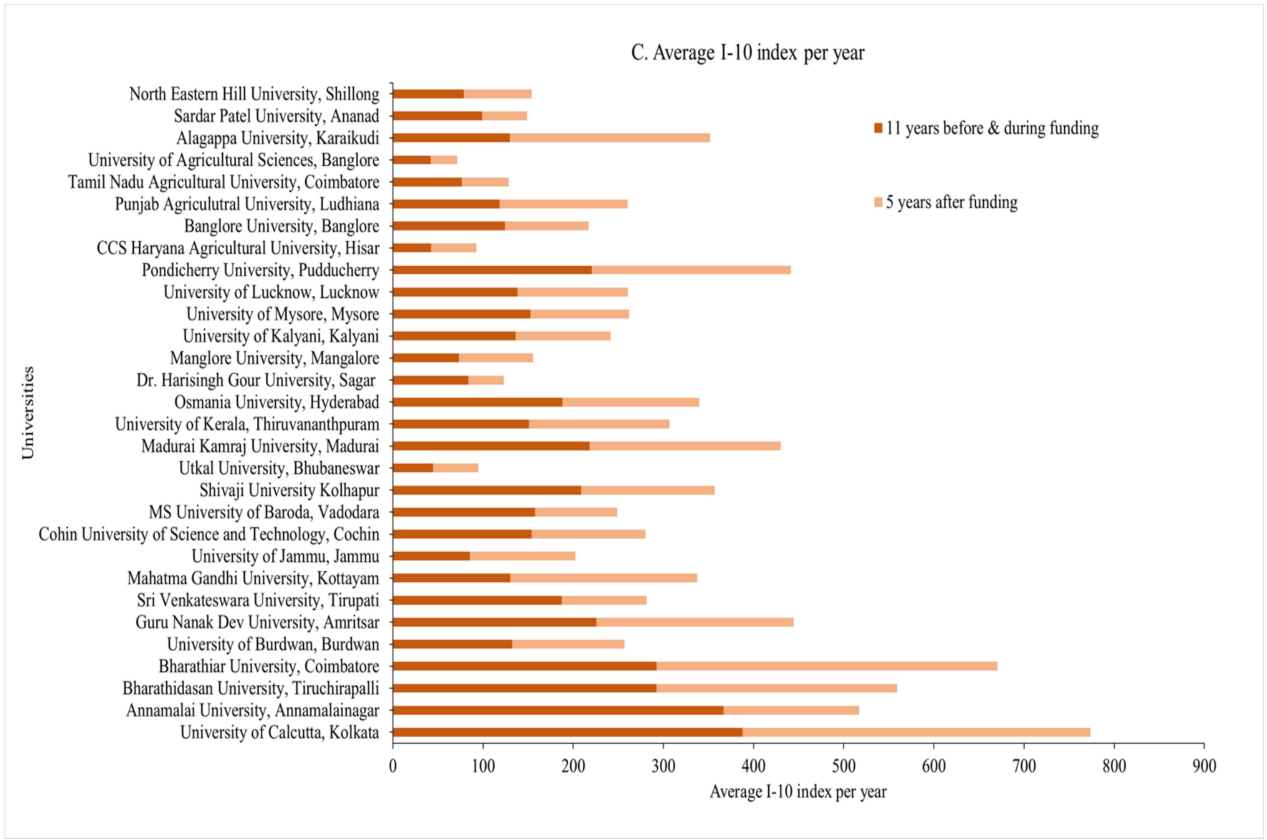


Fig. 5 Outcome of PURSE Phase IIA & IIB funding: **a**. Average publication per year, **b** Average H-index per year, **c** Average I-10 index per year and **d** Average DST funding acknowledged publications



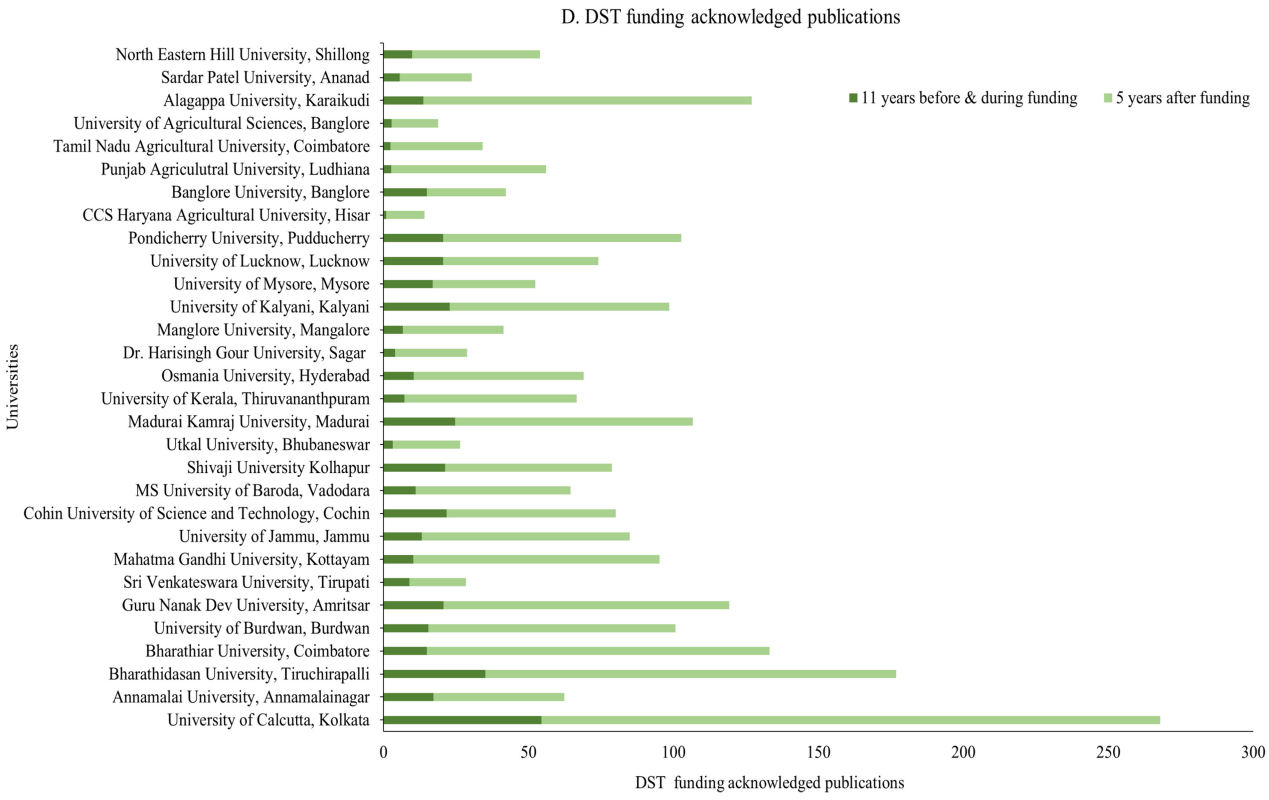


Fig. 5 (continued)

Table 3 Universities took part in the Vishwavidyalaya Anusandhan Utsav to showcase their expertise in various scientific domains

Sr. No	University	Scientific domains
1	Jawaharlal Nehru University, New Delhi	Cutting-edge Biomedical Technologies for Improved Health and Environmental Solutions
2	Punjab Agricultural University, Ludhiana, Punjab	Enhancing Food Security and Environment: Nutritionally Enriched Cultivators and Advanced Technologies
3	SRM Institute of Science and Technology, Kattankulathur#	Advancing Electrification and Smart Connectivity Solutions for the Future
4	Rajiv Gandhi University, Arunachal Pradesh#	Design and Development of Materials for Applications in Energy Harvesting, Sensor applications
5	Jadavpur University, Kolkata, West Bengal	Integrated Research: Medicinal Compounds, Wireless Sensors, Sustainable Fuels
6	Jamia Millia Islamia, New Delhi	Cutting-edge Innovations in Healthcare Diagnostics and Renewable Energy Technologies
7	Madurai Kamaraj University, Tamil Nadu	Advancing Sustainability: Nanotech, Materials, and Green Chemistry for Renewable Energy and Environmental Solutions
8	Mahatma Gandhi University, Kerala	Bio-prospecting for Natural Products and Sustainable Bioprocessing of Fruit and Vegetable Waste
9	Mangalore University, Karnataka	Cutting-Edge Innovations: Advanced Materials, Bioactives, and Optoelectronics for Drug Discovery, Environmental Monitoring, and Oceanic Understanding
10	Jamia Hamdard, New Delhi	Advanced Cryogenic Transmission Electron Microscopy and Model Organism Research for Biomedical Discoveries
11	The University of Burdwan, West Bengal	Interdisciplinary Research in Natural Products, Biotechnology, and Material Science for Sustainable Development
12	University of Kerala, Thiruvananthapuram, Kerala	Advancing Renewable Energy: AI Wind Modeling for Dynamics and Nanotech SERS Sensors
13	Bharathidasan University, Tamil Nadu	Algae Cake Process development as a Semi product display
14	Bharathiar University, Coimbatore	Nanotech for Drug Discovery: Environmental Monitoring, Bioactives, Crystallization
15	Annamalai University, Tamil Nadu	Multidisciplinary Research: Natural Products, Nanotech, and Environmental Science for Health and Sustainability
16	Aligarh Muslim University, Uttar Pradesh	Advanced Research on Nanoparticles, Corrosion Inhibition, Biotechnology, Cancer Therapy, Diabetes Treatment, and Environmental Impact of Heavy Metals
17	Alagappa University, Tamil Nadu	Pioneering Research for Swachh Bharat: Quantum Nanomaterials, Fuel Cell Innovations, and Advanced Nanofilms for Environmental Solutions
18	Amity University, Rajasthan#	Multipronged Approach to Alleviate Disease Burden
19	Institute of Chemical Technology, Mumbai#	Self-reliance in working around sustainable, helpful, reliable and high yielding processes and technologies
20	Guru Jambheshwar University of Science & Technology, Hisar	Healthcare Innovations: Advancing Functional Materials, Nanotechnology, Pharmaceuticals
21	University of Kashmir, Srinagar, Jammu & Kashmir	From Cancer Research to Climate Change and Water Pollution Solutions: Advancing Scientific Discoveries for a Better World
22	Birla Institute of Technology and Science, Pilani#	Cutting-Edge Research: Advancing Cancer Treatment, Rapid Disease Diagnosis, and Clean Energy from Organic Waste
23	Vellore Institute of Technology (VIT)#	Additive Manufacturing for Fostering Transdisciplinary Research
24	JSS Academy of Higher Education and Research, Mysore, Karnataka#	Accelerating Interdisciplinary research for improving human health by the development of molecular therapeutics & devices
25	Punjab University, Chandigarh	Frontiers in Biotech & Biochemistry: Mycobacterium Lipases to Nanomaterials
26	University of Kalyani, West Bengal	Breaking New Grounds in Interdisciplinary Research: Material Sciences, Nanotechnology, Computational Biology, and Drug Development Addressing COVID-19 and Beyond
27	M.S University of Baroda	Advanced Analytical Techniques: Chirality, Catalytic Materials, Environmental Monitoring

Table 3 (continued)

Sr. No	University	Scientific domains
28	Sri Venkateswara University, Tirupati	Convergence of Biological and Physical Sciences for Health-Driven Material Innovation and Nano device Development
29	Cochin University of Science And Technology, Kochi, Kerala	Advancing Environmental Sciences, Biotech & Tech: Raindrops to Therapies, Sensors, IoT
30	Osmania University	Environmental Biotech & Sensing: Metal Nano Composites, Arsenic Sensors, Water Detox, Protein Diagnosis
31	University of Jammu	Glacier Dynamics and Geophysical Investigations in the North Western Himalaya: Assessing Debris Thickness Variability using Electrical Resistivity Tomography
32	University of Hyderabad, Hyderabad, Telangana	Cell Biology and Cancer Research: Immunofluorescence and Immunohistochemistry for Protein Detection
33	Banaras Hindu University, Varanasi, Uttar Pradesh	Exploring Microbial Diversity, Cancer Biology, Nanotech, and Sustainable Materials for Innovative Applications

research and promote university research initiatives (The Anusandhan National Research Foundation Bill, 2023). The overarching goal of the NRF is to foster a culture of research within our universities. Specifically, the A-NRF will lay a strong foundation for merit-based and equitable peer-reviewed research funding, contributing to developing a research-centric culture in the country through suitable incentives and recognition for exceptional research. Universities that have received PURSE grants can significantly contribute to advance research in the context of NEP 2020 and A-NRF.

The Industry-Academia Connect in India has emerged as a critical driver for fostering innovation, bridging the gap between theoretical knowledge and practical application. By allocating a budget for industry-academia collaboration as a new provision in PURSE projects, universities are exploring industry-academia collaboration, conducting workshops and seminars on opportunities and challenges faced by both sectors. It examines successful models of collaboration, emphasizing the mutual benefits derived from knowledge exchange, skill development, and research partnerships. Universities are encouraged to unite their expertise across departments or schools into a cohesive team, aiming to promote interdisciplinary research that aligns with national priorities and missions. The research endeavors should also harmonize well with the objectives of Self-Reliant India (Atma Nirbhar Bharat) and Startup India (Chaudhary et al. 2024). DST's proactive support has evolved into competitive support, promoting inclusivity and safety infrastructure. The restructured program includes provisions for Scientific Social Responsibility (SSR), industry collaboration, and knowledge exchange to enhance research outcomes. The need for scientific safety infrastructure in Indian universities is multifaceted, encompassing human safety, environmental protection, compliance with regulations, public confidence, and the overall success and sustainability of scientific research. SSR is a concept that emphasizes the ethical and societal dimensions of scientific research and its applications. It builds on the idea that universities have a responsibility not only to advance knowledge but also to consider the broader impact of their work on society. The budget allocated under SSR encourages scientists to engage with the public, policymakers, and other stakeholders to ensure that the benefits of scientific advancements are shared. Scientific research and technological innovations contribute significantly to economic growth (Hasan and Tucci 2010). By investing in scientific infrastructure, Indian universities can play a vital role in driving innovation, creating intellectual property, and contributing to the country's gross domestic product (GDP). The restructuring also facilitated the inclusion of more private universities into the PURSE landscape. This also improves another area of concern that arises from the breakdown of the existing R&D expenditure. The government accounts for the majority of R&D spending, exceeding 60%. A significant obstacle to India's overall low R&D expenditure is the limited involvement of the private sector (Reddy and Subash 2020, Mani 2021). Effective strategic planning is essential to support the multitude of universities in India participating in this program. Given the extensive array of promising universities across the country, the inclusion of a large number of universities is imperative.

As per the report of the year-end review 2022 of the Department of Science & Technology (DST), Ministry of Science and Technology, Government of India (GoI), the global ranking of India in the Global Innovation Index (GII) is at 40th position in 2022 among 130 economies of the world and the Indian GII left behind 41 nations within seven years. India holds 3rd position in the number of publications, PhDs (S&T Indicators Tables, Research and Development Statistics 2022–2023), startups, UNICORNs, and investment destinations for technology transactions globally. Women's share in extramural research and development (R&D) has doubled in the last nine years. India secured 9th rank in resident patent filing. The gross expenditure on R&D (GERD)

in India has also increased more than three times in the last ten years (National Educational Policy 2020). This is very well expressed in the increase in the number of publications and h-index due the DST-PURSE funding.

Limitations, insights and prospects for future studies

This study assessed the volume of papers published between 2010 and 2023, explicitly concentrating on Scopus-indexed publications on other parameters like patents, products, experimental techniques, or diverse research outcomes. The publications without mention of the Scheme or name of funding organization prevented the attribution of the analyzed volume of papers. While Scopus includes papers recognizing both DST and DST-PURSE, it is important to highlight that, within the array of DST schemes, the presence of a dedicated DST-PURSE scheme for the university sector brings alterations in the overall research ecosystem of a university. Consequently, the substantial growth in overall publications can be predominantly attributed to the PURSE Scheme in the chosen period for analysis. For future research endeavors, it is suggested to conduct discipline- specific analyses to compare outcomes across various schemes and funding agencies, a study of this nature would help science managers and policymakers develop policy documents to improve the scientific infrastructure and distribution of funds in different regions of the country. The granting agencies should establish a mechanism to acknowledge the funding of the agency/ scheme in all documents generated from the project. Furthermore, the DST restructured PURSE in 2020, using a composite approach incorporating faculty members' I-10, University's H, and NIRF Rankings. Universities are encouraged to focus on mission-oriented research, aligning with national priorities like manufacturing, waste processing, clean energy, and water.

Conclusion

The PURSE scheme has significantly impacted the development of state-of-the-art facilities in universities, enabling the nation to advance in science and technology. 50 Indian universities from 1103 UGC-recognized universities improved their publications records under the PURSE Phase-I & II scheme, thereby promoting further improvement and supporting more Indian universities. The investment in these institutions is certain to yield returns in the long run amidst the rapidly evolving global landscape, a growing student population, an increased emphasis on skill development and graduate employability, the market relevance of academic programs, and the translational impact of research. The present study will act as a policy document that will help DST to devise new selection parameters and course correction parameters in implementing such capital-intensive scientific infrastructure development programs.

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Declarations

Conflict of interest On the behalf of all the authors, the corresponding author states that there is no conflict of interest.

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