India’s Research and Development Landscape

This editorial is based on “Perfunctory panacea: On the Rashtriya Vigyan Puraskar” which was published in The Hindu on 12/08/2024. The article highlights the revamp of India's scientific awards, introducing the Rashtriya Vigyan Puraskar (RVP) to replace the Shanti Swarup Bhatnagar awards, while emphasizing that enhancing funding and support for researchers is crucial for advancing science beyond mere recognition.

For Prelims: Covaxin, Vaccine Maitri, Indian Council of Agricultural Research, Centre for Development of Telematics, Indian Space Policy 2023, Chandrayaan-3, National Quantum Mission, PARAM Siddhi-AI, National Supercomputing Mission , IFFCO Nano Urea, GenomeIndia Project, Economic Survey 2023-24.

For Mains: India’s Achievements in Science and Technology. Status of Research and Development in India

The recent announcement of the Rashtriya Vigyan Puraskar **(RVP)** marks a significant shift in India's approach to recognizing scientific excellence. Replacing the long-standing Shanti Swarup Bhatnagar (SSB) awards, the RVP introduces a new framework for honoring scientists across various career stages and disciplines. While this change aims to streamline and elevate the **stature of scientific awards in India**, it also raises questions about the effectiveness of such recognition in addressing the **fundamental challenges faced by the country's research community.**

Despite the government's efforts to boost scientific recognition, **India's R&D landscape continues to grapple with significant hurdles.** The focus on awards and honors may be overshadowing the pressing need for **increased budgetary allocations, improved research infrastructure, and a more conducive environment** for scientific inquiry. As India aspires to compete on the global stage of scientific innovation, it becomes crucial to address these underlying issues that hinder the progress of its research ecosystem.

What are India's Recent Major R&D Achievements in Science and Technology?

- **Biotechnology:** India's biotechnology sector demonstrated its prowess during the Covid-19 pandemic with the rapid development and production of indigenous vaccines.
    - Covaxin, **developed by Bharat Biotech** in collaboration with ICMR, showcased India's capability in vaccine research and development.
    - The country's ability to manufacture vaccines at scale not only supported its own vaccination drive but also contributed to global vaccine supply through initiatives like Vaccine Maitri.
- **Renewable Energy:** India has made remarkable progress in renewable energy research, particularly in solar and green hydrogen technologies.
    - The country has achieved **record-low solar power costs** and is pioneering **floating solar projects like Kayamkulam Floating Solar Power Plant, Kerala.**
    - These advancements are crucial for India's ambitious renewable energy targets and its

goal of becoming a net-zero emissions country by 2070.

- **Agriculture:** India has been making strides in agricultural biotechnology to enhance crop resilience and productivity.
    - Indian Council of Agricultural Research has developed **109 high-yielding, climate-resilient and biofortified varieties of 61 crops.**
    - These innovations are crucial for ensuring food security and sustainable agriculture in the face of climate change.
- **5G and 6G Technology:** India has been actively working on developing indigenous 5G technology and preparing for 6G.
    - The Centre for Development of Telematics (C-DOT) has successfully developed and tested a completely indigenous **5G NSA Core.**
        - The Department of Telecommunications (DoT) is implementing the **"Digital Communications Innovation Square (DCIS)" Scheme** to advance indigenous 5G and emerging technologies by translating research into practical technology.
    - Nokia established a **6G Lab at its Bangalore center t**o spearhead research in next-generation wireless technology.
    - These efforts aim to position India as a leader in telecommunications technology and reduce dependence on foreign vendors.
- **Space Exploration**: India's space program achieved a historic milestone with Chandrayaan-3's **successful soft landing** on the Moon's south pole region in August 2023.
    - This made **India the fourth country** to achieve a lunar landing and the first to reach the Moon's south pole.
    - The mission demonstrated India's growing capabilities in **space exploration,** including precision landing technology and lunar rover operations.
    - It also paved the way for future lunar exploration and **potential resource utilization missions.**
    - Indian Space Policy 2023 and Indian National Space Promotion and Authorisation Centre (IN-SPACe) is a significant step in this direction.
- **Quantum Technology**: India has made significant strides in quantum technology research with the establishment of the **I-Hub Quantum Technology Foundation (I-Hub QTF) at IISER Pune.**
    - **The** National Quantum Mission and other initiatives aim to develop quantum computers, quantum communication systems, and quantum sensors, positioning India as a potential leader in this cutting-edge field.
- **Supercomputing:** India has made significant strides in supercomputing with the development of PARAM Siddhi-AI, one of the most powerful supercomputers in the world.
    - It's being used for advanced research in artificial intelligence, scientific simulations, and big data analytics.
    - The National Supercomputing Mission has also led to the installation of high-performance computing systems in multiple institutions across the country, boosting research capabilities in various fields.
- **Genomics:** The GenomeIndia Project, launched in 2020, aims to sequence 10,000 Indian genomes to create a reference database for the Indian population.
    - This project is crucial for personalized medicine and understanding genetic diversity in India.
    - Indian researchers actively contributed to global efforts in genome sequencing of the SARS-CoV-2 virus, helping track mutations and variants.
    - The **Indian SARS-CoV-2 Genomics Consortium (INSACOG)** played a key role in this effort, sequencing thousands of samples by mid-2021.
- **Nanotechnology:** Indian researchers have made significant progress in nanotechnology, particularly in developing novel nanomaterials.
    - For instance, scientists at IIT Madras developed a **nano-coated magnesium alloy** that can be used for biodegradable implants, potentially revolutionizing orthopedic treatments.
    - IFFCO Nano Urea **(liquid)** is the **world's first Nanofertilizers** which has been notified by Fertilizer Control Order (FCO, 1985), Government of India.
    - Another team at IISc Bangalore designed a novel **hydrogel** to remove microplastics from water.
- **Robotics and Automation:** India has made significant progress in robotics, particularly in healthcare applications.
    - For instance, researchers at **IIT Madras** have launched India's first indigenously developed

Polycentric Prosthetic Knee called "**Kadam”.**
    - These innovations demonstrate India's growing capabilities in integrating robotics and AI for practical applications.

Why India Still Lags Behind Research and Developments?

- **Funding Famine- The Resource Crunch in R&D**: India's investment in R&D remains critically low compared to glob al standards.
    - As of 2021, India spent just **0.7% of its GDP on R&D,** significantly below the global average of 1.8% and far behind countries like **Israel (4.9%) and South Korea (4.6%).**
    - This underinvestment translates to **fewer grants, outdated equipment, and limited resources for researchers.**
    - The private sector's contribution to R&D in India is also low at about **37% of total R&D expenditure,** in contrast to the global trend, where business enterprises typically contribute over 65% of R&D.
- **Brain Drain**: India continues to face a significant brain drain, with many top researchers and scientists leaving for better opportunities abroad.
    - A report by US-based think tank Centre for Security and Emerging Technology stated that approximately **87% of Indian nationals** who completed **STEM PhD programmes in the US** between 2000 and 2015 were still living in the country
    - This exodus deprives India of its brightest minds, hindering the growth of a robust domestic research ecosystem.
    - The **lack of competitive salaries, limited research funding,** and inadequate infrastructure at home contribute to this ongoing challenge.
- **Bureaucratic Bottlenecks- Red Tape Strangling Innovation:** The Indian research landscape is often mired in bureaucratic processes that slow down progress.
    - Complex **procurement procedures, delayed fund releases, and excessive paperwork** create significant hurdles.
    - For instance, it takes an average of 6-12 months to import specialized scientific equipment in India, compared to 1-2 months in many developed countries.
- **Disconnected Curricula and Industry Needs**: India's education system often fails to nurture research skills and innovation mindset at early stages.
    - Economic Survey 2023-24 stated that about one in two graduates are not yet readily employable straight out of college.
    - The disconnect between **academic curricula and industry needs** results in a shortage of skilled researchers.
    - Moreover, the **emphasis on rote learning over critical thinking** and problem-solving in schools hampers the development of research aptitude from an early age.
- **Publish or Perish-Quantity Over Quality in Research Output:** While India's research output has grown, concerns about quality persist.
    - India was the world's **third-most-prolific publisher of research papers in 2022**, but it was ranked only **153rd for the number of citations it received per paper.**
- **Gender Gap in STEM:** India faces a significant gender disparity in scientific research. A study conducted by UNESCO found that only **35% of STEM students in higher education in India are women.**
    - This underrepresentation is even more pronounced in leadership positions.
    - This gender gap **not only deprives the field of diverse perspectives** but also represents a massive untapped talent pool that could significantly boost India's research capabilities.
- **Intellectual Property Conundrum:** India's performance in intellectual property creation remains subpar compared to its research output.
    - According to the Indian Patent Office, **58,503 patent applications were filed in India in 2020–2021,** significantly lower than China or the US.
    - More critically, the patent grant rate in India is much less as compared to countries like Japan and the US.
    - This low patent output not only reflects gaps in applied research but also results in missed economic opportunities from potential commercialization.
- **Interdisciplinary Divide**: Indian research often suffers from a lack of interdisciplinary collaboration.

- This silo mentality hampers innovation, especially in emerging fields like AI, **biotechnology, and** nanotechnology, which require integration of multiple disciplines.
- For instance, while India has strong individual departments in computer science and biology, the field of **bioinformatics lags due to limited interdepartmental collaboration.**
- This lack of cross-pollination of ideas significantly limits India's ability to tackle complex, multifaceted research challenges.

What Measures can India take to Enhance its R&D Capabilities?

- **Fund to Flourish**: Increase public R&D spending from the current **0.7% to at least 2% of GDP.**
  - Implement tax incentives for private companies investing in R&D, offering tax deduction on R&D expenditure.
  - Create a national research foundation to **fund high-risk, high-reward projects.**
  - Establish a sovereign innovation fund to support startups and research-intensive SMEs.
  - These measures would significantly enhance the financial ecosystem for research and innovation in India.
- **Brain Gain Initiative:** Launch a "**Reverse Brain Drain" program** offering competitive salaries and research grants to attract Indian scientists working abroad.0
  - Implement a **"Flexi-Return" policy allowing researchers** to split time between Indian and foreign institutions.
  - Establish a "**Global Indian Scientist Network**" to facilitate collaborations and knowledge transfer. These steps would help India reclaim its intellectual capital and boost its research capabilities.
- **Industry-Academia Bridge:** Mandate that **2% of CSR funds be allocated to joint research projects** with academic institutions.
  - Establish sector-specific "Innovation Clusters" bringing together industry, academia, and startups.
  - Implement a "**Researcher-in-Residence" program** for faculty to work in industry and vice versa.
  - Create a national portal for industry to post research problems and academia to offer solutions. These initiatives would strengthen the industry-academia linkage and drive more applied research.
- **Quality Quest:** Introduce a national research integrity office to monitor and promote ethical research practices.
  - Implement a **tiered journal ranking system** to incentivize publication in high-impact journals.
  - Establish mandatory research methodology and scientific writing courses for all **PhD students.**
  - Create a national mentorship program pairing early-career researchers with eminent scientists. These steps would help improve the overall quality and impact of Indian research output.
- **STEM for All:** Launch a "**Women in STEM" scholarship** program.
  - Implement gender-sensitive policies including extended maternity leave and childcare support in research institutions.
  - Create **research positions reserved for scientists** for women.
  - Establish a national network of STEM outreach centers in rural and semi-urban areas. These measures would help create a more diverse and inclusive research ecosystem in India.
- **Innovation Incubators**: Establish technology business incubators in universities with a focus on deep-tech startups.
  - Implement a **"Lab to Market" grant program** funding the commercialization of research outcomes.
  - Create a **national IP bank** to facilitate easier licensing of patents to industry.
  - Launch an "**Innovation Challenge" series** with substantial prizes for solving key national problems.
    - These initiatives would help translate more research into marketable innovations and economic value.
- **Global Research Connect:** Establish joint research centers with top global universities in priority areas like AI, quantum computing, and biotechnology.

    - Launch an "**International Research Fellowship**" program funding Indian researchers annually for overseas projects.
    - Create a "**Global Science Diplomacy"** initiative to forge research partnerships aligned with foreign policy objectives.
    - Implement fast-track visas for international researchers coming to India. These measures would significantly boost India's participation in global scientific endeavors.
- **Upgrading Research Infrastructure**: Launch a "Research Infrastructure Modernization" program.
    - Establish **national research facilities in frontier areas like particle physics, gene editing, and advanced materials.**
    - Create a national research cloud computing platform accessible to all accredited researchers. Implement a shared equipment program to optimize utilization of high-end scientific instruments. These steps would provide Indian researchers with world-class facilities to conduct cutting-edge research.
- **Interdisciplinary Nexus**: Establish **Centers of Interdisciplinary Research Excellence** focusing on complex national challenges.
    - Implement a "**Discipline Hopping"** fellowship for researchers to work in fields outside their primary expertise.
    - Create interdisciplinary PhD programs combining STEM with humanities and social sciences.
    - Launch an "**Convergence Research"** grant program specifically for projects spanning multiple disciplines.

Drishti Mains Question:

Discuss the current challenges and opportunities in India's research and development (R&D) sector. What measures can be taken to enhance India's R&D ecosystem to drive innovation and global competitiveness?

UPSC Civil Services Examination Previous Year Question (PYQ)

Prelims:

Q.1 Which of the following statements is/are correct regarding National Innovation Foundation-India (NIF)? (2015)

1. NIF is an autonomous body of the Department of Science and Technology under the Central Government.
2. NIF is an initiative to strengthen the highly advanced scientific research in India’s premier scientific institutions in collaboration with highly advanced foreign scientific institutions.

Select the correct answer using the code given below:

(a) 1 only

(b) 2 only

(c) Both 1 and 2

(d) Neither 1 nor 2

Ans: (a)

Q.2 For outstanding contribution to which one of the following fields is Shanti Swarup Bhatnagar Prize given? (2009)

(a) Literature

(b) Performing Arts

(c) Science

(d) Social Service

Ans: (c)

Q.3 Atal Innovation Mission is set up under the (2019)

(a) Department of Science and Technology

(b) Ministry of Labour and Employment

(c) NITI Aayog

(d) Ministry of Skill Development and Entrepreneurship

Ans: (c)
