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Let noble thoughts come to us from all sides.
Rig Veda

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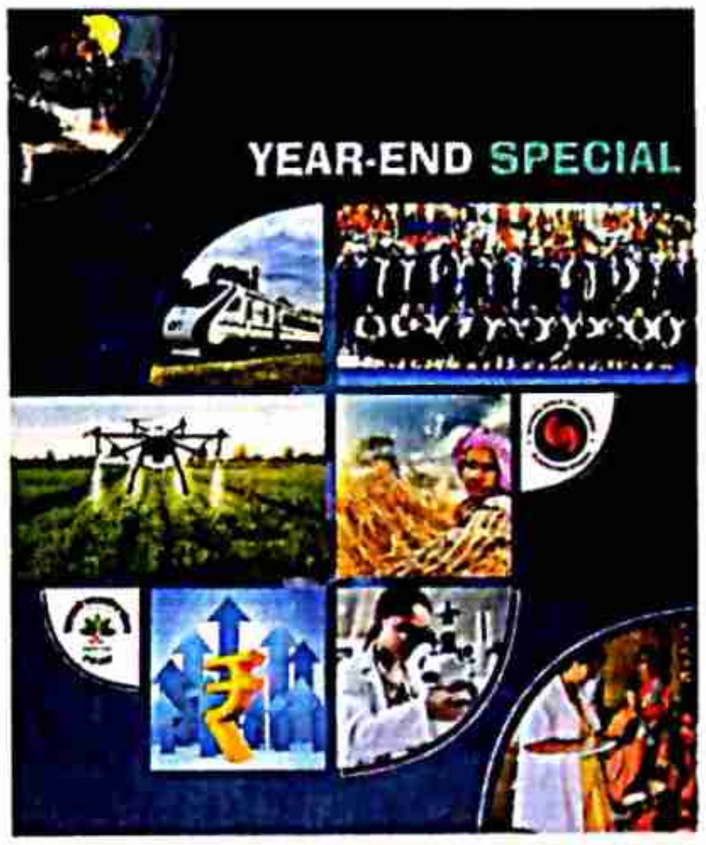
India's Transformation Leap: Progress, Challenges, and Future Directions

India's transformative journey in 2024 has yielded significant strides in various sectors. The government's focus on sanitation, water conservation, and renewable energy has reaped impressive results. *Swachh Bharat Abhiyan* has improved sanitation, contributing to a decline in infant mortality rates. *Jal Jeevan Mission* has connected millions of rural households to piped water, enhancing quality of life and empowering women.



In healthcare, the government has undertaken notable reforms. The historic decision to extend *Ayushman Bharat Pradhan Mantri Jan Arogya Yojana* (AB PM-JAY) coverage to all senior citizens aged 70 and above ensures access to quality healthcare, financial security, and dignity for 6 crore beneficiaries. The National Sickle Cell Disease Control Programme aims to mitigate the impact of this genetic disorder.

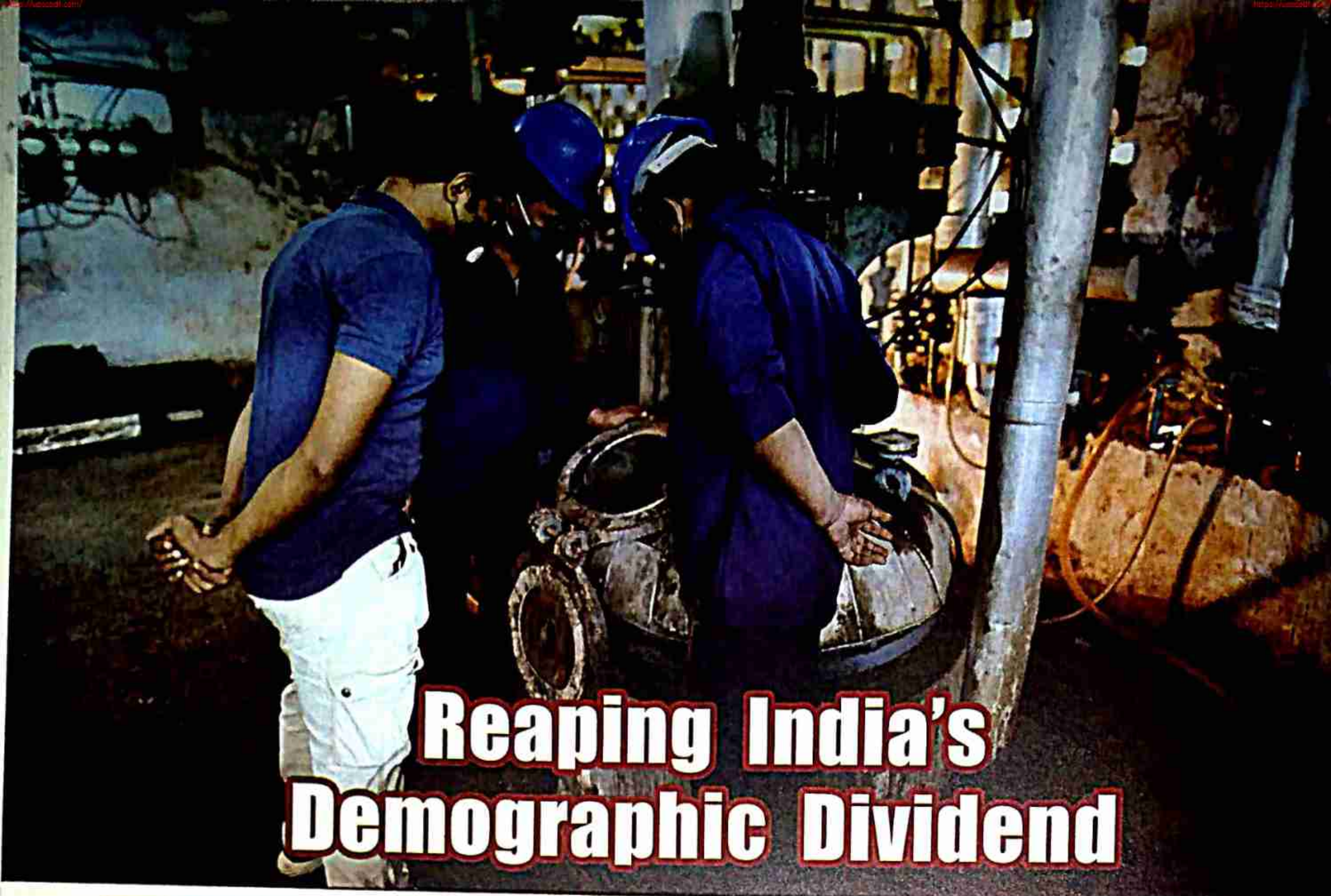
The recently launched *Pradhan Mantri Surya Ghar: Muft Bijli Yojana* has the potential to be a game-changer in India's pursuit of renewable energy. Aiming to promote rooftop solar energy, this initiative seeks to reduce India's carbon footprint and increase energy self-reliance.

The country's commitment to the United Nations' Sustainable Development Goals (SDGs) is reflected in concerted efforts on SDG localisation spearheaded by NITI Aayog, which works closely with States and UTs. Noteworthy advancements have been observed in Goals 1 (No Poverty), 8 (Decent Work and Economic Growth), and 13 (Climate Action). The SDG India Index 2023-24 reports an overall score of 71 for the country, a significant improvement from 66 in 2020-21 and 57 in 2018.

India has made remarkable progress in the science and technology sector, as evident from its significant improvement in the Global Innovation Index (GII) rankings, jumping from 81st to 39th. This achievement showcases the country's dedication to driving innovation and entrepreneurship. The Anusandhan National Research Foundation (ANRF) has been pivotal in this progress, providing strategic direction for research, innovation, and entrepreneurship. Notably, ANRF is also propelling India's push to become a hub for Artificial Intelligence (AI) through initiatives like BharatGen and the Global Partnership on Artificial Intelligence (GPAI). Furthermore, the government's emphasis on manufacturing semiconductors is expected to have a profound impact on the country's economy and global technology landscape. By promoting domestic production, India can reduce reliance on imported semiconductors, create jobs, and contribute to the global supply chain. Digital transactions have surged via the Unified Payment Interface (UPI), crossing 16.58 billion transactions in October 2024.

The Union Budget 2024-25 outlines a strategy for a developed, prosperous, and equitable *Bharat*, focusing on productivity, employment, and innovation. However, despite progress, significant challenges remain. To bridge gaps, sustained efforts, efficient resource allocation, and effective monitoring are crucial. It's essential to address disparities in healthcare access, education, and economic opportunities.

This edition of Yojana presents a comprehensive overview of India's transformative journey in 2024, featuring expert perspectives and in-depth analyses. As we step into 2025, let's build on the momentum gained in 2024, fostering a culture of innovation, entrepreneurship, and social responsibility. With collective effort and resilience, India will emerge as a beacon of hope and prosperity, where every individual has access to quality healthcare, education, and economic opportunities. ❑



Reaping India's Demographic Dividend

SUMAN BERY

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India is at a unique crossroads where it has the potential to leverage its demographic dividend. With a large proportion of people in the working-age bracket, the nation has the ability to greatly expand its economy. The Economic Survey 2023-24, gives an approximation of the jobs that economy needs to generate over years. With the share of agriculture in workforce gradually declining from 45.8 per cent in 2023 to one-fourth in 2047, it is estimated that the Indian economy needs to generate an average of nearly around 8 million employment opportunities in the non-farm sector until 2030 to cater to the rising workforce.

India is at an inflexion point in terms of its demographic transition. The share of its working-age population (between age of 15 years and 64) increased from 59 per cent in 2011 to 63 per cent in 2021 and is expected to remain stable over the next 15 years or so.

India expects to become the world's third largest economy (measured at market exchange rates), by the end of this decade. Discussions across government (supported by NITI Aayog), have determined that India should strive to be a $30 trillion economy (at prices of 2047) with annual per capita income of $18000 per annum. From the perspective of the domestic economy, India's challenge is to increase real per capita income six-fold in the next 23 years. India has recorded real growth of 6 per cent moving average over the last three decades.

Our labour force is at the heart of this challenge. Faster and better growth will be reflected in more workers able to do better jobs at higher pay. In turn this requires better equipped workers who are absorbed by competitive firms, able to integrate with global markets via supply chains.

A careful understanding of the ongoing jobs debate makes it necessary to focus on the underlying measurement and definitional issues, which become important in analysing Indian case with global databases. For the all-important employment and unemployment subject, two important definitions of employment are provided. The first is the ILO near universal definition of employment– current weekly status (CWS) or "did you work at least 1 hour in the preceding week". The second definition maybe unique to India: usual status (US)[1] or "what was your primary and secondary job more than six months in the preceding year?"

For emerging economies with a large fraction of workforce engaged in crop-agriculture like India, usual status is a more appropriate indicator of employment. This for the simple reason that a longer horizon of work better reflects the season-specific nature of agricultural employment. The definitional nuances make significant differences in our perception of the issue.

The Record

Today's baseline for a big push on better jobs is quite positive. Data assembled by the Reserve Bank of India estimates that more than 8 crores (80 million)[2] employment opportunities were created from 2017-18 to 2021-22 translating to an average of over 2 crore (20 million) per year. Similarly, the Periodic Labour Force Survey (PLFS)[3] data shows that during the last 5 years, more employment opportunities have been generated compared to the number of people joining the labour force, resulting in a consistent reduction in the unemployment rate. This is a clear indicator of the positive impact of government policies on employment.

Labour Force Participation Rate (LFPR)[4] for persons of age 15 years and above was 60.1 per cent during July 2023 - June 2024. Overall LFPR (usual status) for persons of age 15 years and above has increased from 57.9 per cent during July 2022 – June 2023 to 60.1 per cent during July 2023 – June 2024. Similarly, Worker Population Ratio (WPR)[5] among persons of age 15 years and above in usual status has increased from 56.0 per cent during July 2022 – June 2023 to 58.2 per cent during July 2023 – June 2024.

Structural Dimension

The behavioural dimension relates to the structural transformation of the Indian economy. Let's consider the change in structure of economic activity. India has had a slow start with industrialisation and hence the rate of absorption of workers released from traditional vocations has been slow. While expansion of non-agrarian activities picked up momentum post 1980s, leading to an acceleration in GDP, the economic transition could not keep up with the demographic transition. However, an improving employment-population ratio is observed in the last decade.

While this is progress, India's past performance and that of its peers suggest that further improvement is possible and that if harnessed, this can become a growth driver.

Second, in most economic models, real wages are linked to labour productivity, which means that the same work can be done by fewer people. In turn rising labour productivity typically reflects both what economists call improved human capital-(better education, better health and better skills, as well as better work practices) and technology. Clearly in India's Amrit Kaal, India must aim for both rising earnings and more employment. This is both a motivation and a source of faster economic growth, and is thereafter essential for a strategy that aims to make the best use of India's human endowment.

The Record of Labour Productivity

Productivity and economic growth are two concomitant factors when it comes to addressing the issue of unemployment. India's long-term productivity record is good. This is what underlines the past record of maintained 6 per cent growth. Since a good part of output growth should ideally be attributable to growth in productivity, employment growth need not and should not keep pace with output growth. Hence the need for a growth acceleration.

Issue Areas

The Economic Survey 2023-24, gives an approximation of the jobs that economy needs to generate over years. With the share of agriculture in workforce gradually declining from 45.8 per cent in 2023 to one-fourth in 2047, it is estimated that the Indian economy needs to generate an average of nearly around 8 million employment opportunities in the non-farm sector until 2030 to cater to the rising workforce.

Women and Youth

Female workforce participation rate in India confirms a positive structural shift. The increase in the female workforce participation (FWFP) rate from 24.5 per cent in 2019 to 37.0 in 2023 is quite remarkable, notwithstanding it being overwhelmingly in the agricultural sector, including own-account and unpaid family work. However accelerating women's participation rate is a major factor that requires policy attention, for both growth and inclusion.

Similar is the case of our youth. While we are trying to reap the favourable demographic dividend, first entrants or the creme de la crème of youth is a cross cutting and overarching issue. For the age bracket of new entrants to labour market, the unemployment rate has reduced from 17.8 per cent in 2017-18 to 10.0 per cent in 2022-23 (PLFS, MoSPI)[6]. Although the unemployment figures among the first entrants is a major concern; the steep fall over years shows promising trend, across states.

Keeping in mind, the educational achievements of the current labour force, an additional area of focus would be the issue of skill deficit.

Budget Response to Issue of Youth and Women

Employment incentives and skilling are at the core of the present Union budget. Three schemes for employment generation are part of the package that, for the first time, includes a wage subsidy for new entrants. To further push the agenda of women-led development and to improve female labour force participation, several notable initiatives including setting up of working women hostels, establishing creches, organising women-specific skilling programmes and promoting market access for women led SHGs/enterprises are laid out in the budget.

Smallness of Firms

Smallness of firms in India is another concern. Indian firms tend to be smaller in employment, grow more slowly, and are less productive than firms not just in the industrial West but also other emerging economies like China and Mexico. The

lack of size and the associated low productivity of firms in India limit their demand for workers. Promoting the proliferation of MSMEs along with targeted approach in scaling up the initiatives or have a gainful creative destruction, is required.

Growth and diversification of sustainable enterprises, especially in the MSME sector, are pivotal in facilitating resilient economic recovery and sustained employment generation in India. According to the latest available information[7], there were 63.4 million unincorporated non-agricultural MSMEs in India in 2015–2016 (Ministry of MSME, Government of India, 2022). An overwhelming proportion of the enterprises – more than 99 per cent – are micro units.

While this may be indicative of the opportunities that the sector provides to promote entrepreneurship, especially in rural and semi-urban areas, the continued prevalence of such a trend, has severely impeded technological advancements and productivity growth in the MSME sector. This, in fact, has added to the huge productivity differentials between MSMEs and the large firms in the organised sector, contributing to increasing productivity and income inequalities. The present union budget identifies this caveat and addresses MSMEs as one of the key sectors that require immediate intervention.

Formalisation

Despite an improvement in employment conditions over time, jobs largely remain informal and of lower productivity. Over 90 per cent employment is informal, and 83 per cent are in the informal sector — it was close to 90 per cent in 2000.

Robust wage growth, particularly of casual and lower strata of regular workers, strengthening of social protection, active policies for formalisation and boosting labour productivity will go a long way in improving the quality of employment.

Issue of Iinformality and Need for Non-farm Employment

Dominance of informality in composition of employment is evident in the sectoral distribution of workers. The employment pattern still remains skewed towards agriculture, which employs around 46.6 per cent workers (compared to 42.4 per cent in 2019). This calls for active steps to accelerate the creation of non-farm employment. Any solution to the unfolding labour market crisis will require private manufacturing firms to scale up their ambitions. A self-sustaining way to achieve that would be to incentivise exports.

Role of States

Labour and employment being a state level issue, we cannot discard the very important roles Indian states need to play in fostering employment generation. Further, the nature of and the future potential for economic growth will vary across Indian States because of their differences in the rates of demographic transitions. The growing population of the young in some of the States in the east and north of the country, notably Bihar and Uttar Pradesh, opens up a huge economic opportunity. It is also a serious policy challenge- to create new opportunities that meet the rising expectations of the job aspirants. At the same time, for States such as Kerala and Tamil Nadu, which have an ageing population, there are limits to future growth based on labour-intensive sectors.

Here, the States should be adequately motivated to curate and implement favourable policies. Policy making must continue to aim for an integrated labour market for the country, keeping in mind the volume of internal migration across states.

Remarks

India is at a unique crossroads where it has the potential to leverage its demographic dividend. With a large proportion of people in the working-age bracket, the nation has the ability to greatly expand its economy. Both central and state governments are working towards focused strategies that convert this demographic potential into an economic reality that makes India a developed society by 2047 and the third largest economy globally. ❑

Endnotes

1. It is based on principal status i.e. what was your main job (more than six months in the preceding year) and secondary status. The secondary status is asked of those respondents who were unemployed or not in the labor force in the preceding year and were employed for at least 30 days. The combination of these two is usual status (US).
2. https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2031529
3. During 2017-2023, Principal Employment rose by over 80 million which at 3.3 percent annually is significantly higher than the estimated population growth during the same period. The annual PLFS data shows that unemployment rate has declined (for age group above 15 years) from 6.0 per cent in 2017-18 to 3.2 per cent in 2022-23.
4. Labour Force Participation Rate (LFPR): LFPR is defined as the percentage of persons in labour force (i.e. working or seeking or available for work) in the population.
5. Worker Population Ratio (WPR): WPR is defined as the percentage of employed persons in the population.
6. https://pib.gov.in/PressReleasePage.aspx?PRID=2038699
7. https://www.ilo.org/sites/default/files/wcmsp5/groups/public/@asia/@ro-bangkok/@sro-new_delhi/documents/publication/wcms_873755.pdf

Vision and Roadmap for Science & Technology

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India, with its rich heritage in science and technology, stands at a unique crossroad to blend traditional wisdom with modern advancements. From Ayurveda and ancient architecture to foundational principles of chemistry and materials science, our historical contributions offer a wealth of untapped knowledge. By harnessing modern tools such as AI and other technologies, India has the potential to create a new paradigm for global scientific progress, offering innovative solutions that combine ancient wisdom with cutting-edge science. By strategically harnessing science and technology, India aims to tackle critical national challenges, foster sustainable economic development, and secure a competitive edge on the global stage. This article explores India's strategic priorities, key focus areas, and the roadmap to leverage scientific and technological innovation for a prosperous and resilient future.

India's progress in the realm of science and technology over the past decade has been nothing short of extraordinary, driven by unwavering commitment and strategic initiatives. As the nation charts its course toward global leadership, it stands poised to leverage its technological prowess, youthful and dynamic workforce, and robust public-private sector collaboration to catalyse transformative growth. By strategically harnessing science and technology, India aims to tackle critical national challenges, foster sustainable economic development, and secure a competitive edge on the global stage. This article explores India's strategic priorities, key focus areas, and the roadmap to leverage scientific and technological

अनुसंधान नेशनल रिसर्च फाउंडेशन
Anusandhan National Research Foundation

ANRF's Partnerships for Accelerated Innovation and Research (PAIR) Program

Objective

- Transforming Research and Innovation in Indian Universities
- Fostering research excellence in universities, aligned with NEP 2020

Eligibility

Hub Institutions

- Top 25 NIRF-ranked institutions
- Institutions of National Importance within top 50 of the NIRF ranking

Spoke Institutions

- Central and State Public Universities
- Selected NITs and IIITs

Start Date: 14 November 2024 **Last Date: 31 December 2024**

innovation for a prosperous and resilient future.

During the last few years, India has achieved several key milestones in the science, technology, and innovation landscape:

- India has significantly improved its global standing in scientific research, advancing from 7th position in 2010 to 3rd position currently. Over the past five years, India has surpassed the United Kingdom, Germany, and Japan in terms of annual scientific publications. The nation's scholarly output in Science and Engineering has surged from 78,135 publications in 2012 to 207,390 in 2022, underscoring a robust growth trajectory in academic research.
- India ranks 3rd globally in the number of PhDs awarded in Science and Engineering, following the United States and China. This reflects the country's expanding capacity for high-level research and development in scientific disciplines.
- India has made notable strides in the Global Innovation Index (GII), climbing from 81st position in 2014 to 39th in 2024. This advancement highlights our growing innovation capacity and the successful implementation of strategic policies to enhance its global competitiveness in technology and research.
- Our patent filings doubled between 2018 and 2023, and the country now ranks 6th globally with 82,811 patent filings.
- Our start-up ecosystem has experienced remarkable expansion in recent years. The country is now the third-largest start-up hub globally, with the third-highest number of unicorns. The total number of startups has surged to 140,000 in 2024, up from just 450 in 2016, while the number of unicorns continues to stay over 115. This growth underscores India's burgeoning entrepreneurial spirit and its role as a critical player in the global innovation economy.

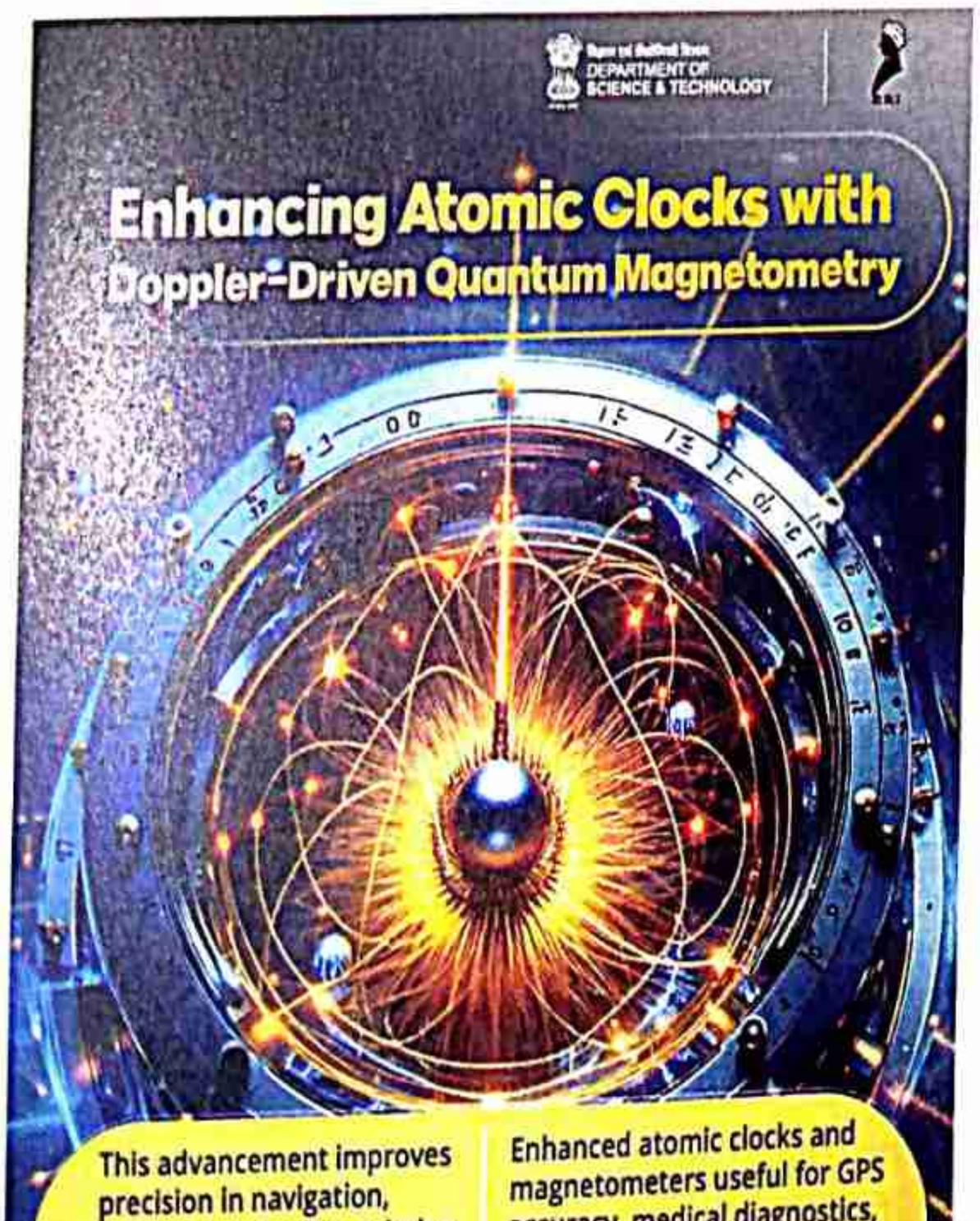
These advancements collectively underscore India's growing stature as a global leader in science, technology, and innovation, driven by strategic investments and an increasingly vibrant ecosystem.

While the aforementioned indicators reflect India's remarkable progress in science and technology, several critical challenges remain that require concerted attention in the years ahead. Notably, the nation's research and development (R&D) expenditure as a percentage of GDP stands at a relatively modest 0.64 per cent, which is significantly below the global average of 1.79 per cent. In comparison, leading economies such as China (2.43 per cent), the United States of America (3.46 per cent), and South Korea (4.93 per cent) spend considerably higher portions of their GDP for R&D, underscoring a gap in investment that needs attention. The number of full-time equivalent R&D professionals per million population in India is a mere 262, a figure that lags behind other major economies. This highlights the need for greater investment in human capital and capacity building within the research and innovation sectors. Low expenditure in R&D is partly due to low private sector investment in R&D, which accounts for only 37 per cent of the total expenditure. This is in stark contrast to countries such as China (77 per cent), the United States (78 per cent), and South Korea (79 per cent), where private sector contributions to R&D are significantly higher. The disparity suggests that we must incentivise private sector and create a more conducive environment for private industry to increase its involvement in innovation and technological development.

To navigate emerging global challenges and ensure sustainable growth, we need to

adopt a strategic, future-oriented roadmap with clear, measurable goals. We should prioritise solutions that address our societal needs while focusing on disruptive technologies that enhance technological sovereignty, global competitiveness and address sustainability, resilience, and resource optimisation. By strengthening these key domains, we can tackle not only the domestic challenges but also position ourselves as a leader in contributing to global solutions.

Sustainability and Fragility: Addressing the multifaceted challenges of global climate change, driven by greenhouse gas emissions and fossil fuel overconsumption, requires transformative technologies such as e-mobility, green hydrogen, nuclear energy, photovoltaics, and solar cells for decarbonising energy systems and transitioning to a low-carbon economy. We also need to build a strong capability in supply-chain in these sectors for strategic autonomy. Simultaneously, to counter emerging geopolitical threats, including cyber warfare and the proliferation of advanced weaponry, developing capabilities in Artificial Intelligence (AI), cybersecurity, and quantum cryptography is essential. These innovations are critical to enhancing national security, achieving strategic autonomy & resilience, while safeguarding infrastructure in an era of evolving technological warfare.



Resource Constraints: The inexorable pressures of a burgeoning global population, rapid urbanisation, and shifting consumption patterns are precipitating acute strains on critical resources, notably in the realms of food and water. To mitigate these challenges and ensure long-term resource sustainability, it is essential to focus on the advancement of technologies such as precision agriculture and the development of advanced materials. Moreover, the global demand for critical minerals—such as lithium, nickel, cobalt, graphite, and rare earth elements—has escalated, driven by the rapid expansion of clean energy technologies and the proliferation of industries such as electronics, telecommunications, transportation, and defense sectors. To address vulnerabilities in the supply chains for these essential minerals, the deployment of cutting-edge technologies in advanced manufacturing, AI-driven optimisation, quantum sensors, deep-sea mining, and deep space exploration will be indispensable. These technologies will not only enhance the efficiency of resource extraction but will also contribute to the resilience and diversification of the critical minerals value chain.

Longevity and Viability of Life: With the steady increase in India's elderly population, advances in healthcare and medical technologies, including assistive technologies, will be paramount in addressing healthcare challenges associated with an aging society. While we focus on modernising healthcare system, need for preventive healthcare is also extremely important for a healthy lifestyle. Simultaneously, rapid urbanisation demands sustainable solutions in transportation, housing, infrastructure, and pollution control. Technologies optimising transportation, housing, infrastructure, and pollution control, while enhancing digital connectivity, are key to building sustainable, livable cities.

The aforementioned technologies must be pursued with resolute commitment, as they hold transformative potential to tackle critical societal challenges and enable sustainable futures. Their deployment is not merely an opportunity but an urgent imperative to counter the multidimensional risks of climate change, resource depletion,

and geopolitical volatility. By strategically advancing these technologies and ensuring robust investment, India can forge a resilient, inclusive, and sustainable society, positioning itself as a global frontrunner in innovation-driven solutions to address the existential threats of the future. While our strategy should harness near-term opportunities in sectors like AI, telecom, semiconductors and space by leveraging existing expertise and policies, long-term investments are needed in disruptive technologies such as quantum computing, biomanufacturing, advanced materials, and green tech, requiring substantial R&D and capital. We need to focus on long-term funding, private sector collaboration, and innovation hubs to integrate R&D with industrial-scale application.

The Australian Strategic Policy Institute's *Two-Decade Technology Tracker: The Rewards of Long-Term Research Investment* report (August 2024) elucidates India's ascension as a burgeoning nexus of scientific and technological primacy, positioning itself as an emergent global S&T superpower. The report reveals India's prominence within the top quintile of nations across 45 of the 64 critical technologies, encompassing domains such as defence, space, energy, artificial intelligence, biotechnology, and advanced materials. Noteworthy sectors in which India has entrenched its leadership include smart materials, biofuels, natural language processing (NLP), AI algorithms, photovoltaics, cybersecurity, quantum sensing, quantum cryptography, advanced optical communications, photonics, drones, and robotics.

While the above accomplishments demonstrate an impressive research portfolio, the imperative now lies in translating this intellectual capital into scalable, high-impact technological infrastructure. To this end, our government under the visionary leadership of Prime Minister Narendra Modi has instituted a series of high-stakes mission-driven initiatives, including the National Quantum Mission, the National Mission on Interdisciplinary Cyber-Physical Systems, the IndiaAI Mission, the India Semiconductor Mission, the National Green Hydrogen Mission, and Mission Mausam, among others.

BioE3 (Biotechnology for Economy, Environment and Employment) Policy, recently approved by the government for fostering biomanufacturing, is set to drive India's bioeconomy to US$ 300 million by 2030 and accelerate green growth. We are poised to become a global leader in bio-economy with a vibrant ecosystem for bio-based chemicals, precision biotherapeutics and lab-grown foods.

Fuelled by technological prowess, indigenous capabilities and continued success, India is set to take a giant leap in global space race through several ambitious space mission programs such as *Chandrayaan 4*, India's next leap towards lunar exploration, commissioning of the *Bharatiya Antariksha Station*, India's first space station module by 2035, *Gaganyaan Mission*, launching a three-member crew into space, and India's astronaut landing on the moon by 2040. We would be a vibrant space manufacturing hub with enhanced private sector participation and a 15 per cent share of the global space economy.

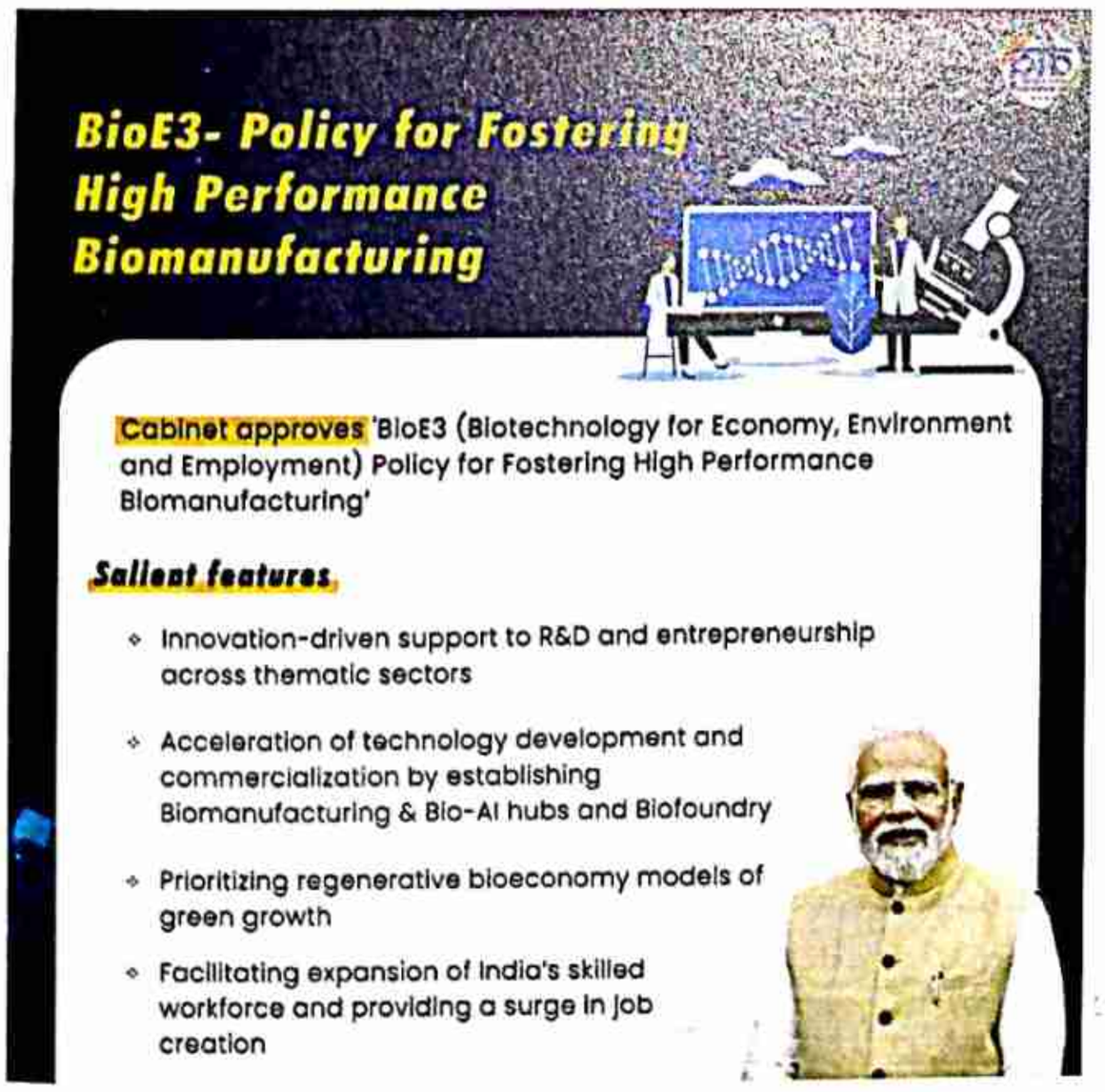
These mission-mode programs, engineered with targeted interdisciplinary focus, are designed to catalyse India's trajectory toward technological ascendancy, with additional mission-mode frameworks under consideration to expedite the nation's S&T (Science and Technology) prowess and consolidate its strategic competitive advantage on the global stage.

India, with its rich heritage in science and technology, stands at a unique crossroad to blend traditional wisdom with modern advancements. From Ayurveda and ancient architecture to foundational principles of chemistry and materials science, our historical contributions offer a wealth

of untapped knowledge. Strengthening these traditional sciences and integrating them with modern research methodologies has the potential for ground-breaking discoveries. By harnessing modern tools such as AI and other technologies, India has the potential to create a new paradigm for global scientific progress, offering innovative solutions that combine ancient wisdom with cutting-edge science.

We are strengthening our technological leadership with the establishment of the Anusandhan National Research Foundation (ANRF) under the ANRF Act 2023, marking a paradigm shift in our R&D ecosystem. The ANRF will drive a multi-phased roadmap for scientific breakthroughs and cross-sectoral collaboration, providing competitive, peer-reviewed grants to optimise resource allocation for high-impact research. Serving as a central nexus for coordinating efforts across government, industry, and academia, the Foundation will track scientific outcomes while enhancing India's participation in global research consortiums. ANRF aims to position India as a global leader in innovative, sustainable technological progress. The Foundation has outlined multifaceted strategic interventions to enhance India's research ecosystem, aligning with national scientific and geopolitical priorities. These include:

(i) **Global Positioning**: Aligning R&D with national imperatives to advance scientific frontiers while strengthening India's global geopolitical influence;



(ii) **Promoting Inclusive Growth**: Building R&D capacities in our central and state universities where research is still at nascent stage, ensuring equitable access to advanced scientific resources and fostering decentralised innovation;

(iii) **Excellence in Science**: Cultivating high-impact research ecosystems that drive cutting-edge, frontier technologies and position India as a global leader in innovation;

(iv) **Capacity Building**: Developing world-class infrastructure and a skilled, multidisciplinary workforce to support sustainable, long-term growth across strategic sectors; and

(v) **Industry-Aligned Translational Research**: Bridging the gap between academic research and industrial applications through robust translational efforts, accelerating commercialisation and fostering knowledge-driven entrepreneurship. These pillars aim to institutionalise an integrated, coordinated, and forward-looking research landscape, positioning India as a leader in both technological innovation and economic growth.

While we have emerged as the third largest startup ecosystem in the world, we have the potential to become global startup capital in deep tech. The government has already announced an ambitious plan to establish a Rs 1 lakh crore R&D fund to encourage the private sector to scale up research and innovation in sunrise domains. It is expected to create industries of global eminence to drive '*atmanirbharata*' in technology.

In conclusion, our aspiration to establish ourselves as a global leader in science and technology is primed for fruition through a series of strategically orchestrated investments, synergistic collaborations, and the institutionalisation of a robust, globally competitive research ecosystem. By nurturing intellectual capital, strengthening public-private alliances, and prioritising disruptive technologies, Bharat is charting a definitive course towards becoming a product nation and achieving strategic autonomy while simultaneously catalysing socioeconomic development of the country. This forward-thinking approach will not only bolster *Bharat's* geopolitical standing but also ensure the enduring sustainability and resilience of its scientific and technological infrastructure, leading to realising the vision of *Viksit Bharat* by 2047. ❑

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Submission Guidelines and Deadlines:

- The full paper must be submitted by **December 13, 2024.** (The full paper should not exceed 5000 words, be typed double-spaced, and follow APA style referencing. Refer to the guidelines available on the conference website.)
- Decisions on the acceptance of full papers will be made by **December 31, 2024.**
- The last date for registration is **January 17, 2025.**

Selected papers will be appreciated based on merit.

For details regarding conference registration and other administrative aspects, please contact:

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YE-2763/2024

India's emergence as a hub of Knowledge and Technology

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India's participation in cutting-edge fields like quantum computing, artificial intelligence, space exploration, and renewable energy reflects its determination to position itself as a global leader. By continuing to invest in R&D, building strategic global partnerships, and nurturing homegrown talent, India is carving out a formidable role on the global stage as a hub of innovation and knowledge.

India's economic evolution has been profoundly shaped by the integration of technology, which has become a fundamental engine of its progress. Across multiple sectors, technological advancements have driven efficiency, innovation, and productivity, helping to propel India's rise as a significant player on the global economic stage. As the largest democracy in the world, with a population of 1.3 billion, India is targeting a Gross Domestic Product (GDP) of 5 trillion USD by 2025[1].

Over the decades, India's journey in science and technology (S&T) has witnessed several transformative milestones. India has consistently pursued technological self-reliance from the Green and White Revolutions, which bolstered food and milk production, to advances in atomic energy, space, and pharmaceutical sectors. The nation's resolve was exemplified in its response to being denied access to a supercomputer, sparking the development of indigenous solutions for various applications like meteorology and computational fluid dynamics. Similarly, the solar and wind energy sectors witnessed robust growth during the 1990s and 2000s, adding new dimensions to India's technological landscape.

Although India has traditionally excelled in generating knowledge, the global shift toward innovation has inspired the nation to focus on translational research. This strategic pivot bridges

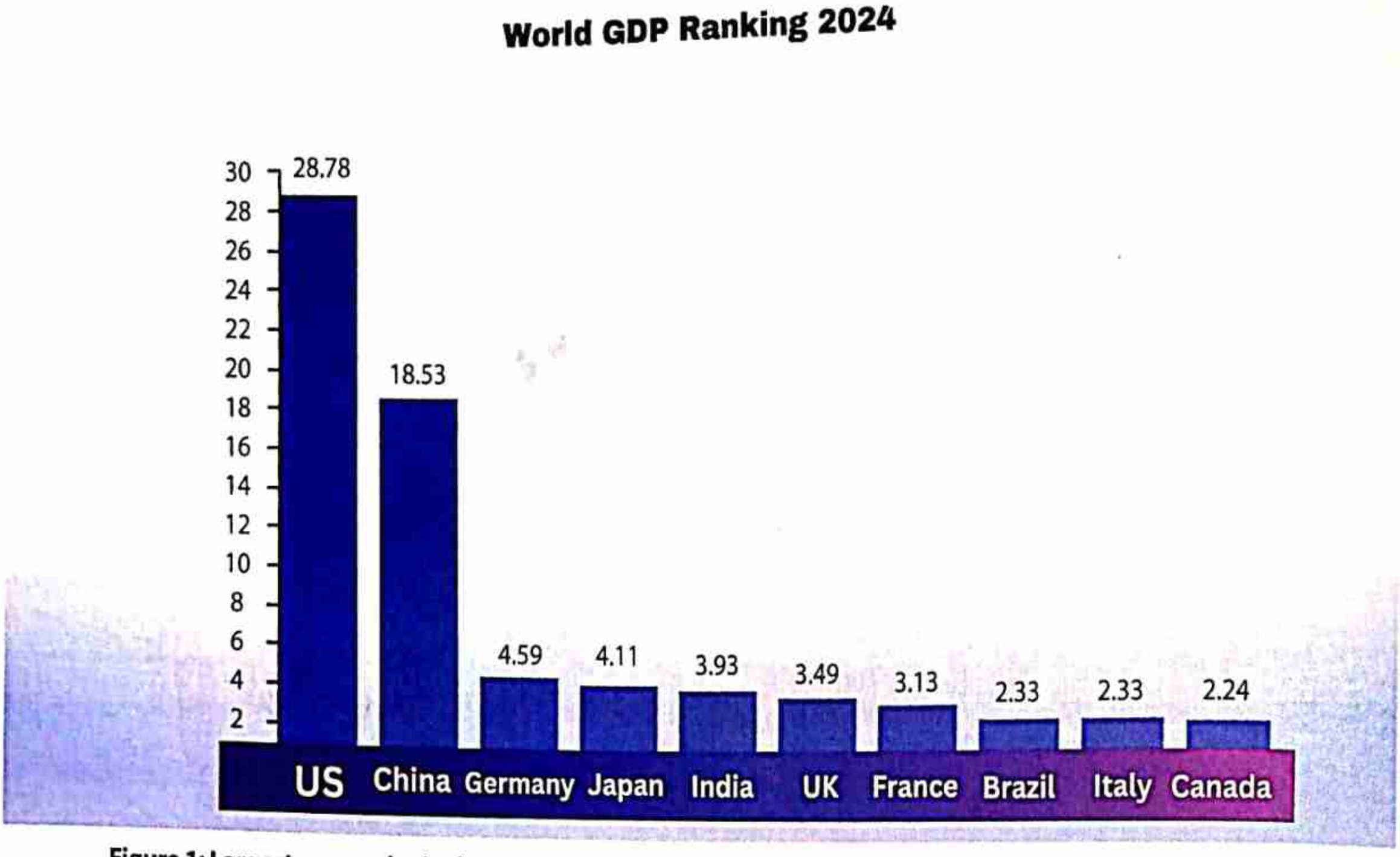


Figure 1: Largest economies in the world by GDP (nominal) in 2024 (Courtesy: International Monetary Fund)

the gap between theoretical advancements and practical applications, ensuring that technological progress benefits all segments of society. Ranked fifth globally by nominal GDP and third by purchasing power parity, India's economy demonstrates resilience, balancing traditional industries with modern, technology-driven sectors[2]. Initiatives such as Digital India, Startup India, and UPI-driven digital payments exemplify the country's commitment to technological innovation, fostering an inclusive future for all[3].

Technology as a National Priority

- **Landscape of Science and Technology in India**

The progress in science and technology has not only improved the quality of life but also laid the groundwork for new opportunities. The Prime Minister has consistently highlighted the nation's scientific capabilities as critical tools for tackling

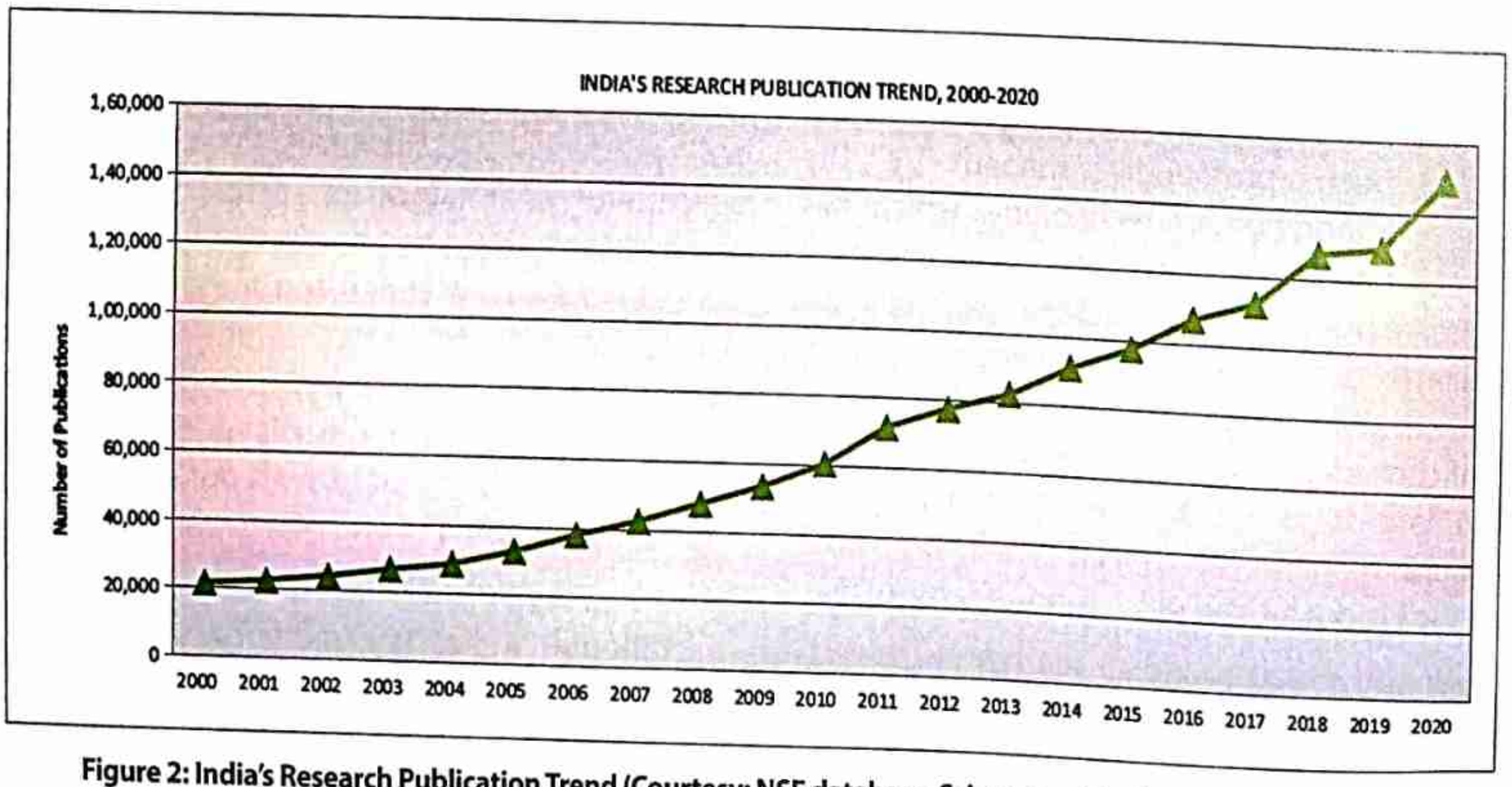


Figure 2: India's Research Publication Trend (Courtesy: NSF database, Science and Engineering Indicators, 2022)

major challenges like climate change, clean energy, and healthcare. The effective transition of innovations from research labs to the broader market is essential for achieving these objectives.

India's commitment to S&T is reflected in its increasing investment in research and development (R&D). Gross Expenditure on R&D (GERD) has doubled in the last decade, reaching Rs 1,27,380.96 crores in 2020-21[4]. While much of this funding is government-driven, the private sector also plays a growing role, contributing 36.4 per cent to the GERD in 2020-21, particularly in sectors like pharmaceuticals, IT, and textiles. The Indian research ecosystem has seen a surge in output, with the number of scientific publications growing 2.5 times from 2010 to 2020, positioning India as a global leader in fields such as computer science, engineering, and health sciences.

Innovation Ecosystem

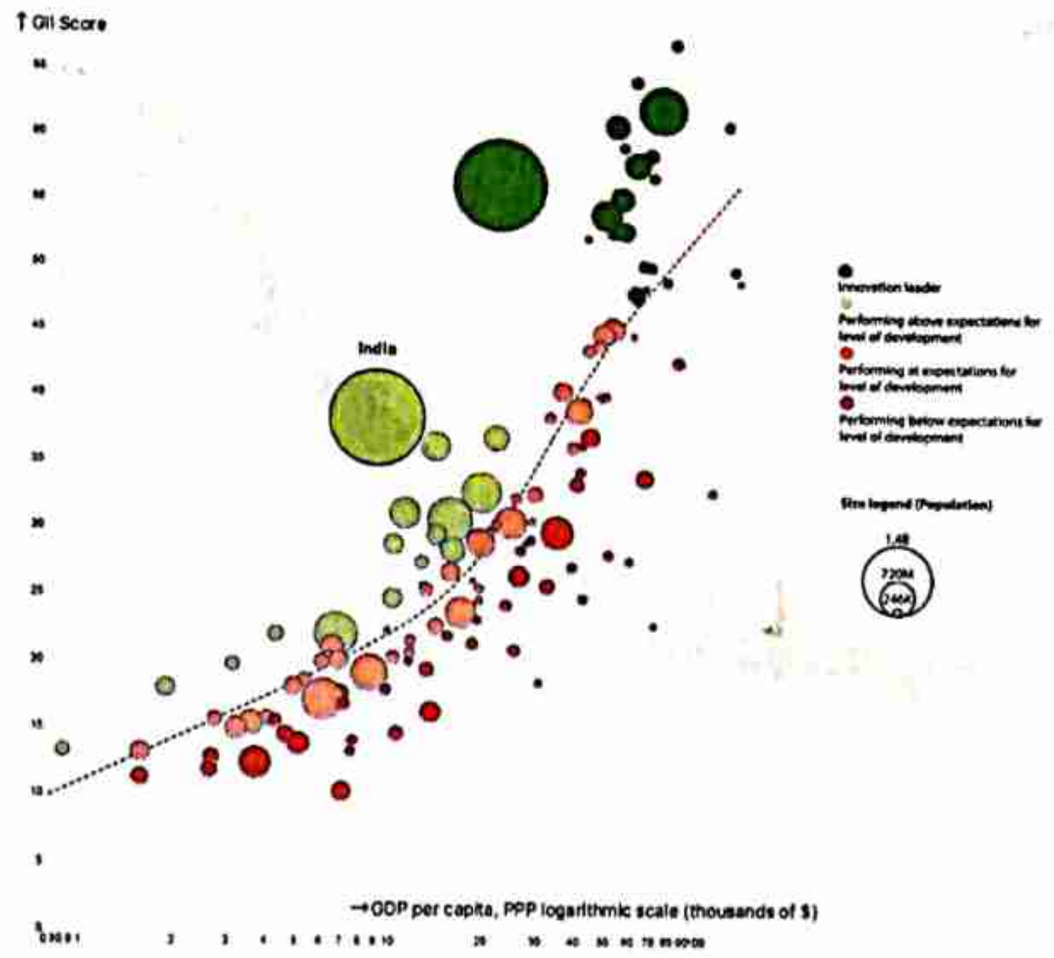
- **Global Innovation Index**

India's steady rise in the Global Innovation Index (GII) showcases the nation's strong focus on fostering innovation. Ranking 39th in 2024, up from 81st in 2015, India has become a dominant force in Central and Southern Asia's innovation landscape[5]. With over 100 unicorns and initiatives such as Startup India, Atal Innovation Mission (AIM), and *Atmanirbhar Bharat Abhiyaan*, India has successfully harnessed the power of technology to fuel global progress. The rise in the GII is a testament to these initiatives, which have transformed India into a global hub of research and innovation.

- **Atal Innovation Mission**

Atal Innovation Mission (AIM), established by the Government of India, has emerged as a central pillar in nurturing innovation and entrepreneurship across the country. AIM's initiatives, such as Atal Tinkering Labs (ATLs) and Atal Incubation Centres (AICs), empower students and startups by providing hands-on technological experience and funding support.

AIM has funded 10,000 schools to date for ATLs. AIM also supports Atal Incubation Centres (AICs) to catalyse startups, with 72 AICs and 14 Atal Community Innovation Challenges (ACICs) established. The Atal New India Challenge (ANIC) program invites innovators to address national issues with creative solutions.[6]



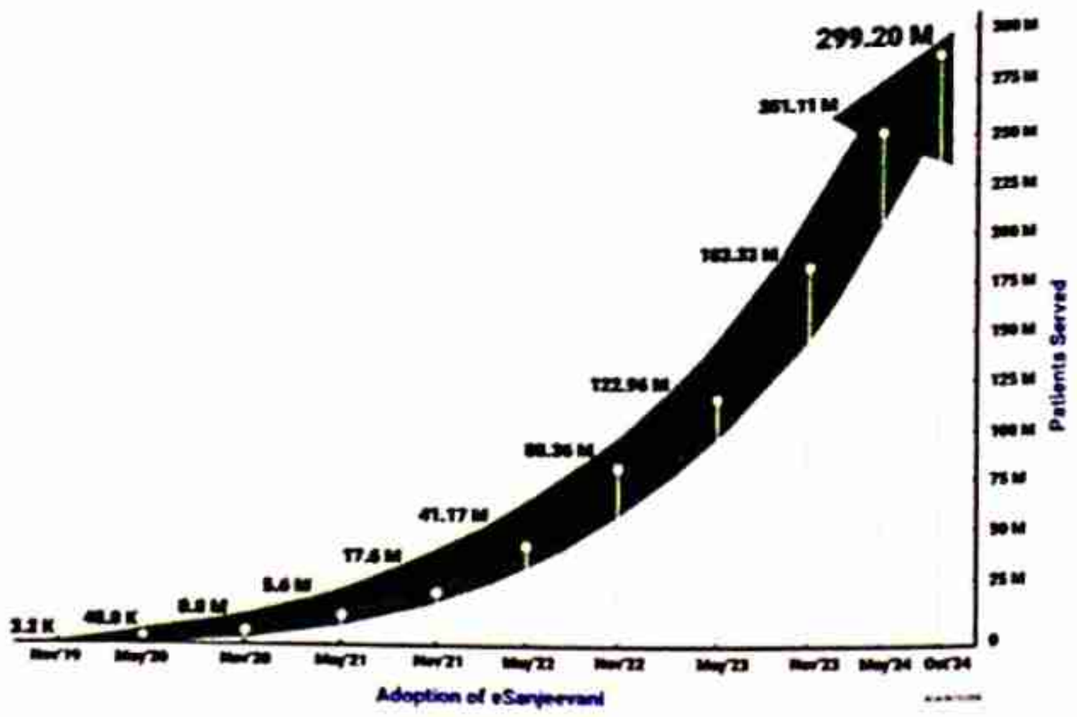
This mission is integral to building a vibrant startup ecosystem that has already produced over 100 unicorns, aligning India's innovation landscape with global standards.

Economic Impact of Technology

- **Transformation across Key Sectors**

Technology's influence spans various sectors of the Indian economy, driving significant improvements in agriculture, healthcare, manufacturing, and mobility. In agriculture, advancements such as precision farming, AI-powered crop monitoring, and the use of drones have drastically improved productivity[7]. The healthcare sector has similarly benefitted from digital interventions, with telemedicine and AI-driven diagnostics transforming the way healthcare services are delivered, particularly in rural areas[8].

The manufacturing sector, especially through the adoption of Industry 4.0 technologies, has achieved remarkable gains in efficiency. Initiatives like 'Make in India' and advancements



in 3D printing and smart factory setups have attracted significant investments, positioning India as a global manufacturing hub[9].

The digital economy is also experiencing rapid growth, with the integration of 5G technology, artificial intelligence (AI), and the Internet of Things (IoT) creating new opportunities for smart cities, telemedicine, and automation[10]. These developments are set to revolutionise the connectivity landscape, driving innovation in fields ranging from transportation to finance.

- **Shift Toward Translational Research**

India's transition from fundamental to translational research has been instrumental in converting scientific discoveries into real-world applications. Through programs like the National Initiative for Development and Harnessing Innovations (NIDHI) and the Biotechnology Industry Research Assistance Council (BIRAC), India has encouraged collaboration between academia and industry. This collaborative approach has led to significant breakthroughs in biotechnology, space technology, and renewable energy, positioning India as a global leader in technology commercialisation.

Social Impact of Technology

- **Digital India and Social Inclusion**

Launched in 2015, the Digital India mission has transformed how citizens access public services, promoting inclusivity and transparency. By focusing on universal access to digital infrastructure and services, this initiative has democratised access to education, healthcare, and financial services. Programs such as *Aadhaar*, Common Service Centres (CSCs), and DigiLocker have empowered millions of Indians, especially in rural areas, by simplifying access to government services[11].

India's success in promoting digital literacy, enhancing cybersecurity, and creating accessible platforms for participatory governance has set a global example for digital inclusion. With more than 15 billion UPI transactions handled in a single month (September 2024)[12], the initiative demonstrates how technology can break down barriers and empower citizens.

- **Health and Family Welfare**

Technology's integration into the healthcare sector has revolutionised medical service delivery, particularly through telemedicine and AI-driven diagnostics. India's *eSanjeevani* telemedicine platform, operational in thousands of government centres, has made healthcare more accessible to remote populations[13]. Meanwhile, initiatives like the *Ayushman Bharat* Digital Health Mission have strengthened collaboration between government and private entities, enhancing overall healthcare infrastructure.

During the Covid-19 pandemic, India demonstrated its healthcare innovation capabilities by developing the indigenous vaccine, 'Covaxin'[14]. The swift deployment of vaccines and subsequent vaccination campaigns were critical in safeguarding the health of millions, while initiatives like 'Vaccine Maitri' showcased India's commitment to global solidarity[15].

- **Education and Empowerment**

The National Education Policy (NEP) 2020 has laid the foundation for a comprehensive overhaul of India's education system. By emphasising multidisciplinary learning and digital infrastructure, NEP 2020 aims to equip students with 21st-century skills while fostering a robust research-oriented higher education system. As the shift to online learning accelerated during the Covid-19 pandemic, the rise of EdTech platforms has transformed access to education, particularly in underserved regions.

The growth of online learning and digital pedagogy is empowering individuals across all socioeconomic backgrounds, enabling them to upskill and participate in the global knowledge economy.

Strategic Impact of Technology

- **Defence and Space Sectors**

India's focus on self-reliance in defence technology has led to notable achievements, including indigenous missile systems, aircraft carriers, and anti-satellite technologies. Programs like the Integrated Guided Missile Development Programme (IGMDP) and *INS Vikrant* showcase India's growing defence capabilities, bolstered by innovations in radar, sonar, and electronic warfare technologies.

In the space sector, ISRO's advancements have been game-changers. From the reliable PSLV launcher to the *Chandrayaan-3* lunar mission, India's space program continues to demonstrate technological prowess. Recent initiatives like *Gaganyaan*, India's human spaceflight mission, and the privatisation of space exploration promise to propel India into a new era of space innovation.

- **Emerging Technologies**

India's strategic investments in emerging technologies are vital for maintaining its global competitive edge. Initiatives like the National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS) are fostering innovation in fields like AI, robotics, and quantum computing. The National Quantum Mission (NQM) and the National Supercomputing Mission (NSM) further underscore India's ambition to become a leader in high-performance computing and next-generation technologies. The NSM enhances research and development capabilities, exemplified by the *PARAM Shivay* supercomputer, one of India's fastest, with over 120,000 compute crores and 833 TeraFlops of peak compute power[16].

Quantum Computing represents the next frontier in computational power. Unlike classical computers, which process information in binary, quantum computers leverage the principles of quantum mechanics to perform complex calculations at unprecedented speeds. This technology has the potential to revolutionise fields such as cryptography, materials science, and drug discovery.

In ocean sciences, the Deep Ocean Mission, with its focus on seabed exploration and energy resource development, highlights India's growing emphasis on sustainability and resource management. The mission demonstrates India's scientific capabilities with manned submersibles that can reach depths of 6,000 meters[17]. Equipped for deep-sea mining, it also addresses climate change, biodiversity conservation, and sustainable bio-resource utilisation.

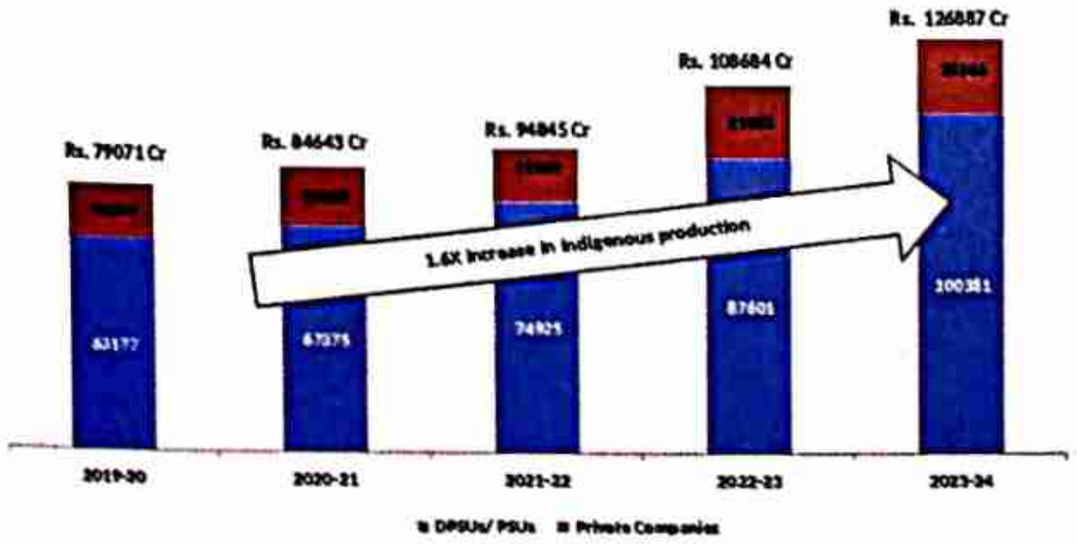
Viksit Bharat: A Vision for a Developed Nation

India's vision of *'Viksit Bharat'* embodies the aspiration to become a developed nation, where science, technology, and innovation drive economic growth, social equity, and environmental sustainability. This vision rests on the belief that India can leverage its rich scientific heritage and technological capabilities to build a self-reliant and prosperous nation.

Achieving this vision requires substantial investment in future scientific technologies and creating an enabling ecosystem for innovation. Fostering a scientific temperament across society, promoting research and development (R&D), and encouraging entrepreneurship, particularly in the tech sector, are essential steps. The *'Atmanirbhar Bharat'* initiative emphasises self-reliance by promoting domestic manufacturing, reducing imports, and advancing indigenous technologies, particularly in fields like AI, quantum computing, and biotechnology, where India aims to become a global leader.

Building a future-ready workforce is crucial, necessitating a strong focus on education and skill development in STEM (Science, Technology, Engineering, and Mathematics). By equipping the younger generation with essential knowledge, India can ensure its citizens are prepared for future challenges.

Additionally, ensuring technology is accessible to all citizens is critical for social equity, with initiatives like Digital India aiming to bridge the digital divide and extend the benefits of technology to every segment of society.



Conclusion

As India stands at the crossroads of an era defined by rapid technological advancement and innovation, the nation's vision for science and technology is not merely about economic growth but about building a resilient, self-reliant, and inclusive future. The roadmap ahead embraces both emerging and critical technologies, with science and technology serving as a driving force that cuts across all sectors, from agriculture and healthcare to defence, space, and education.

The focus on bridging the gap between research and real-world applications through translational research ensures that technological advancements are accessible to all, enabling a future where the benefits of innovation are widely shared. Moreover, India's participation in cutting-edge fields like quantum computing, artificial intelligence, space exploration, and renewable energy reflects its determination to position itself as a global leader. By continuing to invest in R&D, building strategic global partnerships, and nurturing homegrown talent, India is carving out a formidable role on the global stage as a hub of innovation and knowledge.

The future holds boundless possibilities as India leverages science and technology to tackle some of the world's most pressing challenges—climate change, sustainable development, and digital equity. This bold vision will enable India not only to strengthen its economy but also to lead in shaping global progress. As the country moves forward, science and technology will remain at the heart of its mission to build a sustainable, inclusive, and technologically empowered society, ensuring prosperity and global leadership for generations to come. ❑

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Roadmap for India's Geopolitical Recalibration

SUJAN CHINOY

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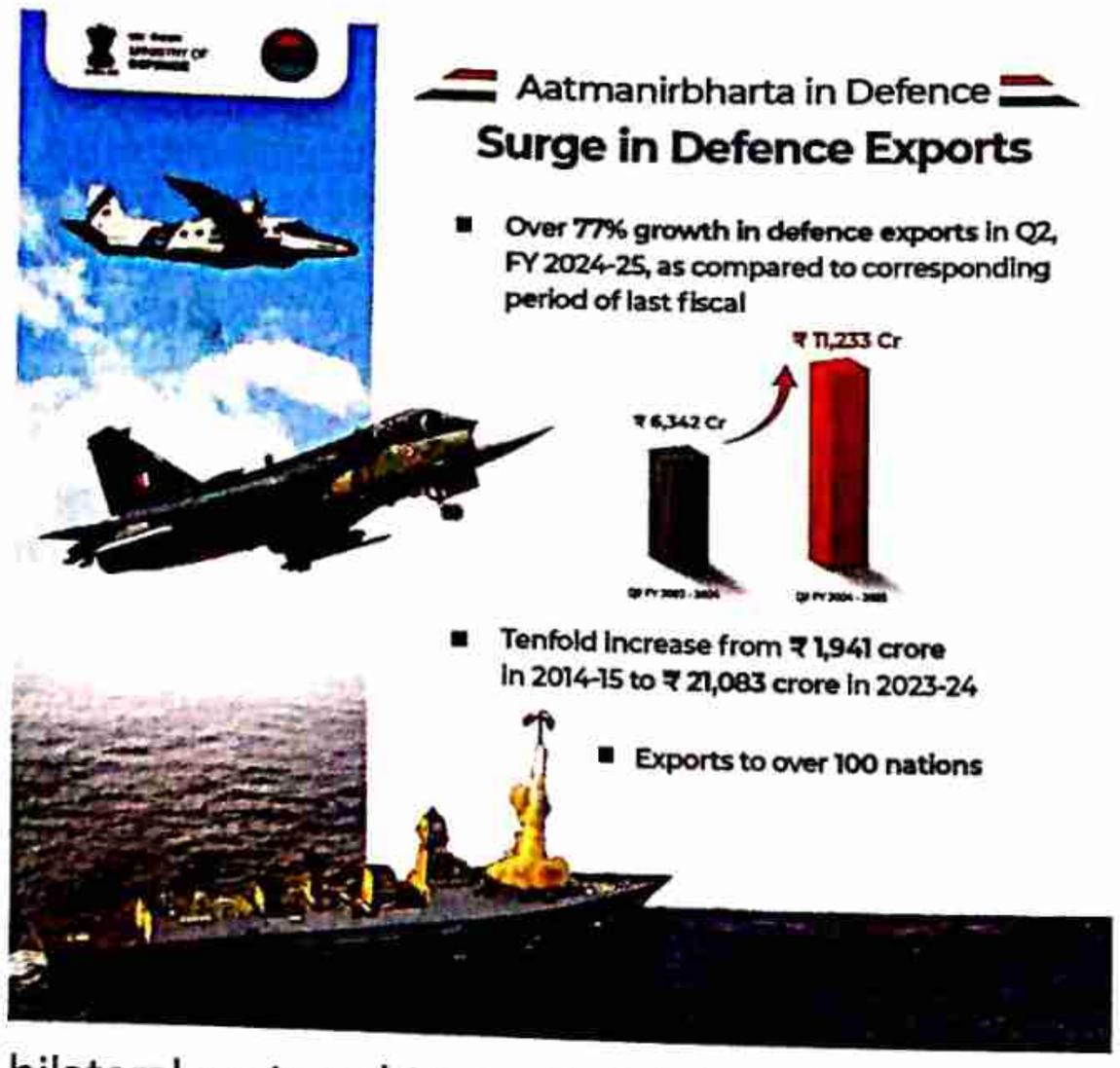
One can aver that India's foreign policy is dynamic and is anchored in a distinctly Indian civilisational milieu of dharma (duty) and *Vasudhaiva Kutumbakam* (the world is one family). India has emerged as a credible voice of the Global South with the ability to straddle the North-South and East-West divides. The multilateral order's failure to preserve peace, prevent wars, or bring conflicts to an early end has encouraged the trend towards multi-alignment and hedging through strengthened bilateral partnerships and mini-lateral groupings. Despite its obvious blemishes, it is not necessary to curate a new global order. A fundamental reordering would presuppose wars and devastation on a magnitude as yet unseen. Even as uncertainties continue, India will usher in 2025 with greater confidence in its external engagements.

International relations stand at a crucial juncture. The multilateral order represented by the United Nations and Bretton Woods has not met the evolving requirements of changes in the balance of power. The global community today is confronted with the spectacle of a United Nations Security Council in stasis, with major powers ranged against one another. The multilateral order's failure to preserve peace, prevent wars, or bring conflicts to an early end has encouraged the trend towards multi-alignment and hedging through strengthened



bilateral partnerships and mini-lateral groupings. In Globalisation 2.0, regional and middle powers are gaining greater agency through strategic autonomy, multi-alignment, and issue-based partnerships with contending powers.

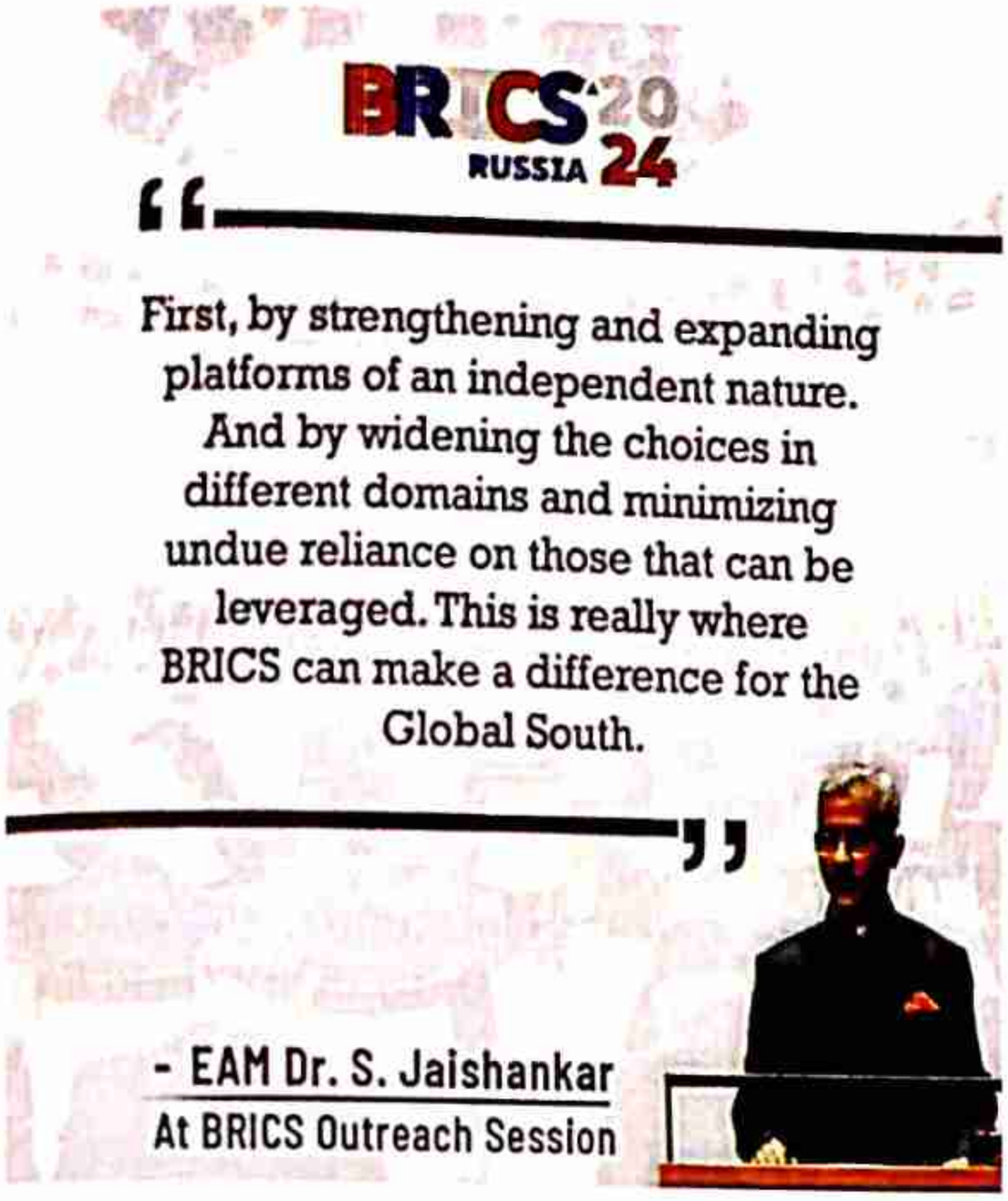
India is not a permanent member of the UN Security Council despite having all the attributes of a responsible major power. It is the world's most populous democracy. It is recognised for its contributions to peacekeeping operations as well as vaccine support during the pandemic to countries around the world. With the fastest-growing large economy in the world, India has emerged as a credible partner for many.

India's vision has frequently been articulated by Prime Minister Narendra Modi. Some of the key elements are (1) focusing on rapid and inclusive economic growth and improvement in social indices and gender equality, (2) strengthening India's defence and security capabilities in order to protect sovereignty and territorial integrity, maintaining a stable periphery, building border infrastructure and promoting development in remote parts of India; and (3) cooperating with partner countries, especially on critical and emerging technologies, to improve India's productivity and manufacturing capabilities and enabling India to integrate itself better in global value chains (GVC).

This vision is predicated on developing a consensus at three different levels to facilitate India's high-growth trajectory—internally, regionally and globally. Many attendant aspects of India's foreign policy, such as its use of domestic events to engage the international community, as evident in the Vibrant Gujarat Summit, its 'Neighbourhood First' policy and its global initiatives such as the International Day of Yoga, International Solar Alliance and Coalition for Disaster Resilient Infrastructure, flow from its civilisational impulse to create synergy, convergence and harmony.

India's G20 Presidency was a watershed moment in its external engagement. It coincided with a number of major conflicts and contradictions. By 2023, the politics of the origins of the pandemic had been overtaken by a protracted war in Ukraine that threatened to wreck the G20 process. India and China were ranged against one another along the Line of Actual Control following the bloody incident in Galwan in 2020. And the lid had blown off a long-festering conflict in West Asia with the Hamas attacks on Israel in October 2023 and the retribution that followed in Gaza. Against all odds, India successfully concluded its G20 Presidency with a consensus document that brought unlikely players around a common table to commit their energies to economic development and the achievement of the UN's 2030 SDG goals.

India succeeded in steering the international community's focus back on core developmental challenges during its G20 Presidency. India has expressed its readiness to share its best practices



in healthcare, disaster management, digital public infrastructure and much else with countries of the Global South.

One can aver that Prime Minister Narendra Modi's foreign policy is dynamic, driven by his personal energy and vision, and anchored in a distinctly Indian civilisational milieu of dharma (duty) and Vasudhaiva Kutumbakam (the world is one family). India has emerged as a credible voice of the Global South with the ability to straddle the North-South and East-West divides. PM's visits to Moscow and Kyiv in quick succession in July and September 2024, respectively, underscored India's image as a country that stands for peace. In both capitals, his message was consistent: that this is not an era of war, that solutions cannot be found on the battlefield, and that differences should be resolved through dialogue and diplomacy.

PM Modi, in effect, has provided the world with a truly kintsugi moment. If the protracted wars in Ukraine and Gaza can be resolved through dialogue, the geopolitical fractures could heal over time and enable the international community to refocus its energies on the urgent challenges of our times, particularly economic recovery and climate action. India's wisdom is proverbially like the vein of gold that runs through the kintsugi of global consensus, making it more resilient.

2024 has tested India's mettle on multiple fronts. Differences with China along certain friction points in the border areas lingered on, even as dialogue continued at the level of the foreign ministries and the armed forces. Eventually, India's patience, perseverance and resolute stance, both in negotiations and in terms of the ground positions, led to a thaw. The breakthrough agreement to restore patrolling along the Line of Actual Control as it prevailed before the incident at Galwan in June 2020 is a significant achievement. The armed forces will now take stock of the new understandings reached and verify their implementation in a step-by-step manner. They will also have an opportunity to review the existing protocols and confidence building measures (CBMs) and address the infirmities that led to the clashes. PM Modi's ability to address an impasse with China against all odds is yet another indication that India is also capable of 'walking the talk' when it comes to advocacy of peaceful settlement of disputes.

Clearly, the relaxation of tensions and restoration of status quo ante paved the way for the recent meeting between PM Modi and President Xi Jinping on the margins of the recent BRICS Summit in Kazan. Restoration of high-level dialogue between India and China has also opened up the possibility of both sides working on the next steps for resuming bilateral engagement in other sectors. The slew of issues includes the question of direct flights between the two countries, the stationing of journalists, the visa regime for tourism and entrepreneurs, and more fundamentally, the future role of Chinese technologies and supply chains in India's Atmanirbhar Bharat in manufacturing.

During India's G20 Presidency, ECSWG successfully reached consensus on matters of climate and environment. One of the longest communiques negotiated with a high success rate thus far under India Presidency with agreement on 95%.

India's relations with Pakistan remain stagnant and adversarial due to Pakistan's unwillingness to eschew terrorism. The democratic elections in the UT of Jammu and Kashmir have opened a new chapter in the development of the region, with Article 370 of the Indian Constitution having been consigned to history notwithstanding the passage of a resolution in the Jammu & Kashmir assembly seeking its restoration.

If Pakistan were to desist from using terrorism as an instrument of state policy, it is yet possible to give meaning to the sentiment that India and Pakistan should bury the past and live together as good neighbours. Even as Prime Minister Modi's government has adopted a firm policy of 'zero tolerance' for terrorism and linked the resumption of dialogue to a change in Pakistan's behaviour, it has also kept the door open for Pakistan to realise a better destiny in tandem with India and other nations in South Asia.

India's Neighbourhood First Policy is aimed at promoting economic development and prosperity in a wider region. Changes in neighbouring countries are inevitable over time. They are a result of idiosyncratic political, economic, and social dynamics driven by their own circumstances. They will throw up fresh and often unanticipated challenges that will have to be suitably tackled.

India's relations with the Maldives are back on an even keel following the visit of President Muizzu to India in October 2024. In the Maldives and elsewhere in the extended neighbourhood, the Indian option for infrastructure, connectivity and capacity building is gaining ground as compared to the alternatives on offer. The political churn in Bangladesh is a reason for concern, especially the treatment of the Hindu minority and the potential for further radicalisation and spillover across a porous border. It is in Bangladesh's interests to heed India's sensitivities, including in regard to illegal migration and the internal security challenges faced by India in the Northeast.

Prime Minister Modi's emphasis on 'a human-centric approach in our collective quest for a bright global future' in his remarks at the 'Summit of the Future' held at the United Nations in September 2024 will hopefully lead to greater introspection at the global level. The disarray in multilateral structures, especially the UN Security Council, is not tenable. The politics of domination are rejected today by the smallest of nations. Building deterrence against arbitrariness and coercion is necessary but detracts nations from developmental goals.

Despite its obvious blemishes, it is not necessary to curate a new global order. A fundamental reordering would presuppose wars and devastation on a magnitude as yet unseen. It could lead to a new set of victors and vanquished, as was the case when the United Nations was founded in 1945 in the aftermath of the Second World War. If the world were to heed India's call for genuine reforms of the United Nations and its affiliated multilateral institutions, the existing Rules Based International Order (RBIO) could find greater acceptability and become more effective in meeting contemporary challenges.

The advent of a fresh Trump presidency in the United States will bring renewed opportunities and some challenges for India. On the plus side, President Trump and Prime Minister Narendra Modi have a very good rapport, which augurs well for the relationship. Going by President Trump's first term, there is a convergence between the two countries on key security challenges, including terrorism, critical supply chains and disruptions in the Indo-Pacific. This convergence is likely to deepen. On the other hand, India will have to carefully skirt any renewed focus on levying tariffs on Indian exports and demands for lowering tariffs for US products. There are bound to be some rumbles on the question of H1B visas and tighter US immigration policies. Joint exercises between the armed forces and defence cooperation seem well consolidated and will continue to provide the bedrock for the strategic partnership. If President Trump succeeds in bringing the wars in Ukraine and Gaza to an end, it will free India of the burden of having to justify its 'strategic autonomy' to contending parties.

Even as uncertainties continue, India will usher in 2025 with greater confidence in its external engagements. India's dynamic and pragmatic foreign policy plays a key role in its rising stature on the global stage. Working in close tandem with key strategic partners, especially the US, while maintaining stable relations with neighbours, especially China, is at the heart of the matter. □

(Views are personal)

2024 : The Year of India's Strategic Emergence

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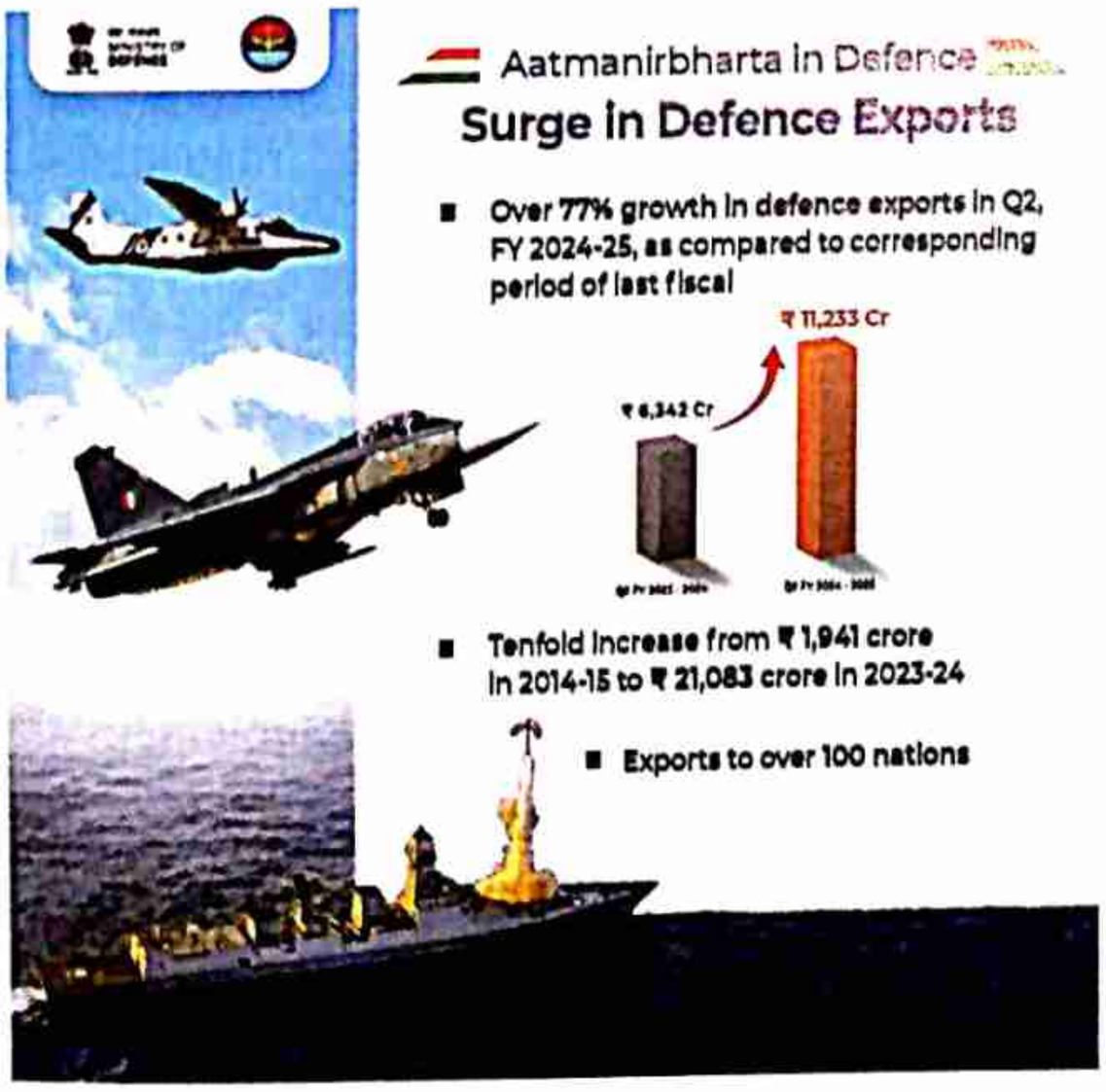
The current rise of India is characterised by rapid and consistent economic growth and political stability, ably complimented by the timely development of its enhanced capabilities. While developing its capabilities, India has embraced the growth characterised by a strong focus on self-reliance and always maintained and ensured its strategic autonomy that defines its overall domestic, regional, and global outreach. While galloping its development, Indian research and development capabilities have achieved a significant milestone in 2024. Aptly reflected in the fact that defence production has surged to a record high of ₹1,27,265 crore, representing an impressive increase of approximately 174 per cent from ₹46,429 crore in 2014-15. India's natural emergence in the global south is characterised by the organic support it has received for its inclusive initiatives like the Voice of Global South Summit and Membership of the African Union as a collective entity in the G20 groupings. This has established a balance in the global world order, strongly supporting freedom, openness, transparency, and rule-based order. Its inclusive sense of responsibility has truly made the difference in the developing world.

Since 1947, after carving out its rightful place in the world, India has emerged as a prominent entity at regional as well as global levels. The current rise of India is characterised by rapid and consistent economic growth and political stability, ably complimented by the timely development of its enhanced capabilities. These elements enabled India to play a decisive role at the global level by defining prominent initiatives like the Solar Alliance, the Counter-Terrorism Convention, hosting the Interpol General Assembly, the No Money for Terror (NMFT) conference, put forth a proposal for establishing a permanent secretariat for 'No Money for Terror' and maritime order at the strategic geography of Indo-Pacific reflects its grown capabilities. While developing its capabilities, India has embraced the growth characterised by a strong focus on self-reliance and always maintained and ensured its strategic autonomy.

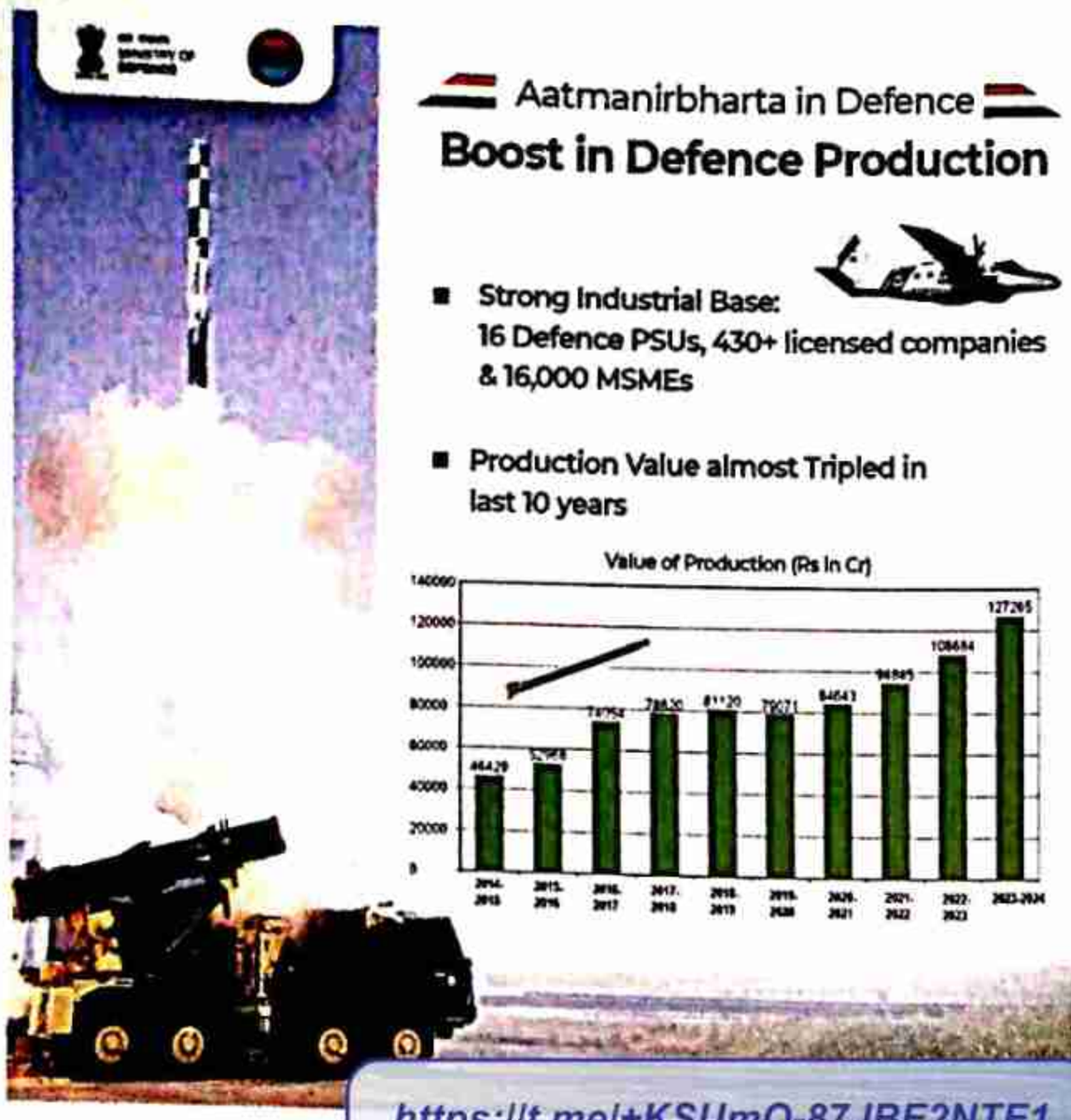
This has reflections at the domestic, regional, and global levels, transforming itself as the bright spot on the global horizon. India's transformative journey from 'Fragile Five' economies to the top 5 economies of the world in a short span of a decade is a saga of evolution of capabilities. In terms of economic development, the same Morgan Stanley, the global financial services firm, which once had classified India as 'Fragile Five', has commended India's development and transformative reforms that made it a leading economy and bright spot for international investment.



While galloping its development, Indian research and development capabilities have achieved a significant milestone in 2024. In a span of nearly a decade, India has made tremendous strides in the Global Innovation Index (GII) rankings, rising from 81st position in 2015 to 39th in 2024 amongst 133 global economies of the world. It strongly endorses India's commitment to fostering a robust innovation ecosystem that is underpinned by strong policies, investment in research and development, and creating a conducive environment for startups and entrepreneurship. The classic example of this transformation in the financial sector is the Unified Payment Interface (UPI), which reached a record high with 16.58 billion transactions worth approximately $279.4 billion USD (₹ 23.5 trillion) for the month of October 2024. In the sunrise sector, emphasised with research and innovation, the space and defence sectors lead the way in this regard. Aptly reflected in the fact that defence production has surged to a record high of ₹1,27,265 crore, representing an impressive increase of approximately 174 per cent from ₹46,429 crore in 2014-15. India's defence exports have reached an all-time high, surging from ₹686 crore in FY 2013-14 to ₹21,083 crore in FY 2023-24, reflecting a remarkable increase of over 30 times in export value over the past decade.

This makes India a preferred global destination for strategic alliances for all prominent players of the world. India too has clearly underscored its intent of playing a decisive role in the region through various policy initiatives like Digital India, the International Solar Alliance (ISA), the 2023 G20 Summit, proposing the establishment of a permanent secretariat for 'NMFT' in New Delhi, and hosting the Interpol General Assembly 2022 in New Delhi, etc. Along with policy initiatives like Act East, Make in India was timely adopted and executed, transforming India into a critical stakeholder in global governance.

The year 2024 remained an engaging year for the largest democracy in the world. It began the year 2024 with celebrations of 75th Republic Day. The past decade has witnessed the emergence of India at the global level. This emergence of India in the global strategic sphere is the reflection of consistent policies and transformative reforms characterised by political stability for the period of a decade that remained a defining feature of 2024



world affairs. In this regard, the re-election of Prime Minister Narendra Modi for the third consecutive term has not only resulted in political stability but has further facilitated strong development oriented reforms and policies that have transformed the economic, military, and diplomatic spheres of influence, strengthening India's governance in various areas.

India's rise is guided by a firm policy of prioritising its immediate neighbourhood and the extended Indo-Pacific region. Its sphere of influence has further extended westward, intensely engaging with the Gulf countries, making them top trade, investment and energy partners for India. India's ambitious India-Middle East-Europe Economic corridor (IMEC) attracts interests from all stakeholders within this region that connects India to Europe through the Arabian Peninsula and could mitigate or de-risk maritime shipping significantly.

India has equally intensified its engagements with Central Asian states in the North and the Indian Ocean Region in the South. The westward engagements with Africa are at their peak, especially along the East African Coastline. In addition, India's all-inclusive approach to quality governance can be seen in its progressive initiative of the International North South Transport Corridor (INSTC), which has emerged as a substantial alternative to access Eurasia and beyond. Its natural emergence in the global south is characterised by the organic support it has received for its inclusive initiatives like the Voice of Global South Summit and Membership of the African Union as a collective entity in the G20 groupings. India's leadership role and strong advocacy towards vaccine equity were greatly admired by countries across the world. India has supplied more than 301 million doses of Covid-19 vaccines till 2023 across 99 countries of the world. The International Solar Alliance (ISA) proposed by India has received great support, and 119 countries have signed the ISA framework and 99 countries have ratified the ISA framework agreement till August 2024. India has provided funds of nearly $3 billion USD across countries towards the development of infrastructure and various projects as per the requirements of the host countries.

From 2008 till August 2024, India has fulfilled the aspirations of across 78 countries and has disbursed so far $951.22 billion USD in the form of grants and lines of credit furthering strong development partnerships across the world. This makes India a true friend for the developing world, underscoring the fact that democracies can really deliver, and the delivery is seen through its own socio-economic benefits efficiently distributed across the spectrum of society at an impressive scale. This scale and transformative operations are aptly witnessed in the global ranking of ports, where 9 major ports of India are in the global top 100 by the World Bank. Amongst these ports, the Visakhapatnam Port and Mundra Port are among the top 30 ports of the world. One of the major aspects that determines the efficiency of the port operations is Median Turnaround Time (MTT). The MTT for Indian ports has effectively improved from the sluggish 28 days of 20th century to 0.9 days in 2024, indicating efficient port management and accentuating India's capabilities to deliver. Currently, the MTT is 1.5 days in the US, 1.7 days in Australia, and 1 day in Singapore.

As a prominent maritime power, India has evolved as a net security provider of the strategic geography of the Indo-Pacific. This stature accentuated the grown capabilities, sustained operational experience, and proactive role in the Indian Ocean Region. This truly compliments the cartographic fact of making the Indian Ocean as India's Ocean. This contextualises the evolving dynamics of maritime and naval discourse resembling the 'great game' at sea. The rising naval engagements across various external players

underscores the broader recognition of the growing significance of the strategic geography of the Indo-Pacific and India as a centre of gravity of global economic development and strategic fulcrum.

While strengthening its strengths in the maritime domain, Indian deterrent capabilities have also evolved decisively in recent times. India has strengthened its nuclear triad, bolstering its deterrence capabilities with the commissioning of its second Ship, Submersible, Ballistic, Nuclear Submarine (SSBN) *INS Arighaat*, that establishes its strategic balance and peace, which play a crucial role in India's security. *INS Arighaat* is India's second *Arihant* class SSBN commissioned in 2024 and strongly characterises India's policy quest of self-reliance (*atmanirbhar*) in the defence sector, showcasing advanced design, manufacturing, technology, and detailed research and development capabilities that persuaded complex engineered indigenous systems. The *Arihant* class SSBNs are conceptualised, designed, developed, manufactured and integrated by Indian scientists, industry and navy personnel. India launched its 4th SSBN Submarine at Visakhapatnam, indicating India's growing emphasis on securing its maritime interests in a volatile geopolitical strategic geography.

While widening its strategic horizon with greater interoperability skills and capabilities, 2 major exercises presided by India have not only showcased the military might of India but have highlighted its decisive strategic adaptability to operate in all operational circumstances. The first one is a mega biennial exercise led by the Eastern Naval Command of India named *Milan 2024* from 19 February 2024 to 27 February 2024 at Visakhapatnam. This exercise received the largest ever participation across 6 continents, 51 countries, 35 ships, 50 aircraft, and 11 heads of maritime agencies participated. The exercise *Milan 2024* has evolved both in terms of operational size and complexity of missions since it began in the Andaman and Nicobar Islands in 1995 with the participation of assets from four navies. This exercise truly reflects India's able maritime capabilities at a global level.

Complementing its maritime capabilities, the Indian Air Force hosted its first multinational exercise, *'Tarang Shakti 2024'* literally meaning

File photo: *MILAN 2024 concluded on 27 February 2024, with Commanding Officers of participating navies onboard the INS Vikrant in Visakhapatnam. (**Source:** Indian Navy)*

waves of power. The exercise spanning from 06 August 2024 to 14 August 2024 had the objective to enhance interoperability and operational coordination amongst Friendly Foreign Countries (FFCs). Inclusion of *Tejas* in this mission manifests the critical role indigenous platforms are playing in modernising India's defence infrastructure.

Figure 2 –*Logo of Tarang Shakti depicting participating countries*

A total of 51 countries have deployed their strategic assets spanning over all continents of the planet. One of the major noticeable absentees in these exercises is that India's strategic partners Russia and Israel have not registered their participation. The mega multinational exercise under the aegis of the Indian Air Force provided an opportunity for participating countries to synchronise their Concept of Operations (CONOPS), mobilise and maintain detachment at distant locations, and hone their capabilities in different operational environments. The exercise witnessed the participation of cutting-edge technologically advanced strategic assets like F/A-18 Super Hornets, French Rafale, European Typhoon, F-35 engaging

with IAF's LCA *Tejas*, Su-30 MKI, Rafale, Mirage 2000, Jaguars, along with LCH *Prachand*, ALH MK-IV *Rudra*, C-130, *Netra* and *Phalcon* AEW&C (Airborne Early Warning and Control), which are normally not deployed abroad for exercises. It has showcased India's advanced capabilities that ensure rapid response and adaptability to emerging threats and security challenges evolving into the strategic geography of the Indo-Pacific.

As prescribed by Barry Buzan, the intersection between politics, economics, and geographic developments has a critical impact on human security and is prominently affected by five major elements, each of which has its own unique contribution irrespective of its ordering priorities (Buzan, 1991).

1. Military – This is the interplay between the armed credentials of states and states perceptions of each other's intentions. Here we refer to it as a strategic aspect to avoid unnecessary confusion.
2. Political – The organisational order of states, the systematic setup of government, and ideologies with their legitimate identities.
3. Economic – Availability of resources, finance, and access to them and markers to sustain an acceptable level of welfare and state authority.
4. Social – The state's sustainability and evolution of traditional language patterns, culture, and religious and national identity and customs.
5. Environmental – it deals with the maintenance of the local and planetary biosphere as it is the most vital support system upon which the entire human race depends.

A predominant security threat from local, regional, and global levels often challenges these prominent elements.

The comprehensive growth of India with stable development in all the above-mentioned five elements makes India a preferred partner across the world, adding strength to the multipolar world order. This has established a balance in the global world order, strongly supporting freedom, openness, transparency, and rule-based order. Its inclusive sense of responsibility has truly made the difference in the developing world. This responsible outreach has played a pivotal role that made India a 'First Responder' and 'Preferred Security Partner' across the globe. ❑

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India's Mission-Mode Approach Against Sickle Cell Disease

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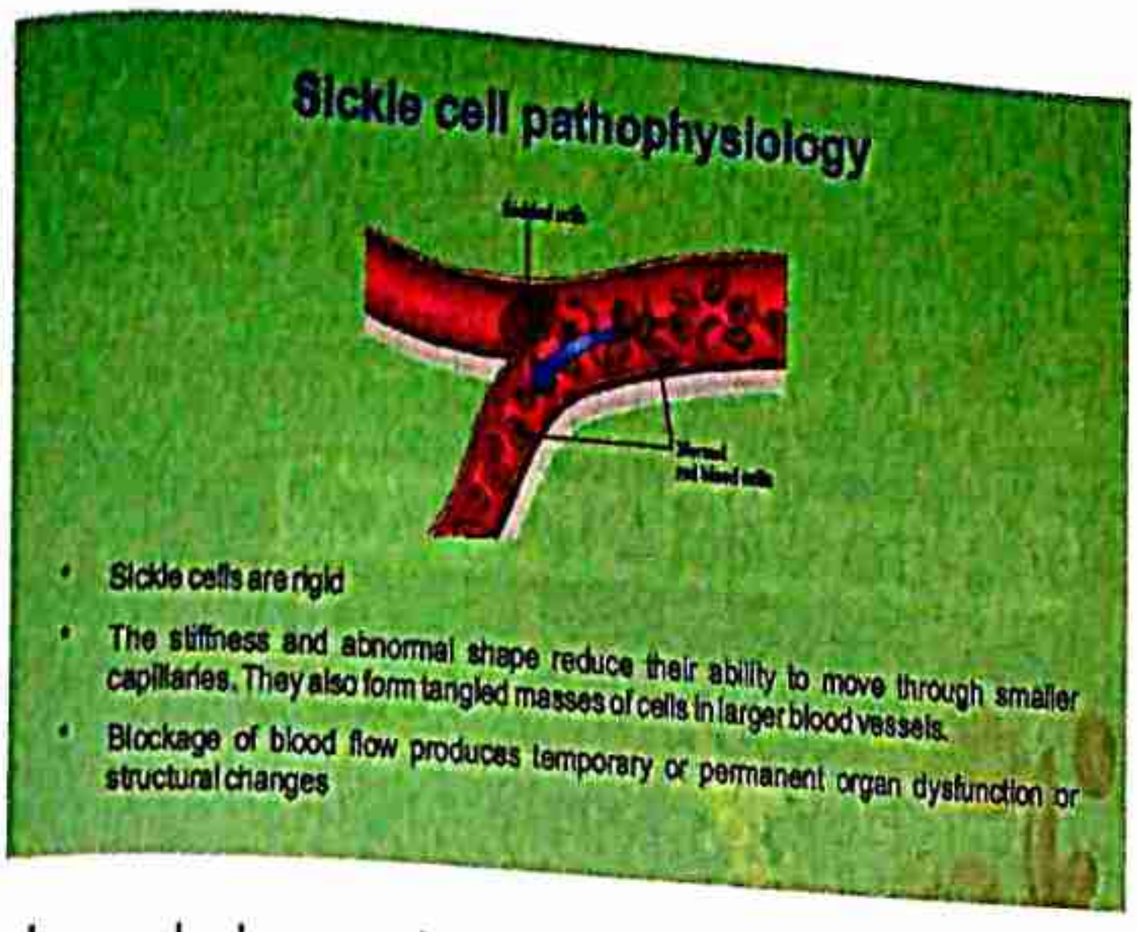
According to the World Health Organization (WHO), more than 40 crore people are the carriers of trait genes for haemoglobin disorders, mainly sickle-cell disease and thalassemia and every year, over 3 lakh babies are born with severe haemoglobin disorders. While normal red blood cells can live up to 120 days, sickle cells can only live for about 30 to 40 days. The sickled cells obstruct the blood flow, leading to blood clots and narrowing of the blood-vessel channel that causes failure of blood supply to the spleen, brain, and kidney that may result in infections, strokes, and organ damage affecting every organ in the body. The Global Burden of Disease (GBD) study in 2021 estimated that approximately 12 lakh people in India are affected by Sickle Cell Disease (SCD). SCD is particularly prevalent among the tribal population in India, though it also affects non-tribals. The National Sickle Cell Anaemia Elimination Mission (NSCAEM) under the National Health Mission was launched in 2023 with the goal to eliminate Sickle Cell Anaemia by 2047. The Mission's objective is to provide affordable, accessible, and quality care to all SCD patients and reduce the prevalence of SCD.

What is Sickle Cell Disease?

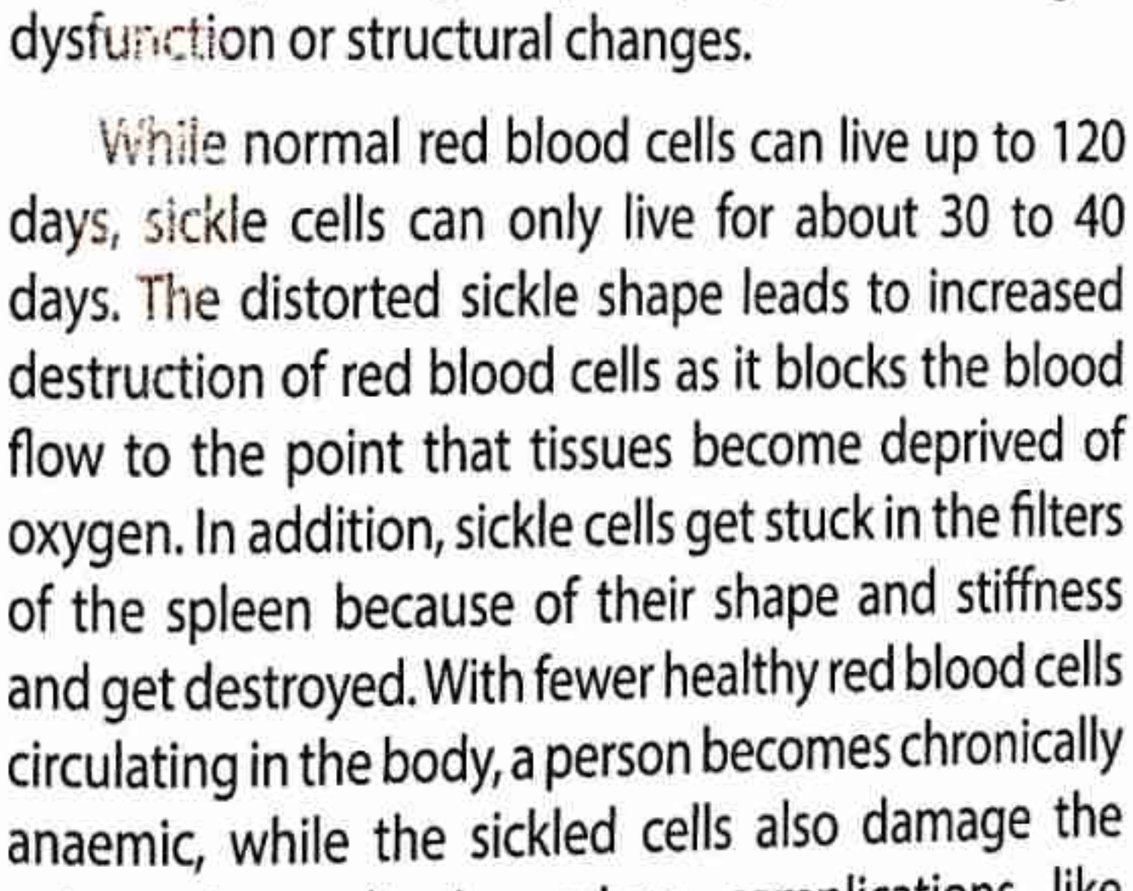
Sickle Cell Disease (SCD) is an inherited disease characterised by abnormal red blood cells that take on a crescent or sickle shape. Irregularly shaped cells can obstruct blood vessels, resulting in a range of health complications.

Blood consists of four primary components: plasma, red blood cells, white blood cells, and platelets. Haemoglobin (Hb) is a protein-based molecule found in the red blood cells (RBC) that carries oxygen in our body and gives blood its red colour. Normal red blood cells are biconcave in



shape, lack a nucleus, and possess flexibility that allows them to easily change shape. This adaptability enables them to navigate through the smallest blood vessels, known as capillaries. A Sickle Cell Disease mutation in the gene causes the formation of atypical haemoglobin. This in turn causes RBCs to lose their normal shape and become C-shaped, like sickles or crescent moons, and they lose flexibility. The stiffness and abnormal shapes hinder their movement through narrow capillaries, leading to the formation of tangled masses in larger blood vessels. These rigid, sticky cells can get stuck in small blood vessels and result in clogging of blood vessels that slow down or block blood flow and oxygen to parts of the body, causing temporary or permanent organ dysfunction or structural changes.

While normal red blood cells can live up to 120 days, sickle cells can only live for about 30 to 40 days. The distorted sickle shape leads to increased destruction of red blood cells as it blocks the blood flow to the point that tissues become deprived of oxygen. In addition, sickle cells get stuck in the filters of the spleen because of their shape and stiffness and get destroyed. With fewer healthy red blood cells circulating in the body, a person becomes chronically anaemic, while the sickled cells also damage the spleen. It results in various complications like anaemia (Sickle Cell Anaemia), frequent infections, pain, and swelling, as well as chronic damage to various organs in the body including the brain, liver, lungs, etc. SCD requires lifelong management and contributes to infant and childhood as well as adult morbidity and mortality.



Types of Sickle Cell Disease

Normal Human Haemoglobin A (HbA), also known as adult haemoglobin (Haemoglobin A1 or $\alpha 2\beta 2$), consists of two subunits of beta-globin and two subunits of alpha-globin. For normal haemoglobin production in children and adults, these two genes must function properly and work together. A person can be a sickle cell carrier or have sickle cell disease if normal haemoglobin (HbA) is replaced by faulty sickle haemoglobin.

Sickle haemoglobin (HbS) is a result of a point mutation in the beta-globin chain. If only one subunit of beta globin is affected, the person has a trait, and if both are affected, the person has SCD. Patients with sickle cell trait inherit HbS from one parent and HbA from the other. Patients with sickle cell disease inherit two genes that code for HbS from both parents, making them carriers of the disease. At times a patient may inherit the *beta* thalassemia gene from one parent and the sickle cell gene from another parent. The most prevalent types of sickle cell hemoglobinopathies include HbSS, HbS *beta* thalassemia, and sickle cell trait.

HbSS: People who have the HbSS form of SCD inherit sickle cell genes ('S') from both parents. This is commonly called sickle cell anaemia/disease and is usually the most severe form of the disease.

HbS Beta Thalassemia: People who have this form of SCD inherit one sickle cell gene ('S') from one parent and one gene for *beta* thalassemia, another type of haemoglobinopathy, from the other parent.

Those with HbS beta thalassemia usually have a severe form of SCD.

According to the World Health Organization (WHO)[1], more than 40 crore people are the carriers of trait genes for haemoglobin disorders, mainly sickle-cell disease and thalassemia and every year, over 3 lakh babies are born with severe haemoglobin disorders.

Inheritance of Sickle Cell Disease/Anaemia

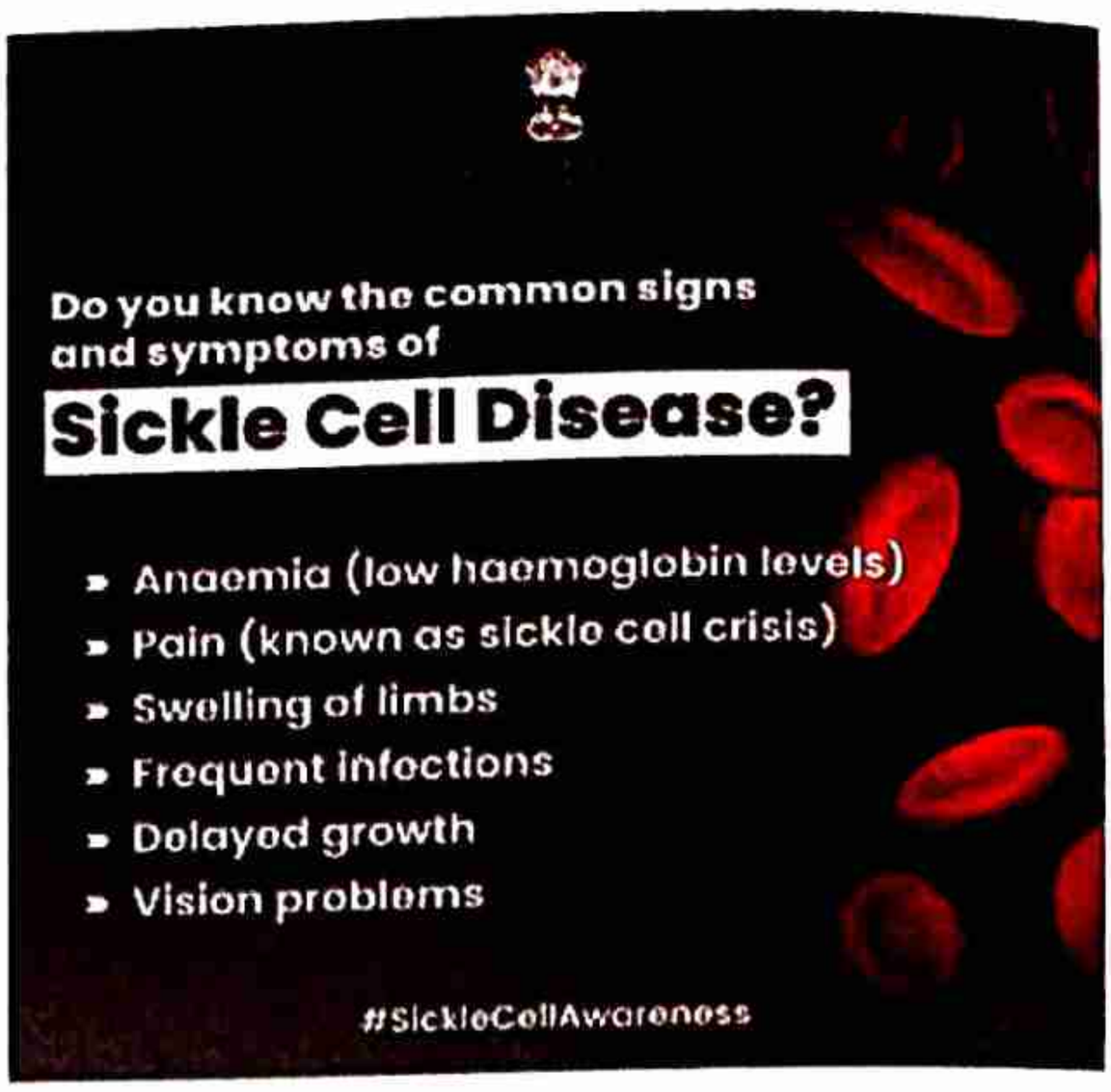
- **Both Parents with Sickle Cell Disease:** If both parents have sickle cell disease, every child they conceive will inherit the condition, resulting in a 100 per cent probability.
- **One Parent with Sickle Cell Trait and One with Sickle Cell Disease:** When one parent carries the sickle cell trait and the other has sickle cell disease, their children have a 50 per cent chance of being affected by the disease and a 50 per cent chance of being carriers.
- **One Parent Healthy and One with Sickle Cell Disease:** If one parent is healthy while the other has sickle cell disease, all children will be carriers of the trait, guaranteeing a 100 per cent likelihood of being carriers.
- **Both Parents with Sickle Cell Trait:** If both parents are carriers of the sickle cell trait, their children face a 25 per cent chance of having sickle cell disease, a 25 per cent chance of being unaffected, and a 50 per cent chance of being carriers.
- *Source: Guidelines For National Programme for Prevention & Management of Sickle Cell Disease (https://sickle.nhm.gov.in/uploads/english/OperationalGuidelines.pdf).*

Features/Symptoms of SCD

Sickle Cell Disease is of two types:

1. Sickle Cell Trait/Carriers, which is largely asymptomatic and does not require any treatment.
2. Sickle Cell Disease (SCD), which has various complications.

Individuals with SCD experience both acute and chronic complications, including recurrent pain episodes like acute chest syndrome (ACS), as well as avascular necrosis, where bone tissue dies due to insufficient blood supply. This condition



can result in tiny fractures and ultimately lead to bone collapse.

The sickled cells obstruct the blood flow, leading to blood clots and narrowing of the blood-vessel channel that causes failure of blood supply to the spleen, brain, and kidney that may result in infections, strokes, and organ damage affecting every organ in the body.

SCD may lead to multi-organ disease as well as other complications like swelling of hands and feet. Given the effects of SCD on the spleen, the immune system also gets affected in individuals with this disease. Thus, individuals with SCD have weakened immune systems and are more likely to get repeated infections.

Among SCD-related complications, numbness, severe pain, acute chest syndrome, inflammation, and fever have long been identified as a higher risk factor for death and the most common cause of hospital admission among SCD patients.

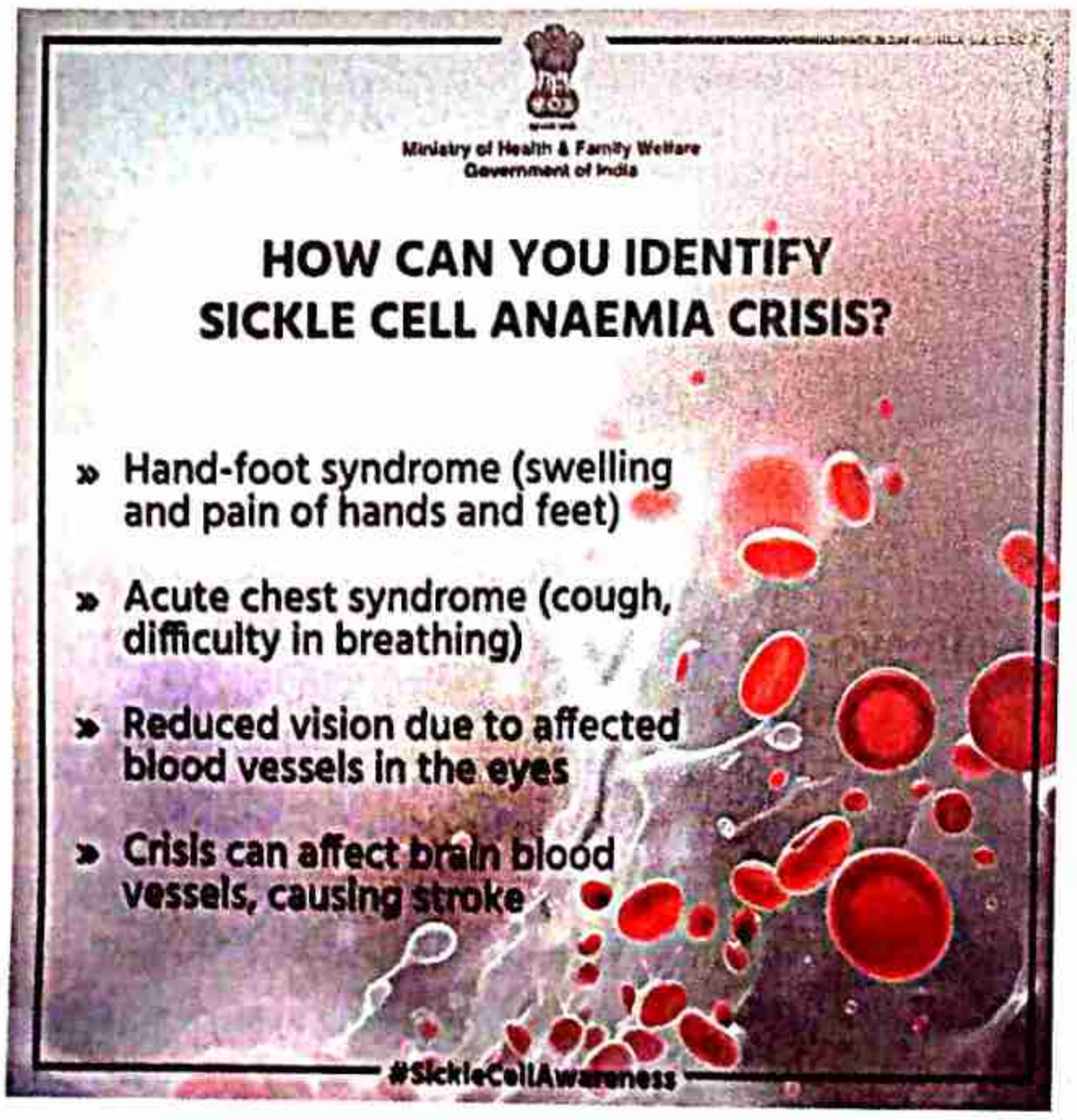
Global Prevalence of Sickle Cell Disease

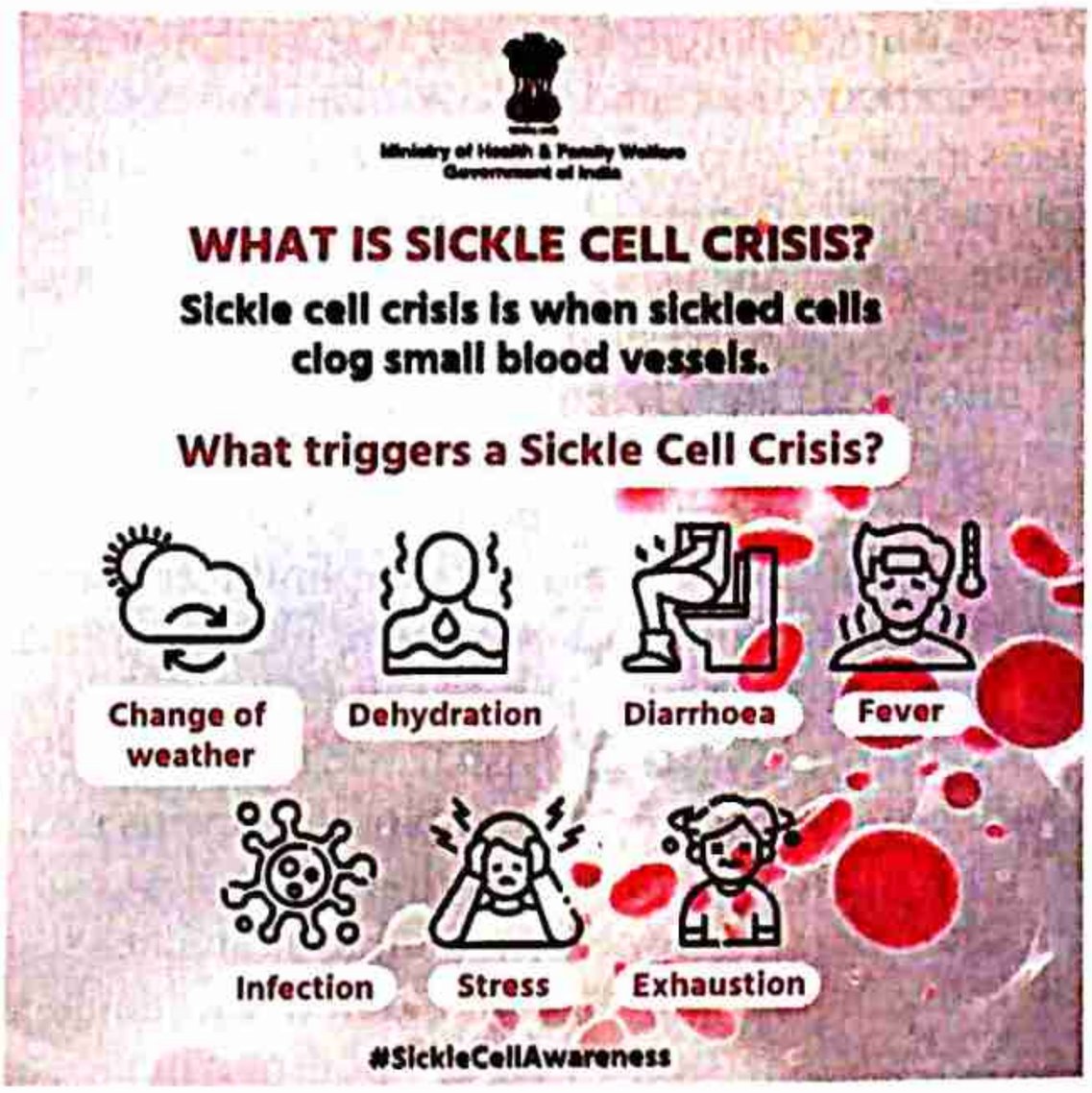
SCD has a large and growing global public health significance. According to a Lancet study on the 'Global Burden of Sickle Cell Disease', a high sickle cell disease burden is seen in historically malaria-endemic regions of Africa, the Middle East, the Caribbean, and South Asia, and the highest SCD disability burden was concentrated in Western and Central sub-Saharan Africa and India (Lancet, 2023).

The study highlighted that more than 5 lakh children were born with SCD in 2021 (with more than

three-quarters in countries of sub-Saharan Africa), and almost 80 lakh people were living with sickle cell disease globally. The rise in global births of babies with SCD can be attributed mainly to a greater share of births taking place in regions with a higher prevalence of the condition, along with possible influences from migration. The number of people living with sickle cell disease globally increased by almost 41.4 per cent, from 54.6 lakh in 2000 to 77.4 lakh in 2021. There were more than 28,000 deaths of individuals with SCD globally in 2000, which increased by 20.8 per cent to more than 34,000 deaths in 2021. In comparison, there was a 43.4 per cent increase in total deaths of individuals with sickle cell disease globally, from almost 2.62 lakhs in 2000 to 3.76 lakhs in 2021.

The incidence and prevalence of sickle cell disease have significantly risen in sub-Saharan Africa across various super-regions. Across super-regions, examining all-age sickle cell disease prevalence, Central Europe, Eastern Europe, and Central Asia had the largest percentage decline. The Lancet study emphasised that the mortality burden of SCD is particularly severe among children, especially in nations with the highest rates of under-five mortality. Females and males had comparable disease patterns. Globally, the all-age prevalence of sickle cell disease among females in 2021 (Lancet, 2023) was 39 lakhs, similar to the all-age prevalence of sickle cell disease among males, which was 38.4 lakhs.





Source: Global, regional, and national prevalence and mortality burden of sickle cell disease, 2000–2021: a systematic analysis from the Global Burden of Disease Study 2021 (https://www.thelancet.com/journals/lanhae/article/PIIS2352-3026(23)00118-7/fulltext)

Prevalence of the Sickle Gene in Tribal Communities of India

The Global Burden of Disease (GBD) study in 2021[2] estimated that approximately 12 lakh people in India are affected by SCD. SCD is particularly prevalent among the tribal population in India, though it also affects non-tribals. India is reported to have the largest tribal population density globally. As per Census 2011, India has an 8.6 per cent tribal population which is 6.78 crore across the Indian states. The tribal health expert committee of the Ministry of Health and Family Welfare has highlighted SCD as one of the ten major health issues disproportionately affecting tribal communities. According to the National Health Mission's (NHM) 'Guidelines for National Programme for Prevention & Management of Sickle Cell Disease', SCD is widespread among the tribal population in India, where about 1 in 86 births among STs have the disease.

Social and Economic Impacts of Sickle Cell Disease

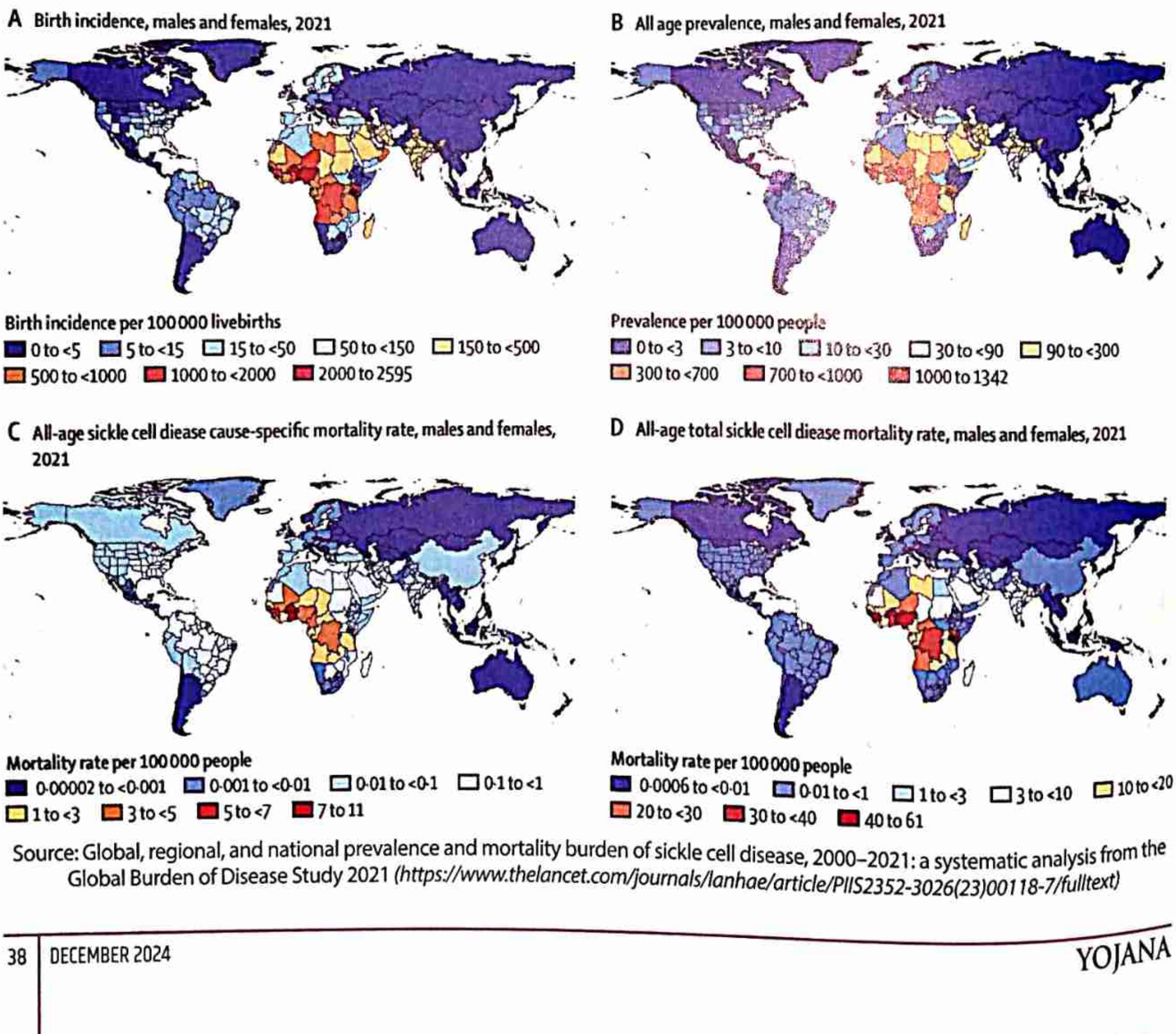
Various studies have highlighted the enormous financial burden suffered by people suffering from SCD. SCD has a profound macroeconomic

impact on a country's economy due to the severe complications associated with the condition and the necessity for routine and lifelong care. This burden compounds existing social and psychological challenges, including clinical symptoms, depression, absenteeism from work, decreased productivity, and even job loss along with broader impacts on quality of life. The financial ramifications encompass both direct and indirect costs. Direct costs encompass expenditures that are met by the healthcare system, including but not limited to screening procedures, primary and emergency care visits, pharmacological treatments, hospitalisations, blood transfusions, bone marrow transplants, and additional out-of-pocket expenses borne by patients. Indirect costs, on the other hand, are shouldered by families and society at large. In a study published in Blood Advances (2022)[3], it was estimated that in the USA, individuals with private health insurance spend approximately $1.7 million on Sickle Cell Disease-related medical expenses over their lifetime in the USA.

Given the association with healthcare costs due to long-term disease management and aforementioned associated factors, this invariably also leads to aggravated financial hardship, especially for population subgroups of middle and lower economic strata. Also, in several countries, the health services are not adequately equipped for long-term management of such diseases, which further burdens the patients and their families.

National Sickle Cell Anaemia Elimination Mission (NSCAEM)

In India, several national and state-specific initiatives have been planned and undertaken for a reduction in prevalence and management of sickle cell anaemia. Identifying SCD as a genetic blood disorder affecting tribal populations in Central, Western, and Southern India, NHM prepared and disseminated comprehensive guidelines to control and prevent Haemoglobinopathies, including SCD. This includes prenatal diagnosis, counseling, and setting up of early intervention centres to prevent and treat the complications arising from the disease.



Source: Global, regional, and national prevalence and mortality burden of sickle cell disease, 2000–2021: a systematic analysis from the Global Burden of Disease Study 2021 *(https://www.thelancet.com/journals/lanhae/article/PIIS2352-3026(23)00118-7/fulltext)*

In a significant step, a mission-mode approach has been taken by the Government of India to tackle the disease. The National Sickle Cell Anaemia Elimination Mission (NSCAEM) under the National Health Mission was launched on 01 July 2023 at Shahdol, Madhya Pradesh by the Prime Minister. With the goal to eliminate Sickle Cell Anaemia by 2047, the Mission's objective is to provide affordable, accessible, and quality care to all SCD patients and reduce the prevalence of SCD.

The NSCAEM has identified 17 states in India that exhibit a significantly higher prevalence of sickle cell disease (SCD). These states are: Gujarat, Maharashtra, Rajasthan, Madhya Pradesh, Jharkhand, Chhattisgarh, West Bengal, Odisha, Tamil Nadu, Telangana, Andhra Pradesh, Karnataka, Assam, Uttar Pradesh, Kerala, Bihar, and Uttarakhand.

The Mission is committed to screening and managing individuals aged 0 to 40 years, with the aim of minimising the impact of sickle cell disease (SCD) on patients and their families. By adopting a whole-of-government and whole-of-society approach, the Mission provides comprehensive support and fosters active collaboration across various sectors.

To combat this disease effectively, the Mission implements strategic interventions that include universal screening and early detection, raising awareness through educational initiatives, and offering premarital counseling. Additionally, it focuses on holistic management of affected individuals at all levels of care—primary, secondary, and tertiary—ensuring that those impacted receive the best possible support throughout their journey.

Screening efforts by the states are being regularly monitored. A dashboard and sickle cell disease portal have been launched to compile the screened data by all states *(https://sickle.nhm.gov.in/)* that serve as crucial resources for analysing the prevalence and distribution of SCD across India. Besides traditional screening methods, point-of-care tests have been approved and validated by ICMR and are being used by the states. Union Health Ministry under the National Mission has released the guidelines and training materials on Operational Guidelines for the Prevention and Management of Sickle Cell Disease *(https://sickle.nhm.gov.in/uploads/english/OperationalGuidelines.pdf)*, and training modules for primary care of Community Health Officers (CHOs), Medical Officers, Multi-Purpose Workers (M/F)/ASHAs, and Staff Nurses *(https://sickle.nhm.gov.in/home/guidelines)*.

A targeted screening approach has been implemented in non-tribal districts, focusing on the prevalence of SCD identified through routine facility-based testing of antenatal mothers in their first trimester at primary healthcare facilities across the states.

The programme has been integrated with existing mechanisms and strategies under the National Health Mission (NHM) to ensure the utilisation of existing resources and also minimise the duplication of efforts. For example, the established platforms of *Rashtriya Bal Swathya Karyakram* (RBSK), *Pradhan Mantri Surakshit Matritva Abhiyan* (PMSMA), and *Anaemia Mukt Bharat* would be leveraged to achieve the targets for the Sickle Cell mission.

Under the National Health Mission (NHM), in the SCD prevalent areas, States are ensuring the availability of sickle cell disease testing at all Sub-Health Centres-Health & Wellness Centres (SHC-HWC) and Primary Health Centre (PHC)/ Urban Primary Health Centres (UPHC)- HWCs/U-HWCs.

Teleconsultation services at *Ayushman Bharat* Health and Wellness Centres (AB-HWCs) are being leveraged, especially in 'sickle cell crises' for prompt management. The states have established guidelines for outsourcing that include relevant selection criteria, such as licensing requirements for laboratories and essential service components like community mobilisation, blood sampling, testing, sample transport, reporting, data entry, quality assurance, coverage, and costs.

Under this Mission, States are ensuring the availability of basic drugs, such as hydroxyurea, prophylactic penicillin, and vaccinations, at public health facilities, including AB-HWCs and referral centres. These medications are prescribed and administered at Primary Health Centres (PHC) and UPHC-HWC, while at SHC-HWC, the Community Health Officer (CHO) dispenses them only under the guidance of the Primary Health Centre Medical Officer (PHC-MO). All first-referral centres have established daycare facilities for transfusions and monitoring. The National Health Mission (NHM) is actively addressing these healthcare needs at both district and sub-district levels. Additionally, treatment facilities at the tertiary level are receiving

financial support from the Ministry of Tribal Affairs, which facilitates connections with lower-level healthcare facilities through established linkages under NHM.

In a new development, the Indian Council of Medical Research (ICMR) has formalised a Memorandum of Agreement with *Zydus* Lifesciences Limited to initiate Phase-2 clinical trials for the drug *Desidustat* in patients with sickle cell disease. Phase IIa a double-blind, randomised, placebo-controlled study to assess the drug's efficacy and safety. The trial is proceeding after receiving approval from the Drug Controller General of India (DCGI).

In continuation with the efforts made by the government to eliminate SCD, World Sickle Cell Disease (SCD) Awareness Day was celebrated across the country on 19 June 2024 to create awareness and halt the transmission of SCD. On the occasion, high-level dignitaries in different states inaugurated various events. More than 44 thousand events were organised in 17 high-burden states and 343 districts. As a part of the activities, more than 6 lakh individuals were screened for sickle cell disease, and more than 2.5 lakh Sickle Cell ID cards were distributed to the screened beneficiaries.

To continue the awareness activities, a 15-day awareness programme (19 June to 3 July) was launched on 19 June. Awareness activities were held at all facilities in 343 districts in 17 identified SCD states. The target for the 15-day program was to screen 10 lakh individuals and distribute 3 lakh Sickle Cell Status ID cards to screened individuals. Exceeding its targets, the programme showed unprecedented success as more than 28 lakh individuals were screened and more than 13 lakh Sickle Cell ID cards were distributed from 19 June to 3 July.

The district-level events included counselling a maximum number of patients and conducting mass awareness activities. Supporting the Ministry of Tribal Affairs (MoTA) in its various awareness-generation activities was one of the key objectives of these events.

According to the screening data from the online dashboard for SCD, since the inception of the National Sickle Cell Anaemia Elimination Mission (NSCAEM) last year, more than 4.5 crore screening records have been uploaded on the portal. Out of the screened individuals, around 4.4 crore individuals are Sickle Cell Negative while Sickle Cell traits were found in more than 12 lakh individuals. States have distributed a total of 1.5 crore Sickle Cell Status ID cards till 6th November 2024.

More than 4.5 crore individuals are registered on the Sickle Cell Disease Portal. The national target for Sickle Cell Disease screenings for the year 2024-25 is 6.3 crore. Chhattisgarh, Madhya Pradesh, Maharashtra, Gujarat, and Odisha are the states with the highest targets (more than 4.45 crores).

Summary

In conclusion, Sickle Cell Disease is a growing global public health challenge. To improve sickle cell disease health outcomes, global action is required, including efficient diagnostic screening, effective case monitoring through population registries, and implementation of high-quality prevention and treatment. In India, the burden of SCD is higher among the tribal than the non-tribal groups. India's dedicated commitment to addressing challenges posed by sickle cell disease (SCD) is highlighted by the comprehensive efforts outlined through World Sickle Cell Awareness Day and the National Sickle Cell Anaemia Elimination Mission. Through increased awareness, strategic screening initiatives, and integrated healthcare approaches in identifying cases, and providing care, significant progress has been achieved toward the elimination of SCD as a public health concern by 2047. These efforts reinforce India's resolve to enhance healthcare outcomes and promote the well-being of the Indian population. ❑

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Making Indian Agriculture Future-Ready

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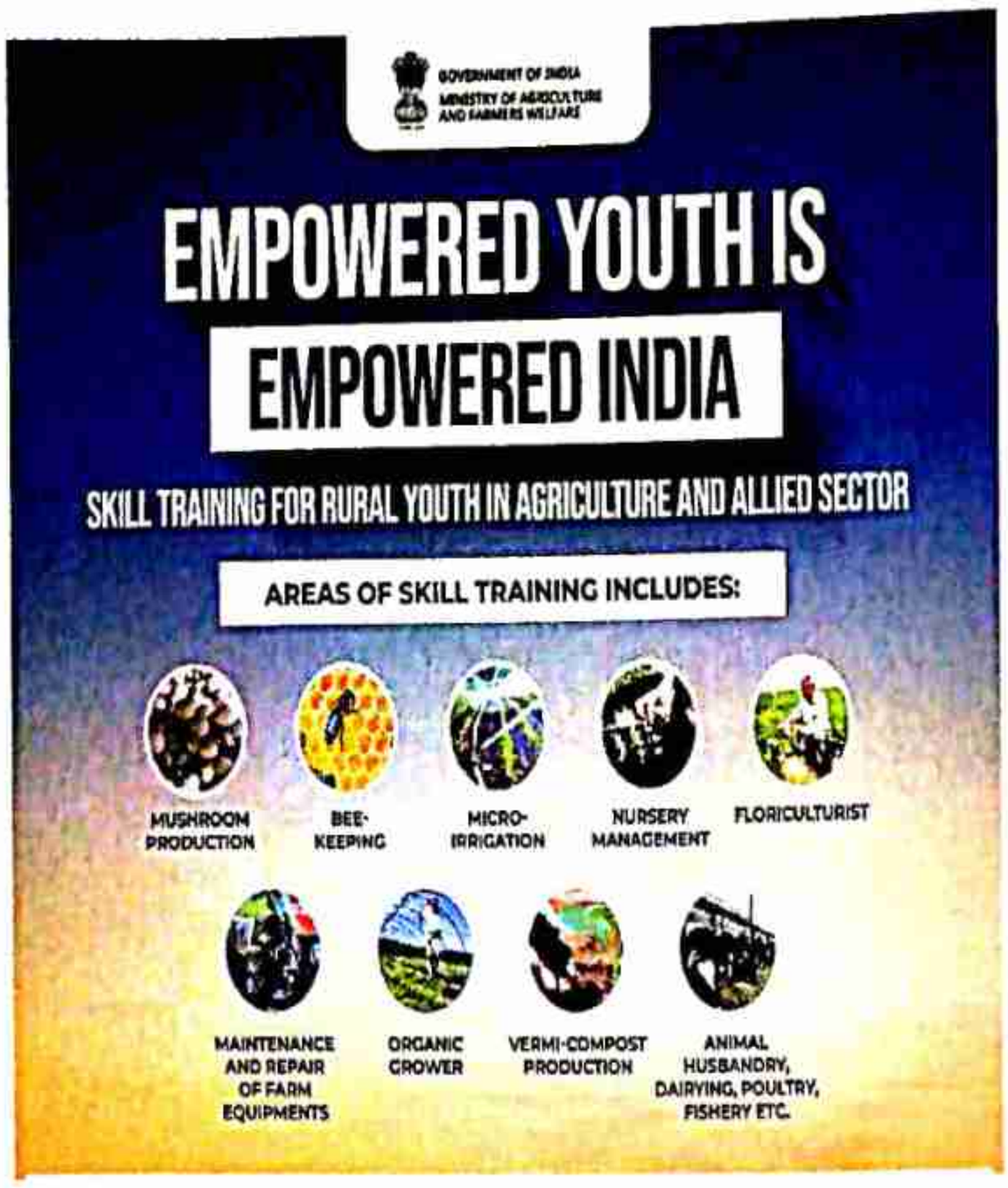
This year has been remarkable for the agriculture sector marked by several milestone achievements, such as record food production, the highest-ever MSP of crops, historic budget allocation, and, of course, a favourable monsoon. Building on this momentum, the Government of India launched several schemes and initiatives to accelerate productivity, profitability and sustainability in agriculture and allied sectors.

A six-point strategy was also unveiled for inclusive development of agriculture and welfare of farmers. Ongoing schemes were further reinforced with frontier technologies to make Indian agriculture future-ready and globally competitive. Scientific research, followed by extension, has been one of the major thrust areas to push up nutritional security and address/mitigate climate change-related challenges. Small and marginal farmers, women and youth remained in focus across all verticals of agriculture for their financial inclusion and empowerment.

Resources and Records

Budget allocation (2024-25) scaled a historic high of Rs 1.52 lakh crore to support ongoing schemes and futuristic initiatives proposed in the budget, and it focused on enhancing productivity and resilience in the agriculture sector. Allocation was raised to Rs 9,941.09 crore to strengthen the



agricultural research ecosystem and develop competent human resources. To support allied sectors of agriculture, Rs 4,521 crore was allocated to the animal husbandry and dairy sector whereas the fisheries sector received a grant of Rs 2,616 crore. Higher allocations are primarily meant to boost dairy, livestock and fisheries processing by facilitating infrastructure development. On the output side, a record foodgrain production of 3322.98 LMT (Lakh Metric Tonnes) was achieved this year (2023-24), which is higher by 26.11 LMT compared to the previous year. The significant increase is mainly contributed by higher production of rice (1378.25 LMT), wheat (1132.92 LMT) and *Shree Anna* (175.72 LMT). In oilseeds, a record production of rapeseed and mustard was achieved due to special initiatives in mission mode. As per third advance estimates, national production of pulses has increased from 163.23 lakh tonnes (2015-16) to 244.93 lakh tonnes during 2023-24. Production of fruits in 2023-24 is expected to increase by 2.29 per cent over 2022-23, that is, to 112.73 million tonne. In the horticulture sector, other than fruits, higher production was also registered in honey, flowers, plantation crops, spices and aromatic and medicinal plants (final estimates). Overall, higher production of vegetables is envisaged to be around 205.80 million tonnes mainly due to the expected increase in production of tomato, cabbage, cauliflower, carrot, tapioca, okra, etc.

Minimum Support Prices (MSP) for all mandated *kharif* and *rabi* crops were raised for marketing season 2024-25 and 2025-26 respectively. In all crops, the increase is in line with the government's policy of fixing the MSP at least 1.5 times of the all-India weighted average cost of production. However, in the declared MSP of *kharif* crops, the expected margin over the average cost of production was highest in the case of pearlmillet (77 per cent), followed by *tur* (59 per cent), maize (54 per cent) and *urad* (52 per cent). In the case of declared MSP of *rabi* crops, the expected margin over the average cost of production was highest for wheat (105 per cent), followed by rapeseed and mustard (98 per cent), lentil (89 per cent), gram (60 per cent) and barley (60 per cent). The absolute highest increase in MSP has been for rapeseed and mustard (Rs 300 per quintal), followed by lentil at Rs 275 per quintal. The increased MSPs ensure remunerative prices to farmers and also promote crop diversification. In recent years, cultivation of crops other than cereals has been pushed up by offering a higher MSP for pulses, oilseeds and nutri-cereals (*Shree Anna*).

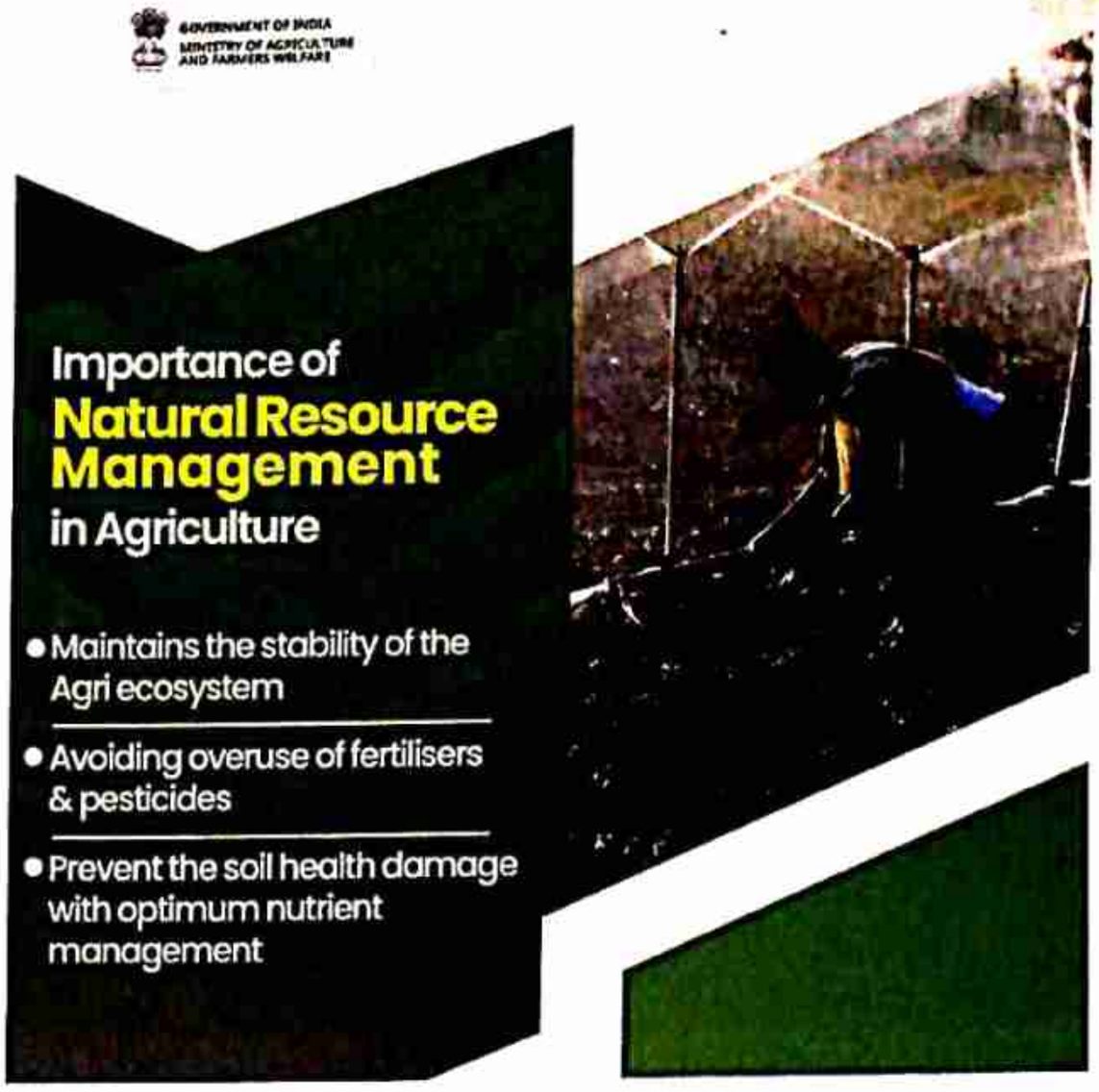
When the south-west monsoon started receding in late September, it recorded 5 per cent surplus rains on all-India basis. However, it was a slow start, which gained momentum in the later half, helping farmers in sowing. Consequently, paddy, oilseeds and pulses gained 2.2 per cent, 1.5 per cent and 7.8 per cent increases in area, respectively, over and above the last year (upto September 2024). Due to late and surplus rains, current storage of reservoirs is nearly 123 per cent of the last year and 118 per cent of normal storage of last 10 years. Soil moisture has also improved and is better than or similar to the nine-year average in most of the southern and northern states. It will benefit winter crops like wheat and chickpea. Good monsoon has raised hopes for better overall farm productivity.

Initiatives and interventions

Taking a quantum leap towards overall agriculture development, the Union Government approved seven major schemes to improve farmers' lives and increase their income. The total outlay of schemes is Rs 14,235.30 crore. 'Digitial Agriculture Mission' is the foremost initiative that aims for digital transformation in agriculture sector by providing farmer-centric digital solutions. Initially, three types of Digital Public Infrastructure (DPI)

will be built under the mission, viz., Agristack, Krishi Decision Support System (KDSS), and Soil Profile Mapping. Agristack will enable efficient, easier, and faster services and scheme delivery to farmers. Similar to *'Aadhaar'*, a digital identity for each farmer will be created for linking with various farmer-based databases, such as land records, livestock ownership, crops sown, family details, schemes and benefits availed etc. KDSS is designed to create a comprehensive geospatial system to unify remote sensing-based information on parameters such as crops, soil, weather, water resources, etc. Another digital platform is designed to make accurate estimates of agricultural production. The mission is expected to provide employment opportunities to about 2.5 lakh trained local youth and *Krishi Sakhis*, and will ensure that our farmers get timely guidance and services related to various farming practices. The total outlay of the mission is Rs 2,817 crore, including the central share of Rs 1,940 crore.

A special initiative was approved with a total outlay of Rs 3,979 crore to prepare farmers for



climate resilience and maintain sustainable food and nutritional security. Efficient management of plant genetic resources and genetic improvement of crops are the major pathways identified to achieve the target. Amid various

Agriculture Import and Export - Key Decisions

Onion: Earlier, the minimum export price of US$ 550 per metric tonne and the export duty of 40 per cent were restricting exports. Foreign importers were reluctant to buy onions from India due to very high prices. The government has taken a decision to remove the restriction on the minimum export price altogether and to cut the export duty from 40 per cent to 20 per cent. This will surely add significant income to the purse of onion growers.

Basmati Rice: This is a major item of India's agricultural export with a significant place in the global market. But Basmati exporters faced a setback due to export restrictions on Basmati rice varieties costing between US$ 800 and US$ 950 per metric tonne. This restriction prevented our producers from realising their potential in the global market. Taking a decision in favour of Basmati rice exporters, this restriction has now been removed. This move will now enable the Basmati rice farmers to recover the foreign market for their premium produce.

Edible Oil: India depends heavily on the import of edible oils to meet domestic demand. However, low international prices of palm and soya oil, and zero basic custom duty on imports of palm, soya and sunflower oil had been negatively impacting their domestic prices. The government took a historic decision to increase the effective import duty on crude edible oil (as in palm, soya and sunflowers) from 5.5 per cent to 27.5 per cent and on refined oil from 13.75 per cent to 35.75 per cent. This is expected to enhance prices of domestically produced edible oils in favour of oilseed farmers.

Integrated Agri-Export Facility: The government has approved the creation of India's first Integrated Agri-Export Facility at Jawaharlal Nehru Port, Mumbai. This is a PPP project worth Rs 284.19 crore to revolutionise agri-logistics and reduce wastage. This facility will address inefficiencies in logistics, reduce multiple handlings, and extend the shelf life of agricultural products. Further, it will empower farmers, boost job opportunities and enhance export capacity. ❑

emerging challenges, a scheme was approved to prepare agriculture students and researchers for taming natural adversities by using cutting-edge technologies. The Indian Council of Agricultural Research is the designated lead agency to operationalise it with a total outlay of Rs 2,291 crore. In addition to research, agri-education will also be modernised in line with the New Education Policy 2020. In addition to core agriculture, an initiative has been taken to increase farmers' income from livestock and dairy enterprises. It comprises various components of livestock and dairy management, including improvements in animal genetic resources. Approved with a total outlay of Rs 1,702 crore, the scheme also aims at modernising veterinary education. A new scheme on sustainable horticulture aims to make it more profitable and livelihood-oriented to attract youth in this sector. Besides, in addition to traditional horticultural crops, the initiative will also focus on increasing farmers' income from plantation crops, spices and medicinal and aromatic plants. The scheme was approved with a total outlay of Rs 1,129.30 crore. A scheme on natural resource management, with an outlay of Rs 1,115 crore, was approved for efficient and sustainable management of water, soil and other natural resources. Activities under 'Lab-to-Land' will be further refined and strengthened through a scheme aiming at modernisation of '*Krishi Vigyan Kendras*' (KVKs). These district-level units offer last mile connectivity of researchers with farmers for extension and expansion of new technologies in fields through various innovative modules.

The Ministry of Agriculture and Farmers Welfare operates a good number of centrally sponsored schemes in collaboration with various state governments. To avoid duplication, ensure convergence and provide flexibility to states, the union cabinet has approved rationalisation of all such schemes into two unmbrella schemes, viz., *Pradhan Mantri Rashtriya Krishi Vikas Yojana* (PM-RKVY) and *Krishonnati Yojana* (KY). Both schemes have many and diversified objectives, but broadly, PM-RKVY will promote sustainable agriculture, whereas KY will address food security and agricultural self-sufficiency. Approved with a total proposed expenditure of Rs 1,01,321.61 crore, both the schemes will focus on emerging challenges of agriculture, nutritional security, sustainability, climate change, value chain development and participation of the private sector. Technology will be leveraged to ensure efficient and effective implementation of all components. Umbrella schemes have given flexibility to state governments for re-allocation of funds from one component to another based on their state-specific requirements. Now, states can prepare a comprehensive annual action plan for approval by the union ministry instead of sanctioning plans for each scheme. Individual schemes pertaining to soil health management, rainfed area development, natural farming, crop diversification, efficient water management, agri-startups, etc. have been clubbed under PM-RKVY.

Strategies and Steps

The Government renewed its thrust on the holistic development of agriculture and the social welfare of farmers by adopting a six-point strategy. Increase in production, reduction in the cost of production, fair prices to farmers for their produce, compensation for losses incurred by natural disasters, diversification of agriculture and value-addition, and natural farming are key thrust areas of the strategy. Under digital initiatives, a National Pest Surveillance System (NPSS) was launched to enhance agricultural pest surveillance and pest management across the country. Operable through a mobile app and web portal, the system includes a pest identification module for 61 crops and a surveillance module for 15 crops for issuing timely advisories. Since its launch on 15 August

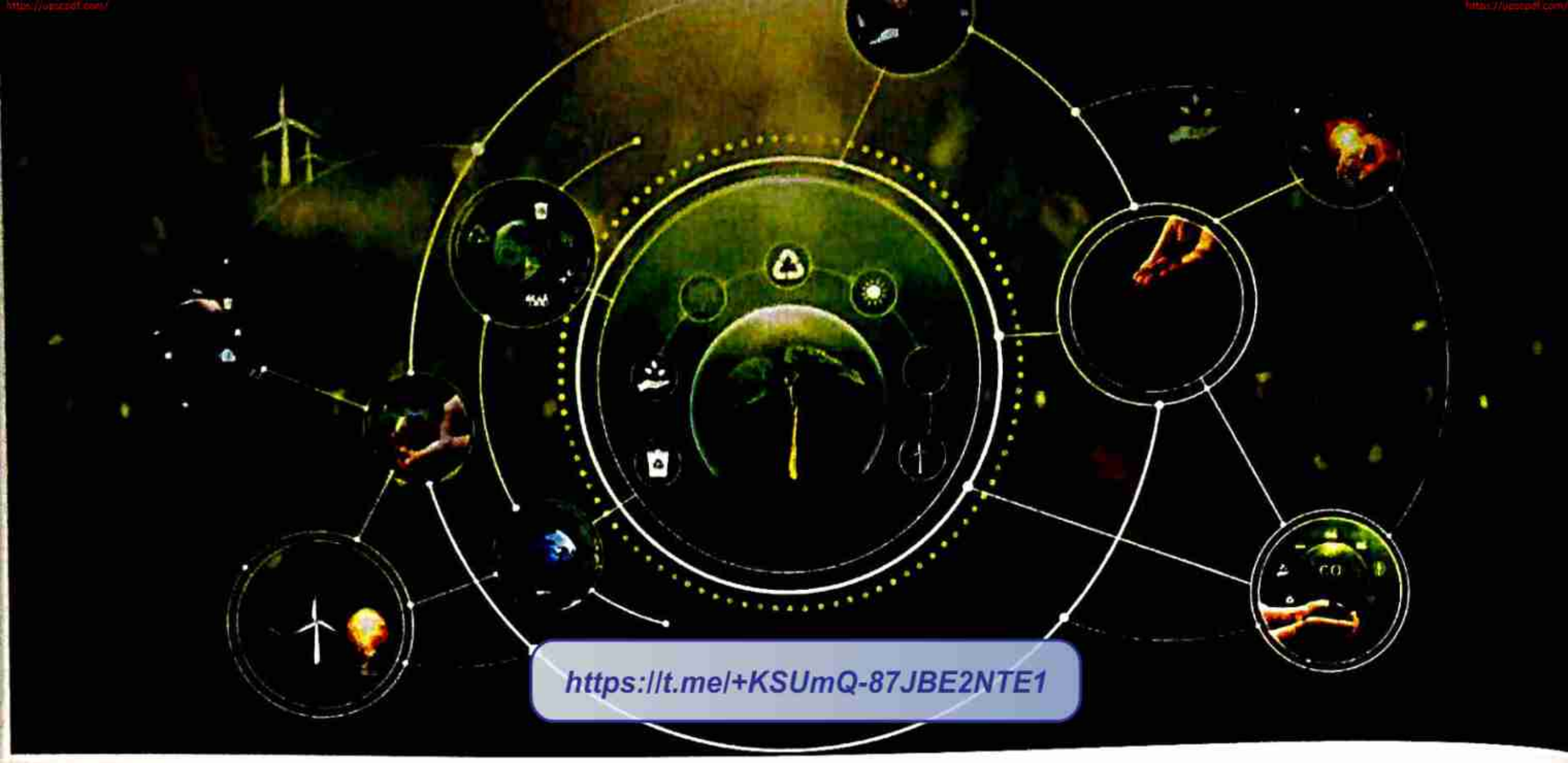
2024, within a month or so, over 16,000 farmers downloaded the NPSS App and identified pests for over 61 crops. More than 22,300 surveys have also been done over the NPSS App.

In a specific move to enhance field productivity, the Prime Minister released 109 varieties of 61 crops, including 34 field crops and 27 horticultural crops. The new varieties encompass a wide range of crops, including cereals, millets, pulses, oilseeds, vegetables, fruits, spices, medicinal plants, etc. These varieties have been developed by the ICAR (Indian Council of Agricultural Research) to address new challenges such as climate change, vagaries of nature, pest attacks, nutritional deficiencies, etc. ICAR, agricultural universities, and states have together prepared a framework to deliver the seeds of these varieties to farmers at the earliest. In addition, the agriculture ministry has onboarded 266 breeder seed-producing centres on the SATHI (Seed Authentication, Traceability and Holistic Inventory) portal to help farmers get quality seeds at affordable prices.

The Government has decided to launch a new TV and radio program, *'Krishi Chaupal'*, to strengthen communication and outreach with farmers. This program seeks to empower farmers to enhance productivity and profitability by promoting best agricultural practices and strategies including efficient use of agri-inputs. As a key feature, *'Krishi Chaupal'* will allow farmers to engage directly with agricultural experts through interactive sessions in their own language. A unique Farmers Grievance Redressal System (FGRS) will soon come up as a multi-channel support to farmers in registering their queries or grievances on various issues, such as subsidies, input supplies, services, programs, schemes, etc. It will be multilingual support with real-time tracking of grievance status and automated updates on the programme.

This year, to further enhance the coverage of *Pradhan Mantri Fasal Bima Yojana* (PMFBY), a special campaign was launched to saturate KCC (Kisan Credit Card) account holder farmers through respective bank branches. Jharkhand was also onboarded under the scheme. As a result of these initiatives, for *Kharif* 2024 the total number of farmers insured is expected to reach an all-time high of 293 lakhs (2.93 cr) and the total insured area is expected to reach 365 lakh hectares, registering a growth of more than 12 per cent. Under the continuing scheme of the Agriculture Infrastructure Fund, the agriculture ministry set an ambitious target under its 100-day action plan to create over 7,000 infrastructure units, a total loan amount of Rs 5,500 crores, and mobilisation of an investment of Rs 7,500 crores for various projects and assets. The target was surpassed with over 10,000 units, over Rs 6,500 crores of loan sanctioned, and attracting over Rs 10,000 crores project investments. The government launched a saturation drive under the *PM-KISAN* scheme to add over 25 lakh new farmers. Thus, the total number of beneficiaries has risen to a record high of 9.51 crore farmers.

As a prime component of sustainable agriculture, the government has proposed a special drive to rope in one crore farmers into natural farming in the next two years. To support the initiative, 10,000 need-based bio-input resource centres will be established across the country to facilitate the supply of specific inputs directly to farmers. A 'National Mission on Natural Farming' is already underway as a separate and independent scheme since 2023-24. Farmer Producer Organisations, agri-cooperatives and start-ups are also being promoted to push up natural faming, organic farming, value addition and supply chain management. Overall, the year 2024 witnessed the restructuring and building up of an agri-ecosystem that strives to make Indian agriculture future-ready while ensuring the well-being of farmers of all classes and categories. ❑



Government Initiatives in Climate Change: A Sustainable Path for Viksit Bharat @2047

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India, as one of the fastest-growing countries globally, confronts the combined task of promoting economic growth while addressing and adapting to the escalating threat of climate change. The nation, significantly susceptible to climatic effects owing to its varied ecosystems and socio-economic circumstances, has adopted a comprehensive strategy to tackle these issues. The Government of India, from time to time, has initiated multiple projects to mitigate greenhouse gas emissions, enhance resilience to climate impacts, and incorporate sustainable practices throughout urban, rural, and industrial environments. Lately, these initiatives have achieved considerable momentum, highlighted by prominent programs such as the Sovereign Green Bonds, MISHTI, and the Green Credit Program. The leadership that India has demonstrated in the global climate conversation demonstrates its dedication to sustainable development. These programs will serve as the basis for a future that is both more environmentally friendly and environmentally resilient. The climate policies that India is implemening for the years 2023 and 2024 represent substantial steps towards ecological restoration and sustainability.

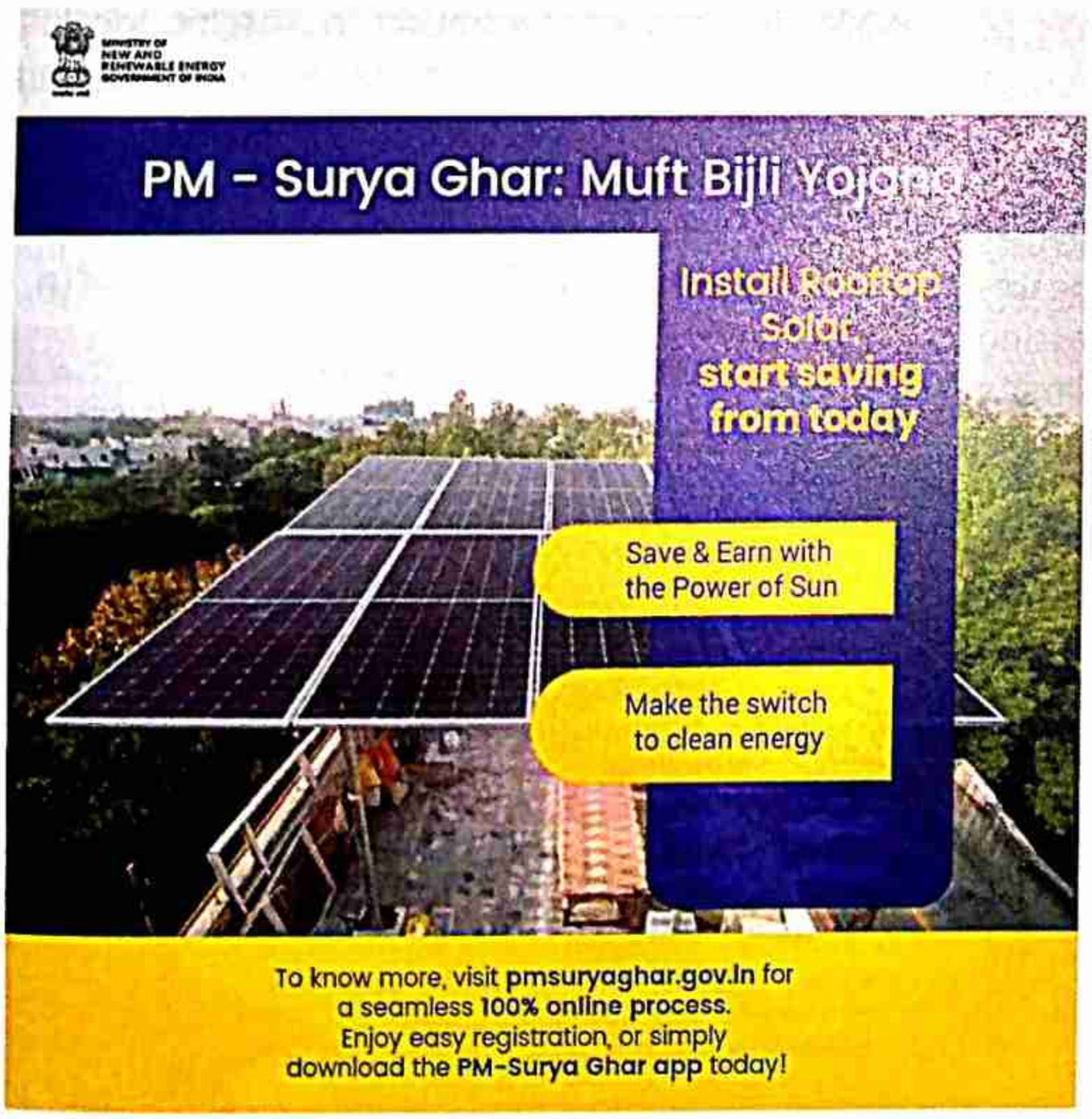
India, being one of the most populous countries globally, has been at the forefront of both contributing to and combating climate change, and the Government of India has enhanced its policy framework to tackle the complex concerns of climate change while ensuring that economic growth is both inclusive and sustainable. As the vision of PM Narendra Modi of *Viksit Bharat*@2047 This article explores this year's journey of the programmes and schemes within the framework of India's comprehensive climate plan, their importance, and future developments.

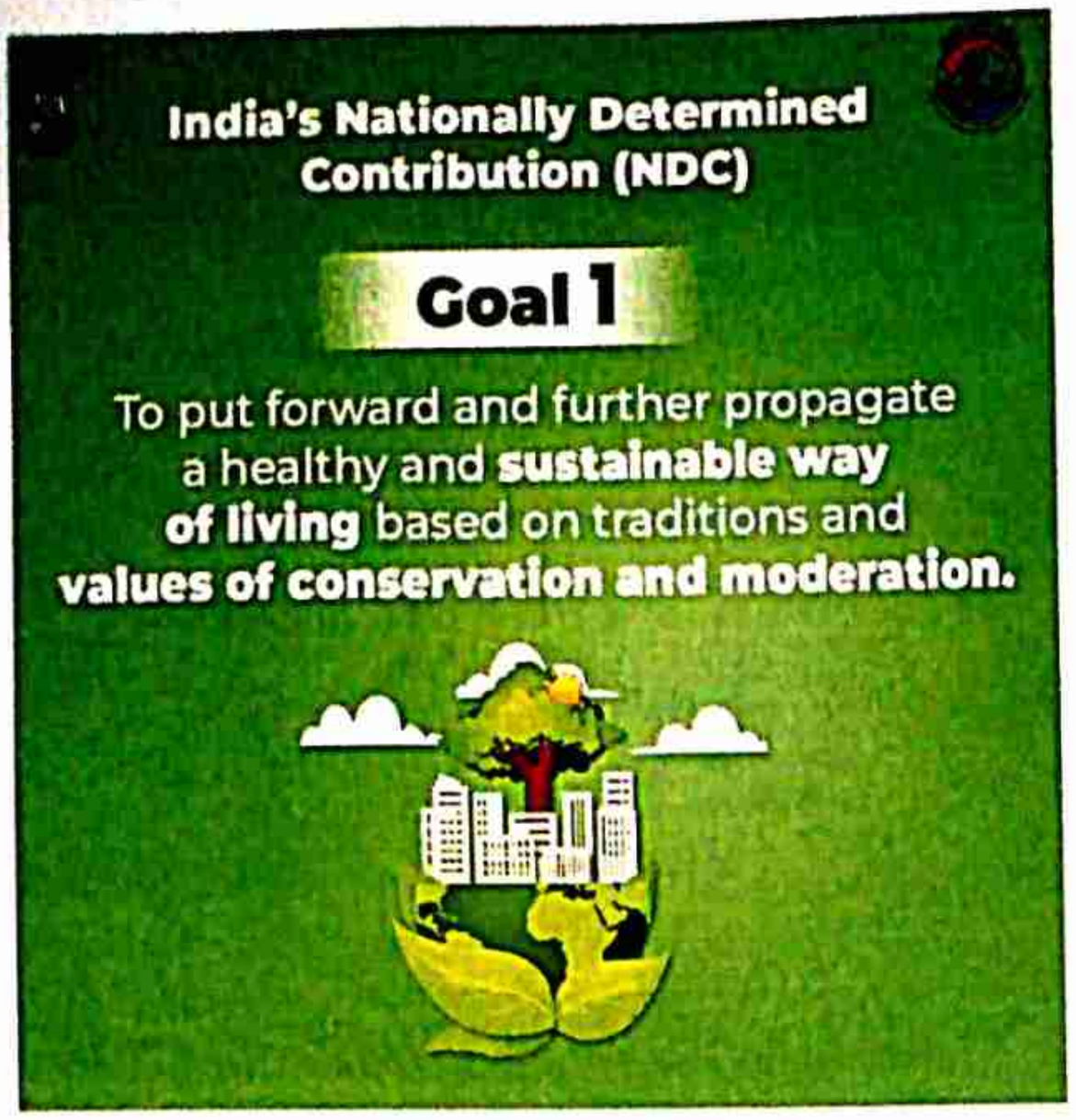
India's achievements against the NDC targets

According to India's inaugural Nationally Determined Contribution (NDC) adopted in 2015, the nation aimed to decrease the emissions intensity of its GDP by 33 to 35 per cent by 2030 compared to 2005 levels and to attain approximately 40 per cent of cumulative electric power installed capacity from non-fossil fuel energy sources by 2030. These two objectives have been accomplished far in advance of the deadline. As of 31 May 2024, the total installed electric power capacity from non-fossil fuel energy sources represented 45.40 per cent of the total cumulative electric power installed capacity. The emission intensity of its GDP fell by 33 per cent from 2005 to 2019. In August 2022, India amended its NDC, elevating the goal for decreasing emissions intensity of its GDP to 45 per cent by 2030 from the 2005 baseline and augmenting the target for cumulative installed electric power capacity from non-fossil fuel energy sources to 50 per cent by 2030. India has achieved substantial advancements in solar power generation concerning climate change. By adding 15.03 GW in 2023-24, the total reached 82.64 GW by 30 April 2024. Numerous substantial initiatives focused on improving climate resilience, carbon sequestration, and sustainability were executed in the fiscal year 2023-2024.

PM Surya Ghar Yojana

The *PM Surya Ghar Yojana*, referred to as the *Muft Bijli Yojana*, was inaugurated by Prime Minister Narendra Modi on 13 February 2024, with a total budget of Rs 75,021 crore. The initiative intends to install rooftop solar panels on one crore residential homes throughout India to supply up to 300 units of complimentary electricity monthly. It also aims to decrease family electricity expenses while promoting sustainable energy practices by allowing them to produce and sell excess power back to the grid. Under this program, homeowners may obtain Central Financial Assistance (CFA) of up to 60 per cent of the cost for a 2kW solar installation and 40 per cent for systems up to 3kW, with a maximum limit of Rs 78,000. Furthermore, families can obtain collateral-free, low-interest loans to enhance the affordability of solar adoption. The program simplifies the installation procedure by offering an online application platform for families to register, choose authorised vendors, and acquire information regarding system sizes and expected savings. The initiative emphasises rural adoption by establishing model solar villages and incentivising local authorities, including *panchayats* and urban local bodies, to encourage solar installations. This effort aims to augment solar capacity by 30 GW, resulting in significant reductions in electricity expenses and advancing India's renewable energy objectives, which target 500 GW of renewable capacity by 2030. Moreover, this scheme is anticipated to generate over 1.7 million employment opportunities in the renewable energy sector.





Sovereign Green Bonds: Financing Climate Action

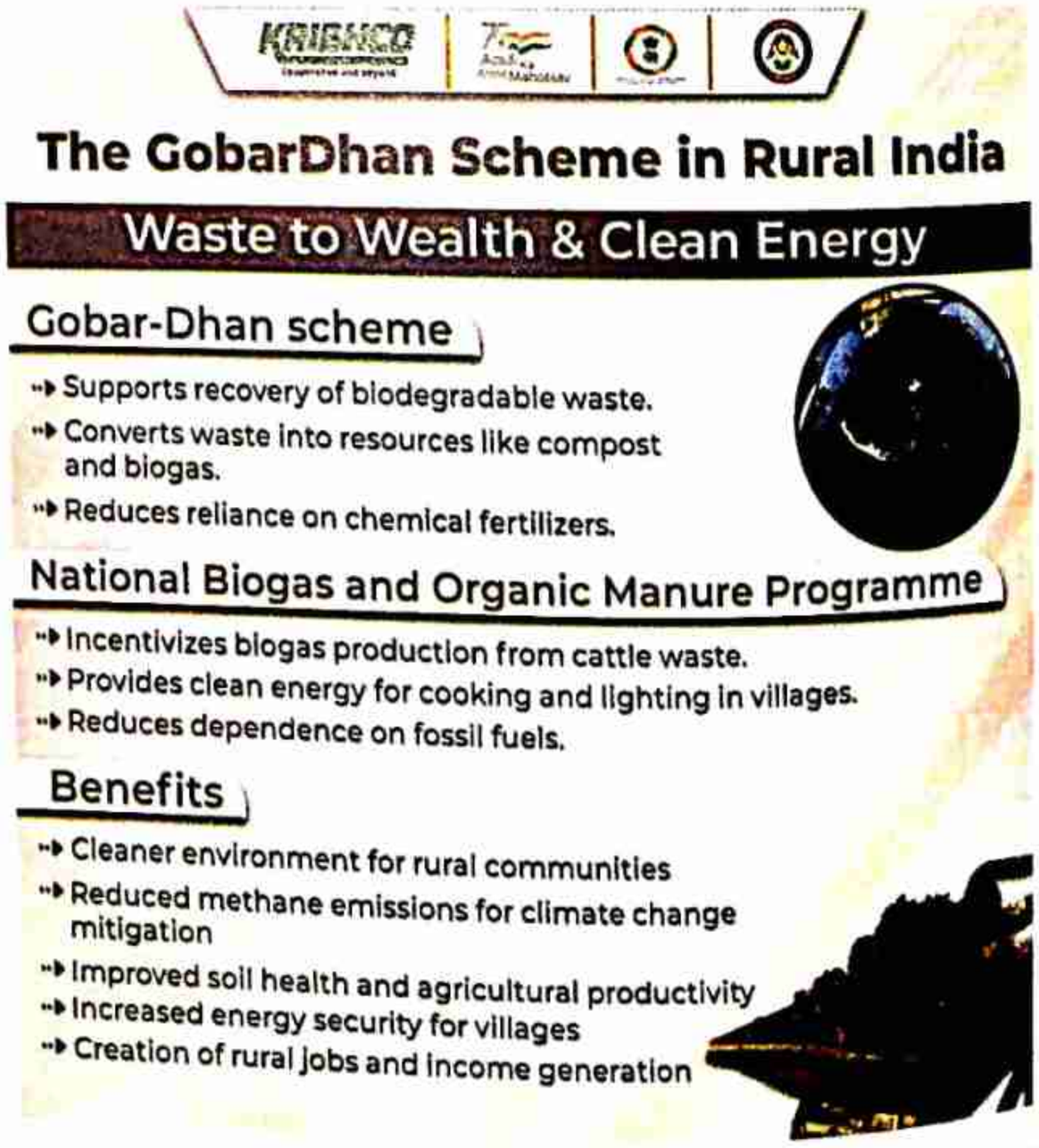
India made significant progress in funding ecologically sustainable activities by issuing sovereign green bonds. The government issues debt instruments termed 'green bonds' to generate capital for environmental enhancement projects. The proceeds from these bonds finance projects that facilitate India's transition to a low-carbon economy, encompassing clean transport, renewable energy, and climate adaptation. India secured Rs 8,000 crores in the initial batch of green bonds issued in 2024. To finance green infrastructure initiatives, an additional allocation of Rs 16,000 crores has been established, demonstrating the government's dedication to enhancing investments in climate resilience. The sovereign green bond framework delineates essential areas for financing, encompassing renewable energy (solar, wind, biomass), climate change adaptation, and pollution mitigation. India's adoption of green bonds serves as both a strategic financial initiative and an international indication of its adherence to obligations established at global climate conferences such as the Paris Agreement and COP26. The expansion of the global green finance industry is supported by India's introduction of sovereign bonds, thereby strengthening its reputation as a climate-conscious country. Nonetheless, obstacles such as increased risk perception and insufficient data concerning the returns on green bonds persist, requiring resolution for sustained success.

GOBARdhan Initiative: Cashing the cattle

The government's GOBARdhan (Galvanising Organic Bio-Agro Resources Dhan) scheme seeks to transform waste into wealth through the establishment of 500 new biogas facilities as announced in budget 2023-24. These facilities will largely convert cattle manure and other organic waste into biogas, a green energy source. This scheme corresponds with India's broader objective of attaining a circular economy and diminishing dependence on fossil resources. GOBARdhan bolsters the Swachh Bharat Mission by facilitating waste management in rural areas and creating economic opportunities through the commercialisation of bio-products and by-products, including organic manure and biofertilisers. This effort mitigates methane emissions from untreated organic waste, directly tackling greenhouse gas (GHG) emissions.

Critical Mineral Mission: Prioritising the minerals

India has launched an important mineral mission under its 2024–25 budget, targeting the enhancement of local production and recycling of essential minerals such as copper and lithium. These minerals are essential for industries such as defence, agriculture, energy, medicines, and telecommunications. Nonetheless, they encounter supply chain risks owing to their restricted availability and concentration in specific locales. The mission's importance is rooted in enhancing



domestic production and recycling, pinpointing essential minerals, diminishing import reliance, accelerating exploration, acquiring minerals from outside, optimising resource efficiency, recycling minerals, and discovering alternatives through appropriate research and development. The mission is to diminish India's reliance on imports and guarantee the domestic availability of certain minerals.

Mangrove Initiative for Shoreline Habitats & Tangible Incomes (MISHTI): Restoration for Climate Resilience

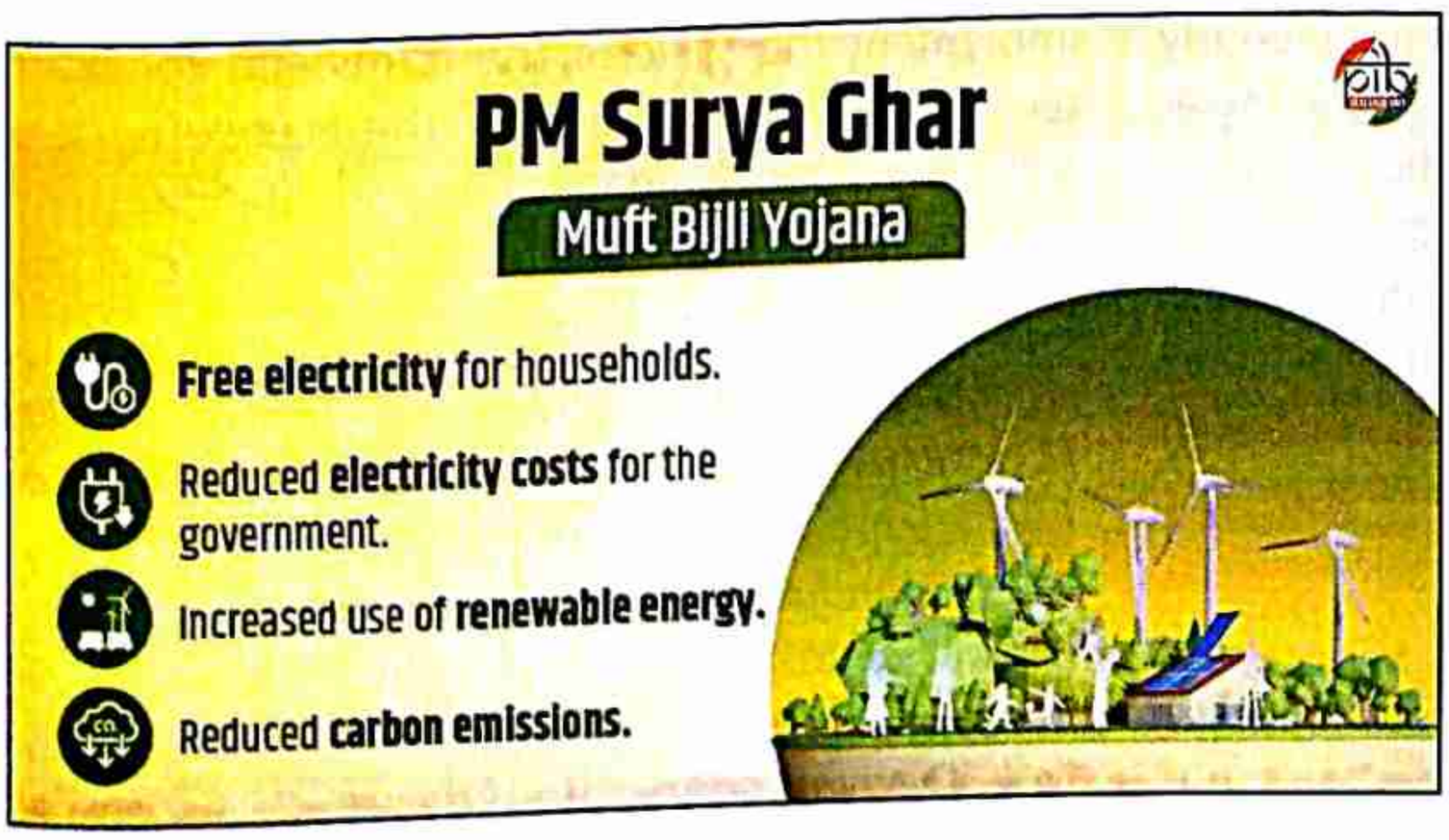
Launched in June 2023, the Mangrove Initiative for Shoreline Habitats & Tangible Incomes (MISHTI) is a comprehensive project designed to conserve and rehabilitate mangroves throughout India's coastal areas. Mangroves are essential in combating climate change by locking up carbon and serving as natural barriers against storms and elevated sea levels. MISHTI plans to restore and reforest mangroves over 540 km², which will span nine states and three union territories, over the course of five years, starting in 2023–2024. Besides its environmental advantages, MISHTI possesses a socio-economic aspect. The initiative seeks to improve the livelihood security of coastal people through the promotion of ecotourism, sustainable fisheries, and various mangrove-based industries. The government is promoting climate resilience and economic opportunity for at-risk groups by offering financial support for mangrove conservation. Mangroves are integral to India's climate plan. They possess significant productivity and carbon sequestration capabilities as natural carbon sinks. The initiative corresponds with India's objective to attaining land degradation neutrality and rehabilitating 26 million hectares of damaged land by 2030.

Amrit Dharohar: Climate combating through wetlands

The *Amrit Dharohar* plan was initiated in Union budget 2023-24 with the goal of maximising the utilisation of wetlands in order to improve the biodiversity of wetlands throughout the nation. The plan will be put into action over the course of the following three years, starting in 2023-24, to promote the best possible use of wetlands and improve biodiversity, carbon storage, ecotourism prospects, and local community revenue creation. *Amrit Dharohar* attempts to restore and safeguard wetlands, which are essential ecosystems for both carbon absorption and biodiversity, by promoting eco-tourism and establishing alternative livelihoods for local communities. Wetlands not only provide habitat for a diverse array of species, but they also enhance the quality of water by storing carbon. The program prioritises the sustainable utilisation of wetland resources and community involvement, thereby ensuring that ecological conservation is in harmony with socio-economic development.

Green Credit Program: Incentivising Afforestation

India's Green Credit Programme (GCP), initiated in 2023, demonstrates an innovative strategy to promote afforestation and reforestation efforts. The Environment Ministry issued revised recommendations for the GCP in April 2024. The new regulations emphasise ecosystem restoration via afforestation. This initiative promotes the planting of trees on degraded forestland by people, industries, and communities, thereby earning green credits for market exchange. These credits serve as a recompense for participation in environmental rehabilitation and enhancement of carbon sinks. This programme is integral to India's broader strategy to attain net-zero emissions by 2070. By facilitating the generation of green credits, the government is both rehabilitating degraded ecosystems and offering economic incentives for enterprises to engage in climate action. The programme seeks to advance afforestation extensively, with the objective of increasing



DID YOU KNOW

Zero Emissions Day is a global initiative held annually on 21st September, aimed at giving the Earth a break by eliminating carbon emissions for one day. It raises awareness about the environmental impact of carbon **emissions and encourages Individuals** to adopt more sustainable choices.

India Presented Panchamrit on India's climate action in glass go!

forest coverage and mitigating carbon emissions. The National Afforestation Program (NAP) and the Compensatory Afforestation Fund Management and Planning Authority (CAMPA) are further initiatives that enhance the GCP. These programs emphasise the rehabilitation of degraded forest regions through community involvement and decentralised governance. Compensatory afforestation under CAMPA has been a fundamental element of India's afforestation strategy, mandating that enterprises engage in plantation efforts to mitigate their environmental impact.

Solar Park Scheme

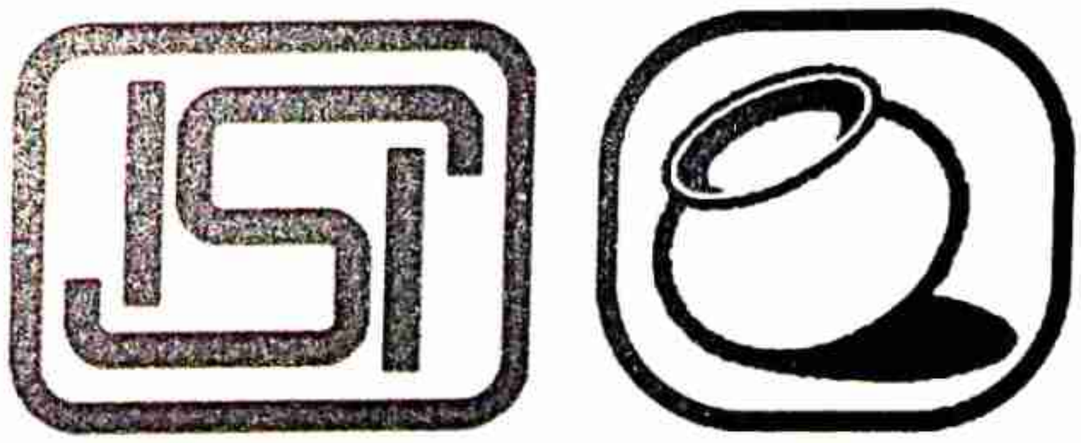
Initially launched in 2014, the Solar Park Scheme has been extended through FY 2025-26. This plan aims to create extensive solar parks nationwide, helping India achieve its ambitious goal of 500 GW of non-fossil fuel electricity by 2030. The scheme encourages the development of renewable energy infrastructure by governments, simultaneously attracting private sector participation in solar energy projects. These parks facilitate the resolution of challenges associated with land acquisition and infrastructure construction, offering an optimum site for solar power generation. The scheme's extension shows the government's sustained dedication to the spread of renewable energy.

ECO Mark Scheme

On 26 September 2024, the Ministry of Environment, Forests, and Climate Change published the Ecomark Rules 2024. The 1991 Ecomark scheme is replaced by the new regulations. The Government of India introduced the Ecomark Scheme to label environmentally beneficial items. The scheme is being managed by the Bureau of Indian Standards (BIS) and covers a range of product categories, including soaps and detergents, paints, food items, lubricating oils, packaging materials, architectural paints, powder coatings, batteries, electrical and electronic goods, food additives, wood substitutes, cosmetics, aerosols and propellants, plastic products, textiles, fire extinguishers, leather, and coir products. The inclusion of the ECO emblem in conjunction with the ISI mark on a product signifies that the product complies with specific environmental standards as well as the quality criteria outlined in the applicable Indian Standard. BIS is accountable for the following functions in the execution of the scheme: Renewal, Suspension and Cancellation of the Licence and Undertaking Inspections and taking samples for analysis of any material or substance in relation to which the ECO Mark has been used.

The combination of ISI Mark and ECO Logo is as given below:

BIS adopted additional standards for the ECO Mark into the relevant Indian Standards to



ECO Mark Logo

implement the system. The terms and conditions regulating the operation of the licence must be subject to the Bureau of Indian Standards Act, together with the associated Rules and Regulations established thereunder.

Param Rudra Super Computers- Prime Minister Narendra Modi launched the *Param Rudra* Supercomputing System on 26 September 2024, signifying a major achievement in India's pursuit of technical progress and self-sufficiency. The cutting-edge facility, created by the Centre for Development of Advanced Computing

(C-DAC), significantly enhances the nation's high-performance computing capacity. *Param Rudra*, named after the mighty avatar of Lord *Shiva*, is engineered to address complex computational issues in diverse scientific and engineering fields. Three *Param Rudra* supercomputers have been created at a cost of Rs 130 crores, domestically under the National Supercomputing Mission. "Every area, including economics, corporate operations, crisis management, and quality of life, is fundamentally reliant on technology and computational capabilities," the Prime Minister stated. "This sector is the cornerstone of India's success in Industry 4.0." He stated that India is developing its own semiconductor ecosystem, which would be a crucial component of the global supply chain. He also launched '*Arka*' and '*Arunika*', a High-Performance Computing (HPC) system designed for meteorological and climatic research, and engaged with the scientists and researchers responsible for the infrastructure's creation.

National Clean Air Programme (NCAP): Despite being separate concerns, air pollution and climate change are strongly interconnected. In January 2019, the Government of India initiated the National Clean Air Program (NCAP) to combat increasing air pollution, especially in urban regions. The initiative aims to decrease particulate matter (PM10 and PM2.5) levels by 20-30 per cent by 2024, concentrating on 132 cities designated as non-attainment areas under the National Ambient Air Quality Standards (NAAQS). NCAP utilises city-specific strategies to advocate for sustainable energy initiatives, regulate automobile emissions, and monitor industrial pollutants. By reducing air pollution, NCAP indirectly aids in climate mitigation, as numerous air contaminants function as short-lived climate forcers that exacerbate global warming.

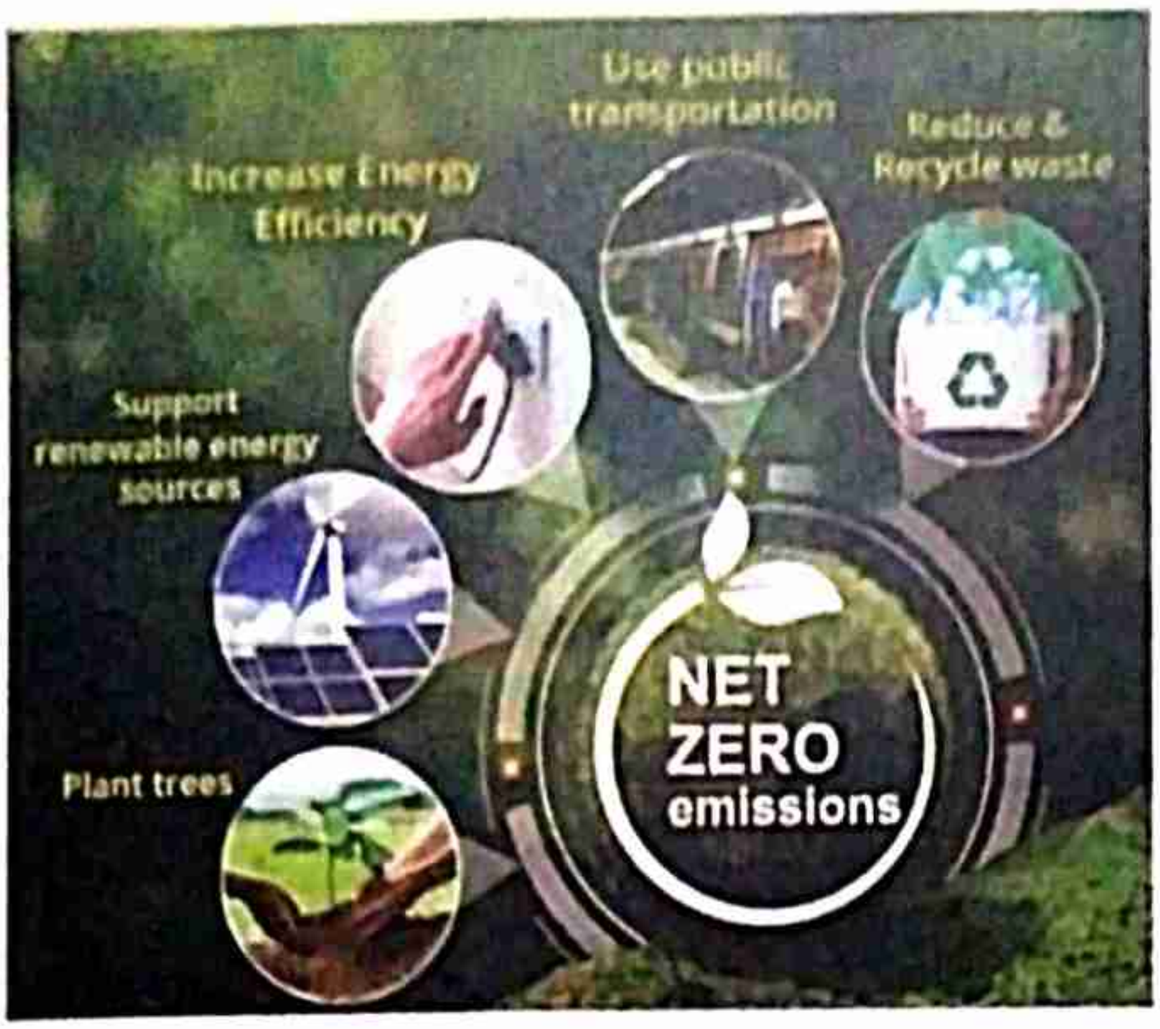
National Action Plan on Climate Change (NAPCC): A Holistic Approach: The National Action Plan on Climate Change (NAPCC), launched in 2008, continues to be India's fundamental approach for addressing climate change, which is seriously being pursued by the current central government also. In the last ten years, the plan has developed, including multiple objectives that target areas including energy, water, agriculture, and urban development. The NAPCC seeks to advance mitigation and adaptation measures to diminish the susceptibility of communities and ecosystems to climate change.

Key missions under NAPCC include:

- **National Solar Mission**: Promotes solar energy development with a target of achieving 100 GW of solar power by 2022.
- **National Water Mission**: Focuses on water conservation, management, and the efficient use of water resources, recognising that water scarcity will be exacerbated by climate change.
- **National Mission for Sustainable Agriculture (NMSA)**: Seeks to make agriculture resilient to climate change by promoting adaptive techniques such as water-efficient irrigation, crop diversification, and soil management practices.
- **Green India Mission**: Aims at afforestation and eco-restoration, enhancing carbon sequestration potential in forests and non-forest areas.

The NAPCC stresses urban adaptation through the National Mission on Sustainable Habitat and advances research through the National Mission on Strategic Knowledge for Climate Change. These missions are essential for establishing a climate-resilient economy and ensuring sustainable growth.

Energy Conservation (Amendment) Bill, 2022: Decarbonising the Economy- The Energy Conservation (Amendment) Bill, 2022, passed in December 2022, represents India's legislative thrust toward energy efficiency and decarbonisation. This amendment to the Energy Conservation Act, 2001, mandates the use of non-fossil fuel energy



sources, which is critical for accelerating India's shift to renewable energy. A notable feature of the amendment is the introduction of a carbon credit trading scheme, allowing industries to trade carbon credit certificates. This system encourages businesses to adopt low-carbon practices by providing economic incentives. Industries can earn carbon credits by reducing emissions below set thresholds, and these credits can be sold to companies that exceed their emission limits. India's Nationally Determined Contributions (NDCs) under the Paris Agreement highlight the importance of reducing carbon intensity, and this bill is an essential tool in achieving those targets. By promoting non-fossil fuel energy and creating a carbon trading market, the bill ensures faster decarbonisation of the economy while supporting the country's renewable energy goals.

India's Long-Term Strategy for Net-Zero by 2070: At COP27 (27th Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) held at Sharm El-Sheikh, Egypt), India submitted its Long-Term Low Emission Development Strategy (LT-LEDS), which outlines the country's roadmap to achieving net-zero emissions by 2070. The strategy emphasises the principles of equity and climate justice, recognising the differential responsibilities of developed and developing nations in tackling climate change.

India's LT-LEDS involves key strategic transitions such as:

- Low-carbon development of electricity systems.
- Efficient, inclusive low-carbon transport systems.
- Urban adaptation and sustainable urbanisation.
- Enhancing forest and vegetation cover.
- CO_2 removal technologies.

The strategy reflects India's holistic approach to climate action, balancing economic growth with the need for environmental sustainability.

Conclusion

The climate change measures that India has undertaken are reflective of a comprehensive multi-sectoral approach that aims to reduce carbon emissions and build infrastructure for resilience. The programmes and schemes, which include financial instruments such as green bonds and afforestation initiatives, are essential to the accomplishment of India's ambitious climate goals, which include the country's goal of reaching net-zero emissions by the year 2070. The success of these efforts will be contingent on their successful implementation, the participation of the community, and the collaboration of international organisations as they continue to develop. The leadership that India has demonstrated in the global climate conversation demonstrates its dedication to sustainable development. These programs will serve as the basis for a future that is both more environmentally friendly and environmentally resilient. The climate policies that India is implemening for the years 2023 and 2024 represent substantial steps towards ecological restoration and sustainability. The government is taking measures to ensure that economic development is not sought at the expense of environmental deterioration through the implementation of programs such as the Green Credit Programme, GOBARdhan, and MISHTI. A holistic approach to climate resilience that encompasses carbon markets, renewable energy, and nature-based solutions is reflected in these programs, which are aimed to incorporate both private and governmental players. As India continues on its road towards a more sustainable climate, these programs are essential in achieving a balance between economic growth and environmental care and achieving the ambitious goal of *Viksit Bharat*@2047. ❑

(Views are personal)

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Milestones & Initiatives in Science & Technology

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In recent years, India has witnessed significant advancements in science and technology, marked by important developments and milestones that aim to propel the nation into a new era of innovation. The Anusandhan National Research Foundation has been created to enhance research and development while cultivating a culture of innovation in India's academic and research institutions. In a significant advancement for India's National Quantum Mission, the central government has announced the establishment of Thematic Hubs at premier institutions to propel quantum research and innovation, on 30 September 2024. The Council of Scientific and Industrial Research has announced a significant milestone in its innovative longitudinal health monitoring initiative, the 'Phenome India-CSIR Health Cohort Knowledgebase'. As these initiatives unfold, they promise to create a vibrant ecosystem for research, development, and entrepreneurship in India.

The establishment of the Anusandhan National Research Foundation (ANRF) underscores the commitment to enhancing research capabilities across various disciplines. The launch of the PARAM Rudra Supercomputer enhances computational power for scientific research, while BharatGen stands out as India's groundbreaking multimodal AI initiative.

Efforts like the Thematic Hubs to drive the National Quantum Mission and the *Vigyan Dhara* initiative further illustrate the country's strategic focus on cutting-edge technologies. Additionally, initiatives such as the Women in Space Leadership

Program and the *Rashtriya Vigyan Puraskar* promote diversity and excellence in STEM fields.

Collaborative efforts like the partnership between ISRO and DBT, the Bio-RIDE Scheme, and the BioE3 Policy demonstrate a holistic approach to biotechnology and innovation. With CSIR's recent MOUs for innovative research and the ambitious 'Phenome India' project, these initiatives collectively pave the way for a robust scientific ecosystem in India.

PM Chairs Inaugural Meeting of Anusandhan National Research Foundation: A Milestone for India's Science and Technology

Prime Minister Narendra Modi chaired the inaugural meeting of the Governing Body of the newly formed Anusandhan National Research Foundation (ANRF) on 10 September 2024, marking a significant milestone in India's scientific and technological landscape. The meeting focused on discussions aimed at redesigning research and development programs to foster innovation and address pressing challenges in the country.

During the meeting, Prime Minister Modi stated, "Today a new beginning has been made with the first meeting of the Governing Body of the Anusandhan National Research Foundation." He emphasised the necessity to identify and eliminate obstacles within the research ecosystem, urging the need for setting ambitious targets and pursuing

अनुसंधान नेशनल रिसर्च फाउंडेशन
Anusandhan National Research Foundation

Groundbreaking PAIR initiative launched in alignment with National Education Policy (NEP) 2020

- **Designed to cultivate research excellence across Indian universities by fostering collaborations with top-tier institutions**
- **Partnership through mentorship-driven hub and spoke framework to facilitate systematic research growth across institutions**
- **This will bridge the gap between institutions & nurture a robust research ecosystem in India**

groundbreaking research. "Research should focus on finding new solutions to existing problems," he noted, stressing that while problems may be global, their solutions must be localised to meet Indian needs.

The Prime Minister also highlighted the importance of upgrading and standardising institutions, suggesting the preparation of a list of domain experts based on their expertise. He proposed the development of a dashboard to easily track research and development activities across the country. "There should be scientific monitoring of the utilisation of resources for research and innovation," he added, reinforcing his commitment that there will be no lack of resources for the scientific community's endeavours.

In discussing the positive impacts of Atal Tinkering Labs, the Prime Minister recommended a grading system for these labs. He also explored research opportunities in various fields, including solutions for environmental change, battery materials for electric vehicles (EVs), and lab-grown diamonds.

The Governing Body decided to launch a mentorship program pairing universities at the nascent stage of research with top-tier established institutions. This initiative aims to enhance collaborative efforts and bolster research capabilities across the nation.

PARAM Rudra Supercomputer

The Anusandhan National Research Foundation (ANRF) has been created to enhance research and development while cultivating a culture of innovation in India's academic and research institutions. Established through the ANRF Act of 2023, this initiative represents a significant advancement in the nation's research landscape, aiming to foster collaboration among universities, colleges, and laboratories. With its ambitious objective to support both basic research and prototype development, the ANRF will provide high-level strategic direction for scientific endeavours. It also aims to facilitate the start-up ecosystem and foster collaborations with industry, academia, government departments, and research institutions, creating a dynamic interface for participation from industries and state governments.

The ANRF focuses on solution-oriented research in priority areas such as electric vehicle mobility, advanced materials, solar cells, smart infrastructure, health & medical technology, sustainable agriculture, and photonics, which will significantly support India's journey toward Aatmanirbhar Bharat. The ANRF is backed by a significant funding commitment, with an estimated budget of Rs 50,000 crore allocated for the period from 2023 to 2028.

Missions on Early Career Research Grant and Electric Vehicle launched under the Anusandhan National Research Foundation (ANRF)

The Anusandhan National Research Foundation (ANRF) has launched its first two initiatives: the Prime Minister Early Career Research Grant (PMECRG) and the Mission for Advancement in High-Impact Areas—Electric Vehicle (MAHA-EV) Mission on 14 October 2024.

The PMECRG aims to attract early-career researchers to contribute to India's scientific excellence and innovation, offering a flexible budget to facilitate high-quality research and technological advancement. It is designed to foster innovative projects that will help position India as a global leader in science and technology.

The MAHA-EV Mission focuses on developing critical Electric Vehicle (EV) technologies, including battery cells, power electronics, and charging infrastructure. This initiative aims to reduce dependency on imports while promoting domestic innovation, thereby establishing India as a global leader in the EV sector.

By concentrating on essential EV components and fostering multi-disciplinary collaborations, the MAHA-EV Mission supports the government's Atmanirbhar Bharat vision, aiming to accelerate technological advancements that are vital for India's future growth and sustainability. Together, these initiatives represent a significant step forward in strengthening India's research ecosystem and driving a greener future.

PARAM Rudra Supercomputer: A Game Changer for Research in Eastern India

The inauguration of the PARAM Rudra supercomputer at the SN Bose National Centre for Basic Sciences (SNBNCBS) in Kolkata was conducted virtually by the Prime Minister on 26 September 2024. It brings high-performance computing capabilities to Eastern India, benefiting around 10-12 institutions and thousands of researchers in the region.

Developed under the National Supercomputing Mission (NSM) and supported by the Ministry of

Electronics and IT (MeitY) and the Department of Science and Technology (DST), the PARAM Rudra series, which includes installations in Pune and Delhi, aims to revolutionise research in fields such as advanced materials, high-energy physics, earth sciences, and cosmology.

The PARAM Rudra supercomputer will enable scientists to perform complex calculations and simulations more rapidly, significantly reducing the time required to address intricate scientific challenges. In materials science, it will enhance high-throughput computational material design, facilitating the discovery of new materials. In earth sciences, it will support computational modelling of planetary materials, integrating first-principles calculations with laser-heated diamond anvil cell experiments.

Additionally, the supercomputer will aid biological sciences by leveraging machine learning to study biomolecular functions, thereby advancing disease understanding and treatment development. In chemical science, it will explore the electronic structure of molecules to improve our understanding of chemical reactivity.

Crucially, the PARAM Rudra will bolster high-energy astrophysics research, providing insights into the fundamental properties of matter and the universe, including studies on dense matter as explored in CERN's ALICE experiment.

BharatGen: India's Groundbreaking Multimodal AI Initiative

The BharatGen initiative, a pioneering project in generative AI aimed at transforming public service delivery and enhancing citizen engagement, was inaugurated by the Union Minister of State (Independent Charge) for Science and Technology, Dr Jitendra Singh on 30 September 2024. This first-of-its-kind government-supported multimodal large language model project focuses on developing foundational models in language, speech, and computer vision, all tailored to Indian languages.

Led by IIT Bombay under the National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS) of the Department of Science and Technology (DST), BharatGen will create AI systems capable of generating high-quality text and multimodal content, prioritising India's rich socio-cultural and linguistic diversity. Collaborating with premier institutes, the project aims to make AI accessible across government, private, educational, and research sectors.

BharatGen's unique features include its multilingual and multimodal foundation, a focus on India-centric datasets, an open-source platform, and a commitment to fostering a vibrant AI research community. The initiative will particularly address the needs of languages that are often under-represented in global AI models, enhancing data sovereignty and cultural preservation.

Aligned with the vision of Atmanirbhar Bharat, BharatGen aims to reduce reliance on foreign technologies by developing domestic AI capabilities, allowing innovators and startups to build applications affordably and efficiently. The roadmap for BharatGen includes key milestones leading to July 2026, focusing on extensive AI model development and scaling AI adoption across various sectors.

BharatGen - Make AI in India, Make AI for India

BharatGen, the world's first government-funded multimodal large language model, exemplifies India's commitment to advancing homegrown AI technologies. This initiative focuses on creating efficient, inclusive AI solutions in Indian languages, emphasising social equity and accessibility. By prioritising open-source foundational models, BharatGen aims to democratise AI, fostering collaboration among researchers and developers. This project aligns with the vision of Atmanirbhar Bharat, positioning India as a global leader in generative AI while ensuring that diverse cultural needs are met. BharatGen is a transformative step

Women in Space Leadership Programme

toward leveraging AI for public welfare and national development.

Thematic Hubs to Drive National Quantum Mission

In a significant advancement for India's National Quantum Mission (NQM), the central government has announced the establishment of Thematic Hubs (T-Hubs) at premier institutions to propel quantum research and innovation, on 30 September 2024. These T-Hubs will position India at the forefront of the global quantum technology landscape, enhancing its leadership in areas such as quantum computing, communication, sensing, and materials.

The four T-Hubs will be located at the Indian Institute of Science (IISc) Bengaluru, IIT Madras (in collaboration with the Centre for Development of Telematics, New Delhi), IIT Bombay, and IIT Delhi, comprising 14 specialised Technical Groups. Selected through a rigorous competitive process, these hubs will focus on key quantum verticals, including Quantum Computing, Quantum Communication, Quantum Sensing & Metrology, and Quantum Materials & Devices.

The NQM initiated a 'Call for Proposals' in January 2024, receiving an overwhelming 384 submissions from across India. After a thorough evaluation, 17 proposals were selected, showcasing the nation's ambition in quantum research, with contributions from 152 researchers across 43 institutions.

Operating under a Hub-Spoke-Spike model, the T-Hubs will foster collaboration among research projects and individual groups, enhancing coordination and resource sharing. The NQM aims to empower institutions and startups with funding, infrastructure, and a collaborative environment, facilitating crucial national and international partnerships. This initiative is poised to ensure sustained growth in quantum technology development, solidifying India's leadership in this transformative field.

Unified Central Sector Scheme Vigyan Dhara

The Union Cabinet approved the continuation of three umbrella schemes, merging them into a unified central sector scheme known as *'Vigyan Dhara'* under the Department of Science and Technology (DST).

Vigyan Dhara integrates three key initiatives: (i) Science and Technology (S&T) Institutional and Human Capacity Building; (ii) Research and Development; and (iii) Innovation, Technology Development, and Deployment. This integration aims to create a cohesive framework for advancing scientific research and innovation across various sectors.

The proposed outlay for implementing the unified scheme *Vigyan Dhara* is Rs 10,579.84 crore during the 15th Finance Commission period from 2021-22 to 2025-26. Merging the schemes into a single framework will enhance efficiency in fund utilisation and establish synchronisation among the sub-schemes and programs.

All programs proposed under the *'Vigyan Dhara'* scheme will align with the 5-year goals of DST towards realising the vision of *Viksit Bharat* 2047. The research and development component of the scheme will be aligned with the Anusandhan National Research Foundation (ANRF).

Women in Space Leadership Programme to Empower Future Leaders

The Department of Science and Technology (DST), in collaboration with the British Council, launched the Women in Space Leadership Programme (WiSLP) on 24 September 2024, as part of the UK-India Education and Research Initiative (UKIERI). This initiative aims to strengthen gender-inclusive practices and foster women's leadership in space sciences through the development of a strategic leadership framework, with Coventry University serving as the delivery partner.

The WiSLP represents a significant step toward creating a more inclusive environment in the field of space sciences. By establishing a robust leadership framework, the program seeks to empower women to make meaningful contributions to scientific research and innovation.

Targeting 250 early-career researchers, the programme will equip participants with the necessary tools to navigate gender biases and build a sustainable support network. It will focus on creating mentoring networks and enhancing scientific innovation by incorporating a gender perspective into key areas such as astrophysics and telecommunications.

Through this initiative, the aim is to not only boost women's participation in space sciences but also to drive significant advancements in the field by ensuring diverse perspectives are included in research and innovation.

Rashtriya Vigyan Puraskar to Celebrate Scientific Excellence

Ministry of Science & Technology, Government of India, has introduced the *Rashtriya Vigyan Puraskar* (RVP), a new set of prestigious national awards aimed at recognising exceptional contributions in science, technology, and innovation. The awards were presented by President Smt Droupadi Murmu during a ceremony at Gantantra Mandap, Rashtrapati Bhavan, on 22 August 2024.

Govindarajan Padmanabhan awarded with the Vigyan Ratna Award 2024 by President Smt. Droupadi Murmu

The RVP honours scientists, technologists, and innovators from both the public and private sectors, including individuals of Indian origin living abroad. Awards are conferred in four categories:

Vigyan Ratna: Recognising lifetime achievements, this award was given to Prof Govindarajan Padmanabhan, a pioneer in molecular biology and biotechnology.

Vigyan Shri: Thirteen scientists received this award for their distinguished contributions across various scientific fields.

Vigyan Yuva-Shanti Swarup Bhatnagar: Eighteen young scientists were honoured for exceptional contributions, including research on the Indian Ocean's warming and the development of indigenous 5G technology.

Vigyan Team: This award was presented to the ISRO's team behind *Chandrayaan-3* for their successful landing of the lunar mission near the moon's south pole.

The *Rashtriya Vigyan Puraskar* aims to highlight path-breaking research and innovations that have a significant societal impact. The nominations for this bouquet of awards will be invited every year on January 14, remaining open until 28 February (National Science Day). These awards will be announced on May 11 (National Technology Day) each year. The award ceremony for all categories of awards will be held on August 23 (National Space Day).

With a focus on transparency and inclusivity, the initiative seeks to elevate the status of scientific achievements in India, ensuring representation across various domains and fostering future innovation.

ISRO-DBT MoU to propel India into a new era of Space and Biotechnology

ISRO and DBT Forge Groundbreaking Partnership to Advance Space Biotechnology

In a landmark agreement, the Indian Space Research Organisation (ISRO) and the Department of Biotechnology (DBT) signed a Memorandum of Understanding (MoU) on 26 October 2024 that promises to revolutionise the intersection of biotechnology and space technology in India. This collaboration marks a significant shift from traditional laboratory settings, aiming to explore the vast potential of biotechnology in outer space. By merging these two fields, the MoU lays the foundation for innovative applications that extend beyond theoretical research.

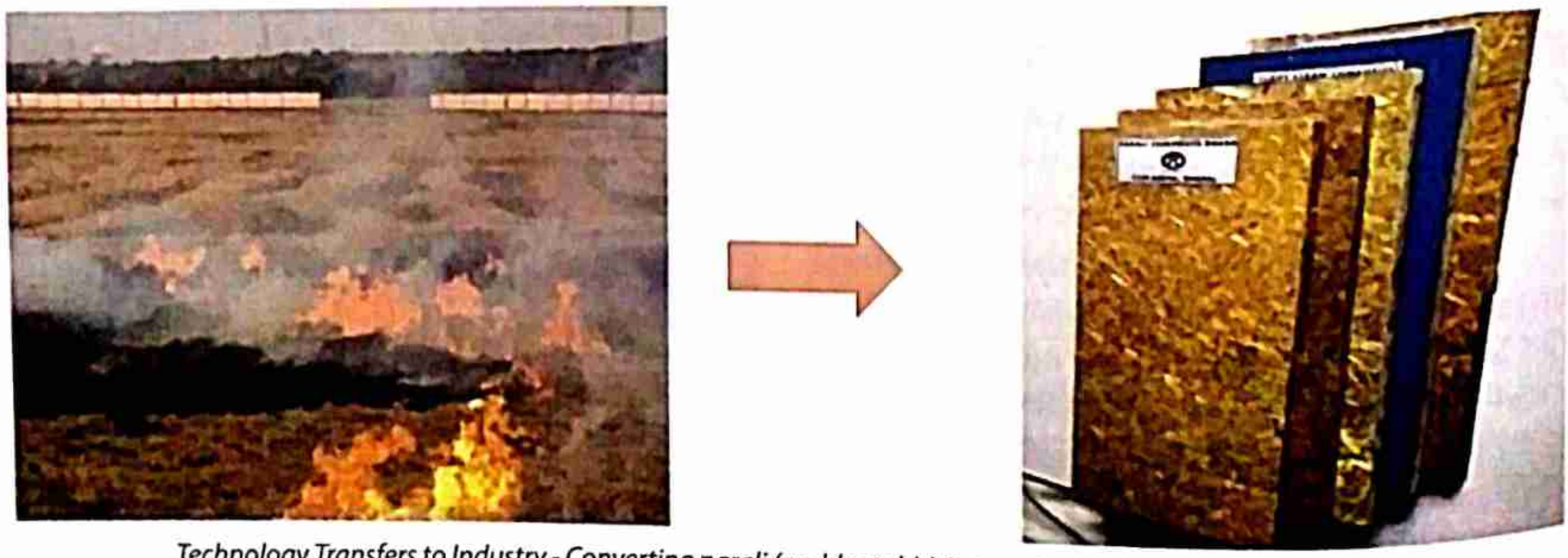
The agreement outlines several ambitious initiatives, including the establishment of a *Bharatiya Antariksh Station* and the introduction of the BioE3 (Biotechnology for Economy, Environment, and Employment) Policy. This policy seeks to promote high-performance biomanufacturing, targeting a $300 billion bioeconomy by 2030. Key focus areas of the partnership will include microgravity research, space biotechnology, bioastronautics, and space biology.

This collaboration is poised to enhance India's national human space program and drive breakthroughs in human health research, novel pharmaceuticals, and regenerative medicine. It also aims to foster bio-based technologies for efficient waste management and recycling. Additionally, this partnership will create opportunities for startups in both the space and biotechnology sectors to develop commercially viable solutions. Together, ISRO and DBT are set to redefine the future of science and technology in India, positioning the nation as a global leader in innovation.

Bio-RIDE Scheme to Propel Cutting-Edge Research and Development in Biotechnology

The Department of Biotechnology (DBT) has launched the 'Biotechnology Research Innovation and Entrepreneurship Development (Bio-RIDE)' scheme, incorporating a new component focused on Biomanufacturing and Biofoundry. The scheme encompasses three broad components: Biotechnology Research and Development (R&D), Industrial & Entrepreneurship Development (I&ED), and Biomanufacturing and Biofoundry.

Bio-RIDE is designed to foster innovation, promote bio-entrepreneurship, and strengthen India's position as a global leader in bio-manufacturing and biotechnology. Its objectives include accelerating research, enhancing product development, and bridging the gap between academic research and industrial applications. This initiative aligns with the Government of India's mission to harness bio-innovation to address



Technology Transfers to Industry - Converting parali (paddy stubble) straw into hybrid particleboard by CSIR.

Technology Transfers to Industry - Pilot Installation of Vegan Leather from Agriwaste by CSIR

national and global challenges in healthcare, agriculture, environmental sustainability, and clean energy.

By creating synergies between academic institutions, research organisations, and industry, Bio-RIDE aims to accelerate the commercialisation of bio-based products and technologies. The scheme will play a critical role in advancing scientific research, innovation, and technological development across diverse fields of biotechnology by providing extramural funding to research institutions, universities, and individual researchers. It will cover areas such as agriculture, healthcare, bioenergy, and environmental sustainability.

The DBT's ongoing efforts reflect its vision of utilising biotechnology as a precision tool for national development and societal well-being, aiming to make India globally competitive in biotechnology research, innovation, translation, entrepreneurship, and industrial growth, with a target of achieving a US$300 billion bioeconomy by 2030. The Bio-RIDE scheme will significantly contribute to realising the vision of *'Viksit Bharat* 2047.'

BioE3 Policy: A Catalyst for High-Performance Biomanufacturing in India

The Union Cabinet approved the BioE3 (Biotechnology for Economy, Environment and Employment) Policy on 24 August 2024, aimed at fostering high-performance biomanufacturing. This initiative, led by the Department of Biotechnology, seeks to drive innovation and support R&D and entrepreneurship across key sectors.

The BioE3 policy will establish Biomanufacturing & Bio-AI hubs and Biofoundries, promoting regenerative bioeconomy models of green growth. It aligns with national goals such as achieving a net-zero carbon economy and the Mission LiFE (Lifestyle for Environment). The BioE3 policy was formally released on 31 August 2024 by the Union Minister of State (Independent Charge) for Science and Technology .

Focusing on six thematic areas—bio-based chemicals, functional foods, precision bio-therapeutics, climate-resilient agriculture, carbon capture, and futuristic marine and space research—the policy aims to significantly impact sectors like food, energy, and health. India's rich biodiversity, including its vast coastline and unique resources from the Himalayas, positions the country well for this initiative.

The BioE3 Policy is expected to enhance job creation and expand the skilled workforce, steering India toward a sustainable and innovative future. By integrating advanced biotechnological processes, it will address national challenges and lay down a comprehensive bio-vision, fostering a circular bioeconomy and promoting green growth.

CSIR Signs MOUs for Innovative Technology Transfers to Industry Partners

The Council of Scientific and Industrial Research (CSIR) has announced the successful transfer of 22 cutting-edge technologies to various industry partners, marking a significant leap in technological innovation and collaboration. These transfers, formalised through Memorandums of Understanding (MoUs), encompass a diverse range of products and solutions aimed at enhancing sustainability, health, and efficiency across multiple sectors. These advancements reflect CSIR's commitment to driving innovation in key areas, contributing to the nation's economic growth and environmental sustainability. The following technologies have been launched and transferred to industries:

1. Handheld IoT-Enabled Field Deployable Water Testing Kit
2. Handheld Minimally Invasive Haemoglobin Measurement System
3. Development of Millet-Based Buns
4. Technology for Protein-Based High-Energy

Products

5. Integrated Technologies for Import Substitution of Quality Essential Oil (Geranium)
6. Herbal Health Soft Drink (Pio)
7. Electric Tiller
8. Compact Electric Tractor
9. Pilot Installation of Vegan Leather from Agriwaste
10. Microbial Consortium for Waste Management in Aquaculture Ponds
11. Portable & Universal Motor-cum-Pump Performance Monitor (PU-MPPM)
12. Modbus-based Energy Management System (EMS)
13. Anaerobic Gas Lift Reactor (AGR) for Biogas and Bio-Manure Production
14. Technology for Converting Diesel Genset to Dual-Fuel Mode
15. Upgrading Raw Biogas to Pipeline Quality Bio-Methane
16. Zeolite Technology for Gas Separation
17. Indigenous MWCNTs (Multi-Walled Carbon Nanotubes) Synthesis by CVD (Chemical Vapor Deposition) and Development of Flexible MWCNTs Paper
18. Novel Biomarkers for Detection of Breast Cancer Types, Grades, and Stages
19. Converting Pathogenic Biomedical Waste to Value-Added Soil Additives
20. Evergreen Hybrid Composites from Agri Wastes (PARALI)
21. Bamboo Composite as a Substitute for Teak Wood
22. Compostable Bio-resin Coating as an Alternative to Plastic Liners

CSIR's 'Phenome India' Project Surpasses 10,000 Sample Mark, Pioneering Precision Medicine in India

The Council of Scientific and Industrial Research (CSIR) has announced a significant milestone in its innovative longitudinal health monitoring initiative, the 'Phenome India-CSIR Health Cohort Knowledgebase' (PI-CheCK). This project marks India's first pan-India longitudinal study aimed at developing improved predictive models for cardio-metabolic diseases, such as diabetes, liver diseases, and cardiovascular conditions.

Despite India facing a substantial burden from cardio-metabolic diseases, the underlying causes for this high incidence remain unclear. The risk factors that are prevalent in Western populations may not directly apply to the Indian demographic. Therefore, the PI-CheCK project recognises that personalised risk assessment is essential; a one-size-fits-all approach is inadequate for the diverse Indian population.

Launched on 7 December 2023, the PI-CheCK initiative has successfully enrolled nearly 10,000 participants, surpassing its initial target. The participants, which include CSIR employees, pensioners, and their spouses from 17 states and 24 cities, have volunteered to provide comprehensive health data. This extensive data collection encompasses various parameters, including clinical questionnaires, lifestyle and dietary habits, anthropometric measurements, imaging/scanning data, and a wide array of biochemical and molecular information.

The project aims to analyse risk factors associated with non-communicable diseases and has set its sights on collecting 100,000 samples to redefine critical health parameters across the country. To facilitate this extensive data gathering, CSIR has developed a cost-effective Standard Operating Procedure (SOP) for sample collection, ensuring a streamlined and efficient process.

As the PI-CheCK project progresses, it promises to contribute significantly to the understanding of cardio-metabolic diseases in India, paving the way for a new era of precision medicine tailored to the unique health profiles of the Indian population.

As these initiatives unfold, they promise to create a vibrant ecosystem for research, development, and entrepreneurship in India. By fostering collaboration between academia and industry, investing in cutting-edge technologies, and empowering diverse talent, India is poised to navigate the complexities of modern science and technology. These concerted efforts not only aim to tackle pressing societal issues but also lay the groundwork for a more resilient and innovative future, ultimately contributing to the vision of a prosperous and sustainable *Viksit Bharat* by 2047. ❑