



# Catalysing sustainable development: the role of DST in attaining SDGs in India and the way forward

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Received: 27 May 2024 / Accepted: 23 January 2025 / Published online: 1 February 2025  
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## Abstract

Attainment of Sustainable Development Goals (SDGs) requires the interconnection of social, economic, and environmental factors for the establishment of an equitable, secure, and enduring surroundings for everyone. Among the developing economies, India has played a significant role and has an explicit influence on universal strides. Despite of several developmental barriers like large population, poverty, quality education, and weak socio-economic indicators, Indian Government has taken several transformative and determined initiatives for accomplishing the SDGs. According to the United Nations Sustainable Development Goals Index and Dashboards Report 2023, India attained a spillover score of 99.4, indicating the positive impact of Government strategies on execution of universal sustainability. This paper provides a comprehensive overview of the strategic steps taken by the Indian government towards a sustainable and resilient path for the achievement of SDGs. The paper also delivers an overview of Department of Science and Technology (DST) interventions for the achievement of SDG goals in India. The pivotal role of DST in achieving SDG through its diverse array of scientific programs and policies is outlined.

**Keywords** Sustainable development goals (SDGs) · Department of science and technology (DST) · Scientific programs · Scientific policies · Government of India · Sustainability

## Introduction

In most situations, *sustainability* refers to providing the requirements of the current generation without jeopardizing those of subsequent generations. Therefore, by following sustainable living practices, we contribute towards the reduction of pollution and preservation of vital resources such as water, food, and energy, thereby eventually fostering a positive influence on the environment (Maletič et al. 2014; Hassan and Lee 2015; Feinstein and Kirchgasser 2015). In response to mounting concerns about the environmental damages caused by current development patterns, the concept of “sustainability” was initially introduced as a paradigm to measure development with the adoption of “Transforming Our World: the 2030 Agenda for Development” by the United Nations (UN) General Assembly on September 25, 2015 (Brolan 2016). The General Assembly passed a

resolution outlining the goals of global development after 2015. The plan of action was designed for the next fifteen years to enhance universal peace within a framework of improved freedom, well-being of people, sustainability of the planet, and the advancement of prosperity. In this resolution, everyone was committed to putting an end to poverty in all of its forms, as well as restoring and protecting our planet by tapping the suggested sustainable development plans into practice (Hajian and Kashani 2021). The resolution states that all countries, irrespective of the economy, were bound to achieve these objectives as a top priority. However, in different national contexts, the challenges may differ in terms of complexity and type.

There is a detailed set of 17 objectives that are further refined to 169 targets within the SDG framework. The development and sustainability of ecosystems are addressed by apiece objective, which is meticulously designed to cover economic, social, and environmental concerns. Everyone has the supremacy to think about and execute plans to drastically reduce social inequality within a generation (Allen et al. 2019). In contrast to traditional development goals, which focus on a small number of categories, the SDGs provide an evaluation of progress that is both holistic

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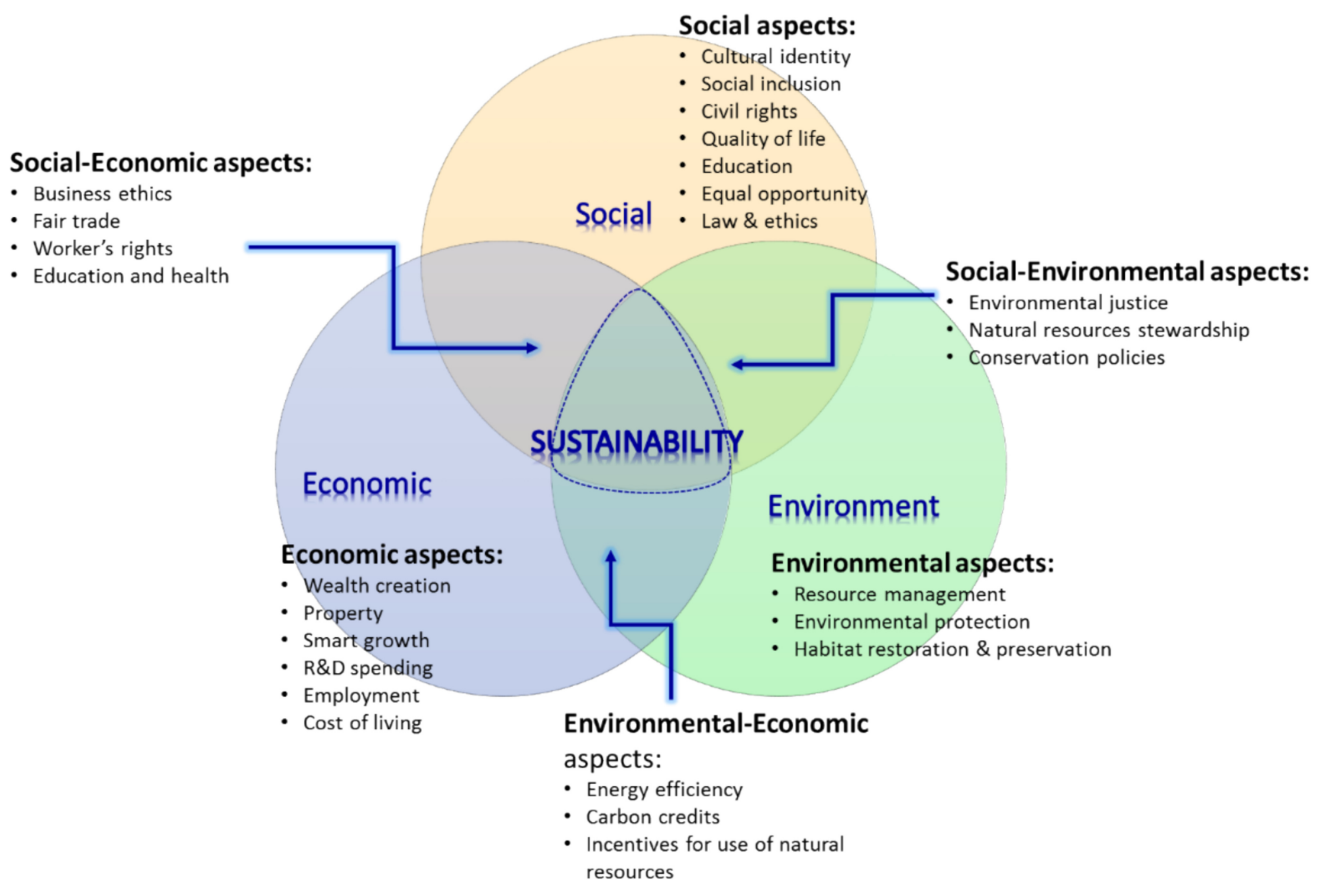
and multi-dimensional. To emphasize a safe and sustainable world, development endeavours must strike a balance among the three pillars of sustainability: economic, society, and the environment (Purvis et al. 2019). Consequently, to tackle both existing and future global difficulties, it is vital to adhere to the three pillars of sustainability, as shown in Fig. 1. There is a strong relationship between these three pillars. The livelihood circumstances of the populace are made feasible by the combination of environmental and economic considerations. However, social and environmental factors make existing conditions more acceptable. While social and economic factors work together to ensure an impartial chance for a decent life for dwellers. Therefore, integrating and intersecting these three components is necessary for sustainable living circumstances (Hariram et al. 2023).

To reach the global objective, each person must collaborate, and these principles reflect the ethical belief that no one should be excluded (Muff et al. 2020). The implementation of SDGs for the attainment of sustainability, is particularly important, thereby, supposed to be accepted and evaluated by people worldwide. For a country like India, as the most populous country with one-sixth of the world's population,

plays a significant responsibility in addressing the sustainable development challenges (Banik 2022). In this present article, we delve into the role of various programs initiated by the Government of India in line with the attainment of SDGs within the nation. Substantial function that the DST plays in addressing sustainability through its various programs and projects has been outlined.

## Genesis and adoption of sustainable development goals

In the 1990s, conferences held by the UN served as the fertile ground for the development of the eight Millennium Development Goals (MDGs), which were a set of objectives for communal improvement from the years 2000 to 2015 (Lomazzi et al. 2014). In terms of social development, the majority of the MDGs were achieved, including access to clean water and sanitary facilities and eliminating infectious diseases like malaria, HIV/AIDS, and tuberculosis. Miserably, they were insufficient to address the issues brought on by climate change (Fehling et al. 2013). As a result, the



**Fig. 1** The three dimensions of sustainability and their interdependence. Source: The authors, based on the information on <https://www.economiesuisse.ch/en/dossier-politics/sustainable-development-includes-several-dimensions>



goals were expanded to encompass sustainable development, which in turn gave birth to the concept of sustainability. The development of the MDGs followed a top-down approach, with international organizations providing consultations throughout the indicator selection process. In contrast, the SDG were crafted through a bottom-up process, where citizens and members of civil society actively involved in defining the goals and indicators (Fukuda-Parr 2016). Inequality, unsustainable consumption habits, inadequate institutional capacity, and environmental degradation are some of the important structural hurdles to sustainable development that the inclusive SDG framework tackles and these issues were not addressed by the MDGs.

## SDG framework

With great consideration, the SDG indicator and monitoring framework keeps tabs on the unified problems and makes it easier to adopt integrated system-based strategies. A thorough narrative explaining how these objectives

will lead to larger results for people and the world will greatly enhance the SDG framework. The new development aspects of “people, planet, prosperity, peace, and partnership” (the “5 Ps”) are included into the SDGs (Urata et al. 2023). In a comprehensive strategy for long-term sustainability, each of these factors is dependent on the others. Figure 2 illustrates the alignment of the 5 Ps framework with their respective SDGs, providing a visual representation of their coordination. This provides a valuable framework for understanding the SDGs and their interconnections. By converging all 5 Ps, we can forge a more sustainable and impartial world for everyone. In addition to this, there exist a number of other frameworks that can be used to understand the SDGs (Tremblay et al. 2020). These models are useful for identifying the unique difficulties and potential gains encountered by various areas and nations as they strive to achieve the SDGs.



**Fig. 2** 5Ps of sustainable development along their mapping with respective SDG. Source: The authors, based on the information on Lekagul A, Chattong A, Rueangsom P, Waleewong O, Tangcharoensathien V (2022). Multi-dimensional impacts of Coronavirus disease

2019 pandemic on Sustainable Development Goal achievement. Globalization and Health. 18. <https://doi.org/10.1186/s12992-022-00861-1>

## The role of science, technology and innovation (STI) in achieving the SDG

In order to achieve the SDGs, especially those that pertain to people's health and prosperity, STI interventions are crucial. For health, sanitation, clean water, climate change, and clean energy goals to be met, it is crucial to coordinate social, economic, technological, and financial resources. The data available to evaluate the issues connected with each SDG is enhanced by STI, which covers knowledge generation, distribution, and usage. From measuring progress, conducting experiments with solutions, discovering new threats and possibilities, and developing evidence-based objectives and indicators, science plays a crucial role in sustainable development (Chersich et al. 2018). Technology entails the practical application of knowledge, while Innovation entails pioneering new approaches to producing, delivering, or using goods and services based on technological advancements. STI emerges as an important mechanism for balancing social, economic, technological, and financial resources to achieve SDGs. The United Nations-Technology Facilitation Mechanism (TFM), established in 2015, stands as an innovative platform designed to enhance the synergies and cooperation among science and technology (S&T) initiatives within the UN systems to drive SDG attainment (Walsh et al. 2020). The main goal of TFM is to encourage cooperation and partnerships among several stakeholders by making it easier for them to share information, lessons discovered, and recommendations for policy.

## SDG in the Indian context

Country like India, with one-sixth of the world's population plays a significant responsibility in attaining sustainable development challenges. India encounters several developmental issues like a large population, poverty, poor infrastructure, health, nutrition, quality education, and weak socio-economic indicators. Despite these concerns, India has taken up many momentous strides towards the accomplishment of SDGs. An important think tank for the Indian government is the National Institution for Transforming India (NITI) Aayog, which is responsible for developing, implementing, and adapting the Sustainable Development Goals (SDGs) to the Indian context (Jain and Mishra 2019). The SDGs objectives have been taken into consideration by NITI Aayog, which is the driving force behind the presentation of India's inclusive and equitable development plan. The first-ever government-led sub-national assessment of SDG development was created by

NITI Aayog and is known as the SDG India Index. Success in localizing the SDGs in India has been based on the SDG India Index, which emphasizes adoption, implementation, and monitoring at the state and district levels.

## National initiatives towards the attainment of SDGs

The many facets of sustainable development are addressed by national programs aimed at achieving the SDGs in India. Government, civil society groups, the commercial sector, and other concerned parties are working together on these projects to achieve sustainable development. To tackle the SDGs and their related objectives, the Indian government is making strategic use of visioning, prioritizing, and implementation approaches. In line with the SDGs and demonstrating India's commitment to sustainable development, a plethora of landmark projects have been unveiled. "Sabka Saath Sabka Vikaas" (Collective Efforts for Inclusive Growth), an axiom that highlights the confluence of SDGs with the national development strategy, symbolizes India's commitment (Sharma et al. 2022). According to this axiom, all the people of the nation should get opportunities for equality, empowerment, and progress. The government has initiated many schemes under this axiom for the attainment of development. Table S1 (in Supplementary Information) provides the schemes started by Indian government to accomplish the respective SDG.

Indian government programs such as *POSHAN Abhiyan* and *Pradhan Mantri Garib Kalyan* aim to improve people's health, food security, and overall quality of life (Rao and Kumar 2023). *Anna Yojana*, *Anganwadi Services*, the *Mid-Day Meal* (MDM) program, *National Food Security Act*, *One Nation One Ration Card* (ONORC), *Integrated Child Development Services* (ICDS), and *Ujjawala* are the initiatives, foster to achieve zero hunger, clean and affordable cooking fuel in rural areas, and ensures affordable access to food for all with sufficient quantity and quality of nutrition (Jose et al. 2020). Several forward-thinking government programs are currently being implemented in the field of energy. These programs include the *National Solar Mission*, *Green Energy Corridors* (GEC), *Bio-Energy Program*, *National Hydrogen Green Mission*, *Technology Mission Program on Clean Energy*, *National Program on High Efficiency Solar PV Modules*, and *Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan* (PM-KUSUM). These initiatives are aimed at increasing individuals' understanding of renewable energy sources, promoting small grid-connected solar energy power plants, encouraging their use, and advancing clean energy technology (Sen et al. 2016).

There have been several initiatives that have considerably assisted the efforts to extend the availability of formal financial services. Some of these initiatives are the *Pradhan Mantri Jan Dhan Yojana* (PMJDY), *Atal Pension*



*Yojana* (APY), *Pradhan Mantri Vaya Vandana Yojana* (PMVVY), *JAM Trinity* (Jan Dhan Yojana, Aadhaar and Mobile number Trinity), and *Micro Units Development & Refinance Agency Ltd. (MUDRA)*. These schemes provide ingenious financial services for people primarily from disadvantaged and marginalized backgrounds (Department of Financial Services 2024). Significant progress has been achieved in the areas of clean water and sanitation via several government initiatives including the *Namami Gange Programme*, *Atal Bhujal Yojana*, *Jal Shakti Abhiyan*, *Jal Jeevan Mission*, and *Swachh Bharat Mission*. These schemes and mission-mode projects have ushered notable progress in addressing challenges related to clean drinking water, waste management, water conservation, and river rejuvenation (Initiatives taken for Water Conservation 2022).

### Current status of India towards the attainment of SDG

As of 2024, India has achieved measurable progress toward the achievement of the Sustainable Development Goals, with the composite score showing an increase from 66 in 2020–21 to 71 in 2023–24. This illustrates that improvement has been registered in states and national initiatives that better align with global targets. According to the Sustainable Development Report 2024, India is ranked at number 109 out of 166 countries with an SDG index score of 64 (Sustainable Development Report 2023). Although this is at a moderate level, huge challenges persist toward attaining the goals by 2030. For instance, India's Spillover Score stands at 95.74%, meaning a significant positive spillover that impacts the ability of other countries to meet their set SDG goals. SDGs 1, 8, and 13 achieved marked progress between 2020–21 and 2023–24. Two out of 17 SDGs are on track while eight are improving moderately. According to sustainable Development Report 2024, in India out of 17 goals, two are on track (SDG1 and SDG4), eight are moderately increasing (SDG3, SDG5, SDG6, SDG7, SDG8, SDG9, SDG14 and SDG17), five are stagnating (SDG2, SDG10, SDG12, SDG15 and SDG16), and two are decreasing (SDG11 and SDG13)

NITI Aayog's SDG India Index has turned out to be a very effective tool in monitoring progress and promoting cooperative federalism (SDG India Index 2023–24). It allows for an inter-state and UT comparison of the performance on SDGs. The top-performing states with scores of 79 each are Kerala and Uttarakhand. Chandigarh tops among the UTs with a score of 77. Such performances clearly bring out the significance of local action in achieving national-level sustainable development.

### Specific challenges India faces in achieving the SDGs

India faces significant challenges in achieving the SDGs by 2030. These challenges span economic, social, and environmental issues and require a comprehensive strategy. Although poverty has decreased, it remains a concern in rural areas, and unequal income distribution restricts opportunities for many people. Problems like malnutrition, food insecurity, and education gaps are particularly evident in less developed regions of the country. Additionally, gender inequality in access to education, employment, and healthcare continues to hinder progress towards the achievement of SDGs in India. Environmental problems, including climate change, deforestation, and water scarcity, put immense pressure on natural resources. Poor sanitation and limited rural healthcare further impact public health. While urbanization boosts economic growth, it often leads to unregulated expansion and overburdened infrastructure. Financial constraints, limited private sector involvement, and poor coordination also slow progress toward the SDGs. Addressing these challenges will require inclusive policies, better governance, and increased investment in sustainable development, including infrastructure, education, and healthcare. Enabling technology, strengthening infrastructure, and fostering global partnerships are essential steps to achieve sustainable progress.

### DST contribution towards accomplishment of sustainable development goals in India

Through the Department of Biotechnology (DBT), DST, and Department of Scientific and Industrial Research (DSIR), the Ministry of Science and Technology has played a significant role in expediting socially important and cost-effective technologies, categorizing region necessitating tactical interferences, and international S&T alliances in vital domains such as energy, water, health, and agriculture (Ministry of Science & Technology 2021). These important domains include energy, water, and agriculture. With concern to the identification of gaps in science, technology, and innovation; development of strategies to fill these slits; implementation of policies to address societal needs; and cultivation of new areas of S&T to fulfill future demands, the DST is the central agency for these matters in the country. In its efforts to improve the nation's S&T infrastructure, DST provides the largest extramural research and development support in the country (Sharma et al. 2021). Researchers from a wide variety of academic institutions and disciplines through a competitive mode reinforces scientific and industrial R&D, and the overall STI landscape of the country. Adhering the recommendations from the SDG India Index, the 2018 Baseline Report, NITI Aayog, the following SDG

objectives should be carried out by DST for the achievement of the respective SDG goals in India (SDG India Index Baseline Report 2018).

- DST is contributing towards the achievement of SDG 3's Target 3.b, which seeks to ensure healthy lives and promote well-being. This is accomplished through the organization's efforts in innovation, technology development, and deployment.
- Through the S&T Institutional and Human Capacity Building efforts, the DST is working in the direction of achieving Target 5.b of SDG 5, which aims to empower women and promote gender equality.
- Concerning SDG 8, which seeks to encourage productive employment, and inclusive and sustainable economic development, the DST is working towards achieving Target 8.2. This goal's purpose is to increase economic productivity through innovation, technological development, diversification, and giving labour-intensive, high-value industries priority.
- SDG 9 aspires to create resilient infrastructure, encourage inclusive and sustainable industry, and foster innovation. DST is engaged in the achievement of Target 9.2, 9.4, and 9.5 by S&T Institutional and Human Capacity Building, R&D Innovation, Technology Development and Deployment, Industrial and Entrepreneurial Development, Digital India, strengthening technical and scientific research capabilities. DST also supports domestic IT R&D, innovation, and development under Target 9.b.
- Target 12.a of SDG 12, ensuring sustainable patterns of production and consumption is accomplished with the aid of DST, which supports developing nations in enhancing their scientific and technological capacities.
- Target 17.8 for SDG 17, Strengthening the means of implementation and reviving the global partnership for sustainable development, will be spearheaded by DST, this can be done through fully operationalizing the technology bank and the mechanism for building capacity in science, technology, and innovation as well as through improving the use of enabling technologies, particularly information and communication technology.

India has launched numerous S&T missions during the last decade to encourage study, new information generation, and developing cutting-edge technical solutions. These missions, primarily guided by the DST in conjunction with research institutes, contributed to tackle urgent problems and drive technical progress. Advanced forming technology, nanomaterials, pharmaceuticals, bio-manufacturing, robots, and precision manufacturing are the main areas of focus in this project. The department continues its efforts to fortify the nation's STI ecosystem and position itself as a leader in the field of S&T. The goal is to use S&T to create

a better, safer, and more secure society to prepare for future disruptions.

### DST programs towards the achievement of SDGs in India

The Anusandhan National Research Foundation (ANRF), is a major initiative to strengthen R&D and industry-academia partnerships in India. ANRF aims to promote research and innovation across universities, colleges, and research institutions, fostering collaboration among academia, industry, and government (Anusandhan National Research Foundation 2023). Guided by the National Education Policy (NEP) 2020, the ANRF will strategically direct scientific research, encouraging participation from state governments and various sectors. Administered by the DST and overseen by a board of distinguished experts, this initiative is set to accelerate progress toward achieving India's SDGs. Through this initiative DST, work towards SDG 4 (Quality Education), SDG 8 (Decent Work and Economic Growth) and SDG 9 (Industry, Innovation, and Infrastructure). The ANRF has recently introduced the Partnerships for Accelerated Innovation and Research (PAIR) Program (ANRF PAIR program 2024). This pioneering initiative is closely aligned with the goals of the NEP 2020, aiming to foster research excellence in Indian universities, particularly central and state public universities with limited research infrastructure. The PAIR program adopts a mentorship-driven hub-and-spoke model to facilitate structured research development. In this framework, established institutions (hubs) will mentor and collaborate with emerging institutions (spokes), sharing resources and expertise to strengthen their research capabilities. By bridging institutional gaps, this initiative seeks to build a resilient and dynamic research ecosystem across India. This contributes to SDG 4 (Quality Education) by promoting research excellence and advancing skill development in universities, and SDG 9 (Industry, Innovation, and Infrastructure) by encouraging innovation and strengthening collaborative research efforts to enhance institutional capabilities and infrastructure.

The Union Cabinet, led by the Prime Minister, has approved the integration of three umbrella schemes into a unified initiative, 'Vigyan Dhara,' under the DST (Vigyan Dhara 2024). This merges Science and Technology (S&T) Institutional and Human Capacity Building, Research and Development, and Innovation, Technology Development, and Deployment in one. This program focuses on capacity building, research and development, and innovation-driven technology deployment to strengthen India's STI ecosystem. By enhancing infrastructure and establishing advanced R&D facilities in academic institutions, Vigyan Dhara aims to promote innovation, address societal challenges, and contribute to the achievement of SDGs through sustainable and



inclusive growth. Therefore, through this initiative DST, work towards SDG 4 (Quality Education), SDG 8 (Decent Work and Economic Growth) and SDG 9 (Industry, Innovation, and Infrastructure).

DST launched the National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS) in 2018 to strengthen collaboration between academia, industry, government, and international organizations to promote innovation and technological advancement (National Mission on Interdisciplinary Cyber-Physical Systems 2018). Its objectives include building human resource capabilities, fostering start-ups, establishing world-class research centers, and addressing national challenges through technology and cross-sector partnerships. The NM-ICPS aligns with SDG 9 (Industry, Innovation, and Infrastructure) by fostering technological innovation and building robust infrastructure, and SDG 11 (Sustainable Cities and Communities) by enabling smart and sustainable urban solutions.

The National Super Computing Mission (NSM) is significantly enhancing High-Performance Computing (HPC) capabilities in India to support the growing computational needs of academic institutions, researchers, small and medium enterprises (SMEs), and startups (National Supercomputing Mission 2015). This includes applications in fields such as oil exploration, flood forecasting, genomics, and drug discovery. The DST-NSM aligns with SDG 9 (Industry, Innovation, and Infrastructure) by building advanced computing infrastructure to drive innovation and industrial growth, and SDG 4 (Quality Education) by fostering research, education, and capacity building in computational science and technology.

The National Quantum Mission launched by the DST aims to make India a frontrunner in the field of quantum technologies. The mission focuses on advancing quantum computing, communication, cryptography, and sensor technologies through cutting-edge research and practical applications (National Quantum Mission 2023). It seeks to build a robust quantum ecosystem by strengthening research infrastructure, developing a skilled workforce, and encouraging collaboration across academia, industry, and government. The initiative also aims to support innovation and foster start-ups in the quantum technology sector. The DST Quantum Mission supports SDG 9 (Industry, Innovation, and Infrastructure) by driving advancements in quantum technologies to foster innovation and enhance technological infrastructure, and SDG 4 (Quality Education) by promoting research, skill development, and capacity building in quantum science and technology.

To strengthen the nation's scientific and technology infrastructure, the R&D Infrastructure programs of DST aim to fund the building of state-of-the-art research facilities at educational and research institutions and universities. Through flagship schemes like FIST (Fund for

Improvement of S&T Infrastructure), PURSE (Promotion of University Research and Scientific Excellence), SAIF (Sophisticated Analytical Instrument Facilities), Support for Up-gradation Preventive Repair & Maintenance of Equipment (SUPREME) and SATHI (Sophisticated Analytical & Technical Help Institutes), DST is advancing the R&D labs and upgrading research infrastructure in the country (R&D Infrastructure 2024). With these schemes DST endeavours to align itself with the national mission of Self-Reliant India, thereby supporting SDG 9 (to build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation). With the primary goal of enhancing human resource and knowledge capacity building through practical training and awareness programs, providing open access to S&T research facilities nationwide, and other similar initiatives, DST launched the STUTI program (Synergistic Training Program Utilizing the Scientific and Technological Infrastructure) (STUTI 2024). Through capacity building and open access to S&T state-of-the-art facilities along with the encouragement for the women to participate in training and awareness programs, DST is promoting SDG 5 (to ensure that girls and women have equal opportunities to pursue higher education) and SDG 9 (Enhance scientific research, upgrade the technological capabilities in developing countries).

The Science for Equity Empowerment and Development (SEED) divisional programs of the DST, provides opportunities to motivated scientists & technologists from national Research and Development (R&D) labs, S&T-driven Non-Governmental Organizations (NGOs), and field-level workers (Science for Equity Empowerment and Development 2024). Therefore, in order to achieve the Sustainable Development Goals (SDGs), the plans and activities of the division are coordinated with those of line ministries and departments, as well as with national development programs. Initiatives such as SUNIL (Strengthening, Upscaling & Nurturing Innovations for Livelihood), SYST (Scheme for Young Scientists and Technologists), and S&T for Women have the objective of advancing healthy lives and prosperity for all (SDG 3) and promoting gender equality (SDG 5).

The WISE-KIRAN (Women in Science and Engineering -Knowledge Involvement in Research Advancement through Nurturing) scheme is intended to achieve gender parity in S&T through various mechanisms (Women in Science and Engineering-KIRAN 2024). WISE Post-Doctoral Fellowship (WISE-PDF), Women's Instinct for Developing and Ushering in Scientific Heights & Innovations (WIDUSHI), WISE-SCOPE (Societal Challenges with Opportunities), WISE Internship in Intellectual Property Rights (WISE-IPR) and Women International Grant Support (WINGS) are some programs under WISE-KIRAN which supports and provide opportunities to women, thereby enhance their participation in the field of S&T with ultimate goal to bring gender parity.

The Vigyan Jyoti scheme aims to encourage girls to pursue higher education and careers in STEM (Science, Technology, Engineering, and Mathematics) to balance gender ratio across the streams. CURIE (Consolidation of University Research for Innovation and Excellence) program strengthens women's institutions by establishing state-of-the-art research infrastructure to improve R&D activities. Gender Advancement for Transforming Institutions (GATI) under Policy Intervention for Gender Equality targets to cultivate a native commission for Gender equivalence in STEMM (Science Technology Engineering Mathematics & Medicine), with a focus on bringing about transformational changes at the Institutional level. Innovation in Science Pursuit for Inspired Research (INSPIRE) scheme attracts and nurtures young bright students to study basic and natural sciences at the college and university level and to pursue research careers in both basic and applied science areas. Through these schemes, DST is working for the achievement of SDG 3 (i.e. to ensure healthy lives and promote well-being for all at all ages), SDG 5 (to achieve gender equality and empower all women and girls), and SDG 9 (Enhance scientific research, upgrade the technological capabilities).

The National Mission on Nano Science & Technology (Nano Mission) initiative of DST has promoted the basic research and focuses on Nano Technology adaptation and transfer to industry for use by the masses (Mission on Nano Science and Technology (Nano Mission) 2024). The programs under this umbrella are based on Energy and Nano electronics, Nano Technology, Nano Science, Agriculture, Energy & Environment, Quantum Materials in Nano Science and Applications, and Nanoelectronics Network for Research and Applications. Through these programs, DST is working in the area of SDG 7 (to ensure access to affordable, reliable, sustainable, and modern energy for all) and SDG 13 (to take urgent action to combat climate change and its impacts).

In the Climate Change Programme, DST is coordinating the two national missions on climate change under the National Action Plan on Climate (NAPCC), viz., National Mission on Strategic Knowledge for Climate Change (NMSKCC) and National Mission for Sustaining the Himalayan Ecosystem (NMSHE) (Climate Change Programme 2024). Both of these missions, NMSKCC & NMSHE, focuses on building national S&T capacities in the area of climate change. While the main objective of NMSHE is to develop a capacity to scientifically assess the vulnerability of the Himalayan region to climate change and continuously evaluate the condition of the Himalayan ecosystem, NMSKCC focuses on building human and institutional S&T capacities in climate change and developing strategic knowledge in the key areas of climate change science, adaptation and mitigation. With this Climate change program, DST is working on achieving Target 13.3 (i.e. to improve education,

awareness-raising, and human and institutional capacity on climate change mitigation, adaptation, impact reduction, and early warning) and SDG 15 (to protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation, and halt biodiversity loss).

Through the Clean Energy Research Initiative (CERI), DST is working to establish R&D centres in areas such as Smart Grids, Clean Coal, Solar Energy, Energy Storage, and Water Technology to strengthen and develop S&T infrastructure (Clean Energy Research Initiative 2024). CERI envisaged nurturing S&T breakthroughs to make clean energy affordable and accessible through strengthening research and innovation ecosystem via several initiatives like R & D on Clean Coal Technologies, Materials for Energy Storage, Solar Energy, Energy Storage Solutions, Mission Innovation (MI) 2.0, smart grid and clear air, etc. Through these initiatives DST is working to achieve the targets of attaining clean air free from contaminants under SDG 3 (i.e. good health and well-being), to ensure that every individual has access to clean and sustainable energy resources under SDG 7 (i.e. affordable and Clean Energy) and to Invest in clean energy under SDG 13 (Climate Action).

The WTI (Water Technology Initiative) program of DST is a pro-active India—centric ‘solution science’ endeavour that aims to strengthen the R&D capacity and capability to develop research-based solutions for existing and emerging water challenges faced in the country (Water Technology Initiative (WTI) 2024). The program aims to promote R&D activities for providing safe drinking water at affordable cost and in ample quantity using appropriate S & T interventions evolved through indigenous efforts. The overarching goal of the scheme is to promote R&D activities that enable the fetching of water from sustainable sources, augmentation of water quality for specific applications, and recycling and reuse of water. Several projects are being implemented to address water related issues. Water Technology Research and Innovation Centres (Water-IC) are the virtual network centres that support R&D for water extent, quality, reprocessing, and reclaim. Through these initiatives, DST is working for the attainment of SDG 6 (i.e. ensure availability and sustainable management of water and sanitation for all) and SDG 14 (i.e. conserve and sustainably use the oceans, seas, and marine resources for sustainable development).

The National Science & Technology Entrepreneurship Development Board (NSTEDB) of DST, is leveraging the technological strength of the higher learning institutes to nurture the technology start-ups, through its strong network of incubators (National Science & Technology Entrepreneurship Development Board 2024). The Board, having representations from socio-economic and scientific Ministries & Departments, aims to convert “job-seekers” into “job-generators” through S&T interventions. Many



initiatives like the National Initiative for Developing and Harnessing Innovations (NIDHI), NewGen Innovation and Entrepreneurship Development Centre (NewGen IEDC), Innovation—Science and Technology based Entrepreneurship Development (i-STED), and Technology Business Incubator (TBI) have been initiated to ensure inclusiveness of innovation and entrepreneurship across the country and foster innovation and start-up culture among the students, faculties, entrepreneurs, and nearby communities. Through these schemes, DST is working on the achievement of SDG 1 (i.e. end poverty in all its forms everywhere), SDG 3 (i.e. ensure healthy lives and promote well-being for all at all ages and SDG 8 (i.e. promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all).

The purpose of the Scheduled Caste Sub Plan (SCSP) and the Tribal Sub Plan (TSP) scheme is to strengthen the livelihood system and build sustainable livelihoods for Scheduled Tribe (ST) and Scheduled Caste (SC) populations (Scheduled Caste Sub Plan (SCSP) 2024; Tribal Sub Plan 2024). This will be accomplished through the provision of elucidations that are led by science and the development of technology that is appropriate for the specific location. Projects implemented by these programs helped individuals in many ways, including raising their incomes and enhancing their skill sets by using and expanding existing local innovations and expertise. As a result of these programs, SDG 8, to promote continuous, inclusive, and sustainable economic development, full and productive employment, and decent work for all, and SDG 3, to ensure healthy lives and promote well-being for all at all ages, were both accomplished.

DST under the Ministry of Science and Technology provides various fellowship opportunities for young researchers in the country. These fellowships significantly contribute to the growth and progress of the research community (Fellowship Opportunities for Researchers 2024). Extra Mural Research (EMR) Funding, National Post-Doctoral Fellowship (N-PDF), Early Career Research Award (ECRA) scheme supports potential scientists and young researchers for undertaking research in frontier areas of S&T. Empowerment and Equity Opportunities for Excellence in Science (EMEQUE) is aimed at providing research support to scientists belonging to the Scheduled Caste and Scheduled Tribe in undertaking research in newly emerging and frontier areas of science and engineering. The science-specific and highly selective J C Bose National Fellowship is meant to recognize active scientists and engineers for their outstanding performance and contributions. Ramanujan Fellowship is meant for brilliant scientists and engineers from all over the world to take up scientific research positions in India. These fellowships deliver financial support to young researchers for pursuing innovative research and play an essential part in driving research excellence advancing knowledge and

encouraging researchers. Through these prestigious fellowships and schemes, DST works for SDG 3, to ensure healthy lives and promote well-being, and SDG 8, to promote sustained, inclusive, and sustainable economic development, full and productive employment, and decent work for everyone.

In the Technical Research Centres (TRCs) program, five TRCs were established in DST institutions. These TRCs provide financial and techno-legal assistance to help scientists, entrepreneurs, and the business community to realize the goal of translating research into goods and processes that may benefit society and the economy (Technical Research Centres 2024). Through this program, DST is working for the achievement of target 8.3 of SDG 8 (i.e. to Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity, innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services) and SDG 9 (i.e. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation).

The Technology Development Board (TDB) was established by the DST to nurture the development and commercialization of indigenous technology as well as the adaptation of foreign technologies for wider application (Technology Development Board 2024). Industrial companies may get equity financing or loans from TDB, while research and development organizations can receive financial support. The TDB is unique among government agencies in that it exists only to facilitate the commercialization of indigenous research findings. The Board takes the initiative by pushing businesses to adopt tech-focused goods. Recently TDB celebrated the National Technology Day, on 11th May 2024, themed on ‘Promoting Clean and Green Technologies for a Sustainable Future’. The event witnessed the convergence of eminent scientists, dignitaries, and thought leaders, aiming to plan a path in the direction of a cleaner, greener, and more resilient nation (Technology Development Board 2024). Through this organization, DST is working for the achievement of SDG 8 (i.e. to promote sustained, inclusive, and sustainable Economic growth, full and productive employment, and decent work for all) and SDG 9 (i.e. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation).

The international interventions on STI aspects have been done by the International Cooperation (IC) Division of DST (International Cooperation Division 2024). IC division has the obligate concern of transferring, directing, and employing STI agreements of India with other countries. This can be achieved via bilateral cooperation, multilateral and regional cooperation, and thematic cooperation. Under bilateral cooperation India has STI cooperation agreements with more than eighty countries, including Australia, Canada, US,

UK, Russia, Japan, France etc. India's regional and multilateral engagements and partnerships have been fostered by Multilateral and Regional cooperation. Whereas, partnerships in international programs like, International Solar Alliance, Mission Innovation, International AIDS vaccine initiative etc. has been promoted by thematic cooperation. The STI agreements result in advanced capacity building (through conferences, workshops, seminars, meets, lectures, visits, etc.), support for R&D projects (through training, advanced research facilities, fellowships, grants, etc.), promote commercial R&D and Innovation (by academia-industry applied R&D projects, technology development, and technology transfer). DST is working on SDG 17, strengthening the means of implementation and reviving the global partnership for sustainable development.

### Some highlighted achievements of DST towards the attainment of SDGs in India

Based on data from the NSTMIS, Government of India, for the year 2022–2023, the DST emerged as the leading contributor to extramural R&D projects in India, accounting for 55% of the total support (India on the Cusp of Transformation 2023). Numerous projects were funded under various schemes and programs, benefiting several academic and research institutions across the country. The initiatives taken through the schemes and programs showcase how DST aligns scientific innovation and technology with India's commitment to the SDGs, fostering sustainability and inclusivity.

The DST has taken major steps in promoting innovations in renewable energy technologies that support the achievement of SDG 7 (Affordable and Clean Energy). Such interventions have encouraged the development of solar energy and other forms of sustainable energy with the view of improving energy access and efficiency. The Autonomous Institutes (AI) Division of the DST manages 26 Autonomous Institutions, which includes 16 R&D Institutes, 5 Service Organizations, and 5 Professional Associations or Science Academies. Among these, the Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR) has made notable progress by discovering a novel material, single-crystalline Scandium Nitride (ScN) (Novel Insights into Electron Scattering 2024). This material demonstrates high efficiency in emitting, detecting, and modulating infrared light, making it highly applicable in solar and thermal energy harvesting as well as optical communication technologies. The International Advanced Research Centre for Powder Metallurgy & New Materials (ARCI), an Autonomous Institute under the DST, has developed an innovative method to produce hydrogen with high purity (99.99%) from a methanol–water mixture at ambient pressure and temperature. This method is highly energy-efficient, requiring only one-third of the

electrical energy needed for conventional water electrolysis. The process represents a significant advancement in sustainable hydrogen production (ARCI Scientists develop energy-efficient method 2022). Additionally, ARCI has developed a platinum-based electrocatalyst for use in fuel cells through an efficient synthesis procedure. This electrocatalyst exhibits performance comparable to commercially available alternatives and has the potential to enhance the durability and efficiency of fuel cell stacks, marking a step forward in fuel cell technology. Through the research facilities provided by DST-FIST program, researchers from the Department of Physics, BITS Pilani, have developed a thermally stable solid electrolyte for lithium-ion batteries (Novel composite materials 2021). This innovation enables energy storage solutions across a wide temperature range (30 to 500 °C).

DST has also advanced water security initiatives, addressing SDG 6 (Clean Water and Sanitation). Projects leveraging geospatial technologies empower communities to tackle water challenges effectively. Under the DST-Water Technology Initiative (WTI), The Energy and Resources Institute (TERI), in collaboration with ONGC Energy Centre (OEC), Delhi, has developed The Advanced Oxidation Technology (TADOX) (New advanced oxidation technology 2021). Using UV-Photocatalysis, TADOX treats municipal sewage and industrial wastewater streams affordably and sustainably, enhancing wastewater reuse for municipal and industrial applications. Under the DST-WTI initiative, in collaboration with the Indian National Academy of Engineering (INAE) and Laxmi Textile Prints, Jaipur, an advanced water management system was developed to treat toxic textile effluents (Improved water management system 2021). This technology fully recycles industrial dye wastewater from textile industry, eliminating toxicity and enabling reuse for domestic and industrial purposes. It reduces treatment costs and supports water reuse in arid regions. With support from the DST-PURSE scheme, the University of Kalyani has established an advanced imaging facility for ion sensing and toxic chemical removal from wastewater (Novel tools for visual ion sensing 2022). Researchers have developed smart materials capable of visually detecting biologically relevant ions and removing toxic dyes and chemicals, such as picric acid, from water.

DST schemes have advanced affordable healthcare solutions, particularly in rural and underserved areas, aligning with SDG 3 (Good Health and Well-being). These initiatives address healthcare disparities and support innovations like cancer management techniques and early disease detection. The Centre for Augmenting WAR with COVID-19 Health Crisis (CAWACH), an incubator network under the DST-NIDHI program, played a pivotal role during the COVID-19 pandemic. CAWACH supported innovations in diagnostics, drugs, disinfectants, sanitizers, ventilators, PPEs, and informatics, aiding in the containment, treatment, and



management of the crisis (DST sets up rapid response centre 2020). Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), an autonomous institution under DST, developed critical technologies and products to combat diseases. Notable contributions include a one-step confirmatory diagnostic kit for COVID-19, a UV-based facemask disposal bin for safe decontamination, and a superabsorbent material for managing infected respiratory secretions. Additionally, SCTIMST scientists created a nickel-titanium alloy-based occlusion device for non-surgical closure of Atrial Septal Defect (ASD), offering a revolutionary solution for treating "hole in the heart" conditions (Amid lockdown, SCTIMST gears up to meet COVID-19 2020).

In agriculture, DST collaborated with its autonomous institute, the Maharashtra Association for the Cultivation of Science (MACS) -Agharkar Research Institute (ARI), Pune, to develop high-yielding, disease-resistant, and early-maturing wheat and soybean breeder seeds (Scientists of ARI, Pune develop biofortified 2020). These were distributed to seed industries, farmers, and producer organizations. Farmers also received grape variety ARI-516 cuttings and saplings to enhance agricultural productivity. With support from the DST's PURSE grant, the Punjab Agricultural University (PAU) has developed a range of improved crop and vegetable varieties. These nutrient-rich varieties have the potential to significantly contribute to meeting the nutritional needs of India's population (Punjab new nutrient rich crop 2021).

DST's collaborations and initiatives underscores India's commitment towards the attainment of SDGs, with concerted efforts directed towards poverty eradication, sustainable consumption and production, protection of natural resources, water resources and environment, build resilient infrastructure, promote inclusive and sustainable industrialization and fostering innovation etc. Figure 3 highlights SDG

goals and schemes undertaken by DST for affluence the path towards the achievement of SDG. While extensive progress has been made, challenges such as limited resources, population growth, inequalities, and climate change persist. These challenges can be eradicated by collaborative efforts involving government, civil society organizations, and domestic and global stakeholder to accelerate progress towards a sustainable future for generations to come.

## Conclusion and future recommendations

The SDGs aim to set the objectives for driving forces to tackle the world's most tenacious challenges such as poverty eradication, eliminating inequalities, and achieving sustainable economic growth. In this concern, Government of India, has started several transformative and determined initiatives for the sustainable and resilient path towards the achievement of SDGs. India attained a spillover score of 99.4, which indicated the positive impact of the government's actions and strategies towards the accomplishment of global sustainability. The DST has been continuing its efforts in India's journey towards achieving SDGs by strengthening the national STI ecosystem. Its persistent efforts aim to play a critical role in S&T for bringing positive transformations for a safer, secure, and better society, while also preparing the nation for future disruptions. The present study highlighted the diverse initiatives undertaken by Government of India, towards achieving the SDGs in India. Here, the role of DST towards accomplishing the various targets of SDGs via implementation of its numerous scientific schemes and policies has been described.

The DST envisions a future driven by innovation, robust research infrastructure, and global collaboration to tackle

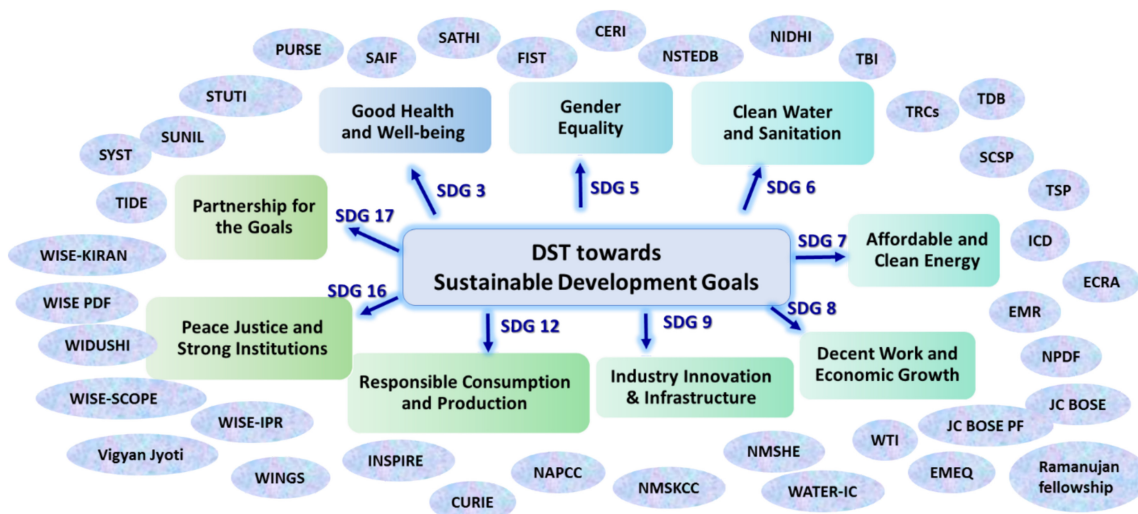


Fig. 3 SDG goals and schemes undertaken by DST. Source: The authors

pressing challenges. Its key goals include developing multidisciplinary R&D facilities, fostering industry-academia partnerships, and advancing sustainable development through climate and environmental research. The DST is also focused on strengthening international cooperation, promoting advancements in healthcare, energy, and space exploration, and ensuring diversity in STEM fields by supporting women and underrepresented regions. By utilizing digital tools for governance and public engagement, the DST aspires to establish India as a global leader in science and technology, committed to creating a sustainable and innovative future that addresses societal needs. However, for SDGs where progress remains limited, it is crucial to identify obstacles and implement targeted strategies to accelerate outcomes. Areas such as reducing inequalities (SDG 10), achieving gender equality (SDG 5), and combating climate change (SDG 13) demand renewed attention. Bridging gaps through technology, fostering cross-sector collaborations, and enhancing grassroots engagement are essential steps. Incorporating SDG objectives into national frameworks, incentivizing private sector contributions, and employing data-driven approaches for monitoring can further catalyse the progress. Aligning these initiatives with global best practices and channeling investments into underperforming sectors will make sustainable development more inclusive and effective. By addressing these challenges holistically, the DST can strengthen resilience and drive long-term progress toward achieving the SDGs.

Despite of challenges imposed by several factors like large population, limited resources, social and economic inequalities, poverty, and climate change, India has made momentous progress in the achievement of several sustainable development goals and a substantial improvement has been made in several SDG indicators. India improved its performance on certain indicators including poverty, access to education, maternal and child health, clean water and sanitation, and sustainable consumption. So far, significant progress has been achieved in several SDGs, but there is still a long way to go to achieve the SDG targets by 2030. Collaborative efforts between the government, civil society organizations, and stakeholders can be done to accelerate the progress towards the attainment of sustainability in India. The synergies between science, technology, and innovation can influence the complex challenges posed by the SDGs. Therefore, investing in research and development, adopting innovative solutions, and improving academic-industry collaborations, can pave the way towards a more equitable, prosperous, and sustainable future for all.

**Supplementary Information** The online version contains supplementary material available at <https://doi.org/10.1007/s43538-025-00398-y>.

**Acknowledgements** The authors are thankful to Secretary, Department of Science & Technology (DST) for providing the opportunity for writing this article.

**Author contributions** Dr. Chanchal Gupta—study conception and design, data collection, analysis and interpretation, and manuscript preparation. Dr. Pratishtha Pandey—identifying the research question, designing the study framework, directed the project and supervised the work, ensures the manuscript's accuracy, final approval and submission of the manuscript.

**Data availability** The data referred in the manuscript is available on the internet and can be open accessed through the mentioned URLs. The authors declare that the data supporting the findings of this study are available within the paper and its Supplementary Information files.

## Declarations

**Conflict of interest** On behalf of all authors, the corresponding author states that there is no conflict of interest. All co-authors have seen and agree with the contents of the manuscript and there is no financial interest to report. We certify that the submission is original work and is not under review in any other publication.

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