India

spotlight

THE PAPERS FROM INDIAN RESEARCHERS THAT ARE SHAPING SCIENCE

Heavily cited research from Indian scientists is making an impact in a variety of fields. **By Michael Eisenstein**

India was the world's third-most-prolific publisher of research papers in 2022, but it was ranked only 153rd for the number of citations it received per paper. Indeed, in 2020, about 30% of papers from India were not cited at all, compared with 20% in both the United States and China. These trends are mirrored in many other low- and middle-income countries whose researchers struggle to get published in high-impact journals.

But despite this challenging publishing environment, some Indian scientists have produced influential, highly cited studies in a number of fields in the past few years. Here *Nature* highlights several of these key areas of research that have the potential to improve public health and quality of life both domestically and globally.

Strategies to reduce air pollution

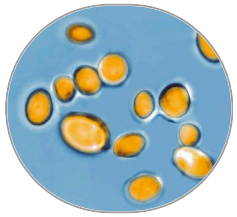
Many parts of India have highly polluted air. The University of Chicago's Air Quality Life Index ranks India as the second-most-polluted nation in the world in terms of air quality, behind only Bangladesh, and refers to Delhi as "the most polluted city in the world".

To improve India's air quality, researchers must first develop a deeper understanding of the sources of this pollution and how it interacts with weather systems. Sachin Gunthe, who studies aerosols at the Indian Institute of Technology Madras, based in Chennai, has published a series of highly cited papers exploring the composition, formation and distribution of airborne pollutants. In particular, he has studied particulate matter that has a diameter of 2.5 micrometres or less ($PM_{2.5}$), which can create visible haze and wreak havoc on human health, contributing to more than one million deaths a year in India alone.

In 2020, Gunthe teamed up with Narendra Ojha at the Physical Research Laboratory in Ahmedabad and his colleagues to investigate seasonal patterns of $PM_{2.5}$ production and windborne distribution[1]. Using simulations based on meteorological data, they determined that the sources of pollution change considerably over just a few months. In October, following the monsoon season, most $PM_{2.5}$ originates from burning biomass in wildfires, agriculture and household stoves, and creates pollution that spreads across northwest India to Delhi and other cities (see page S25). By December, most $PM_{2.5}$ arises from industrial and fossil-fuel sources in cities, where it is trapped and accumulates because of the relatively stagnant winter wind patterns. This work shows that strategies to control pollution must address seasonally changing conditions.

Gunthe then collaborated with researchers including Pengfei Liu at the Georgia Institute of Technology in Atlanta to take a deeper dive into Delhi's air-pollution crisis. In a 2021 publication, they traced the origins of Delhi's haze to the behaviour of a particularly small category of airborne particles measuring less than one micrometre[2]. They subsequently showed that in high humidity, this particulate matter interacts with ammonia and chlorine in the air, forming bigger particles that contribute to worse visibility and heightened health risk.

A follow-up study in 2022 found a feedback loop in which condensation from high water content in the air reduces the dispersal of particulate matter[3]. This leads to worse pollution and higher humidity, exacerbating the problem. On the basis of these results, the authors proposed a two-pronged intervention to reduce both ammonia emissions, from agriculture and fossil-fuel use, and chlorine production, which is a consequence of plastic burning and e-waste disposal in particular.



Electrodes for a hydrogen economy

One of the most exciting routes from fossil-fuel dependency is the 'hydrogen economy', in which energy-rich hydrogen is efficiently extracted from a cheap and abundant fuel source: water. Earlier this year, the Indian government announced its intention to build the country's production capacity to at least 5 million tonnes of hydrogen a year by 2030, with the goal of ultimately making the country energy independent and an exporter of 'green hydrogen' to other major economies.

One promising strategy is to use electrochemical water-splitting systems in which

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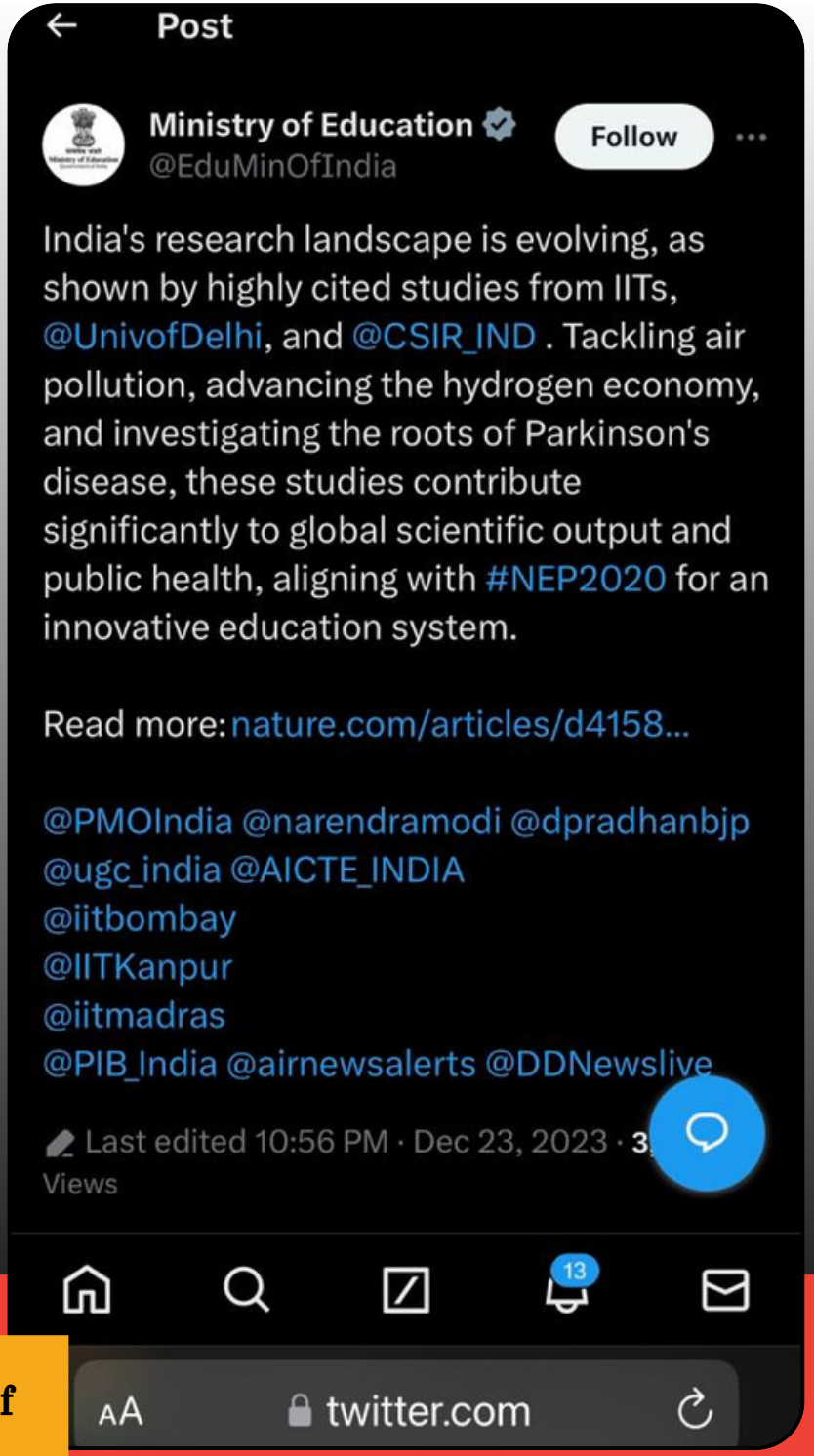

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