National innovation system for CRISPR genome editing research in India: an empirical analysis

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The clustered regularly interspaced short palindromic repeats (CRISPR)-Cas genome editing technology holds great potential in advancing the fields of healthcare, agriculture, and basic biology research. This study uses the national innovation system framework to identify key actors in India's CRISPR research landscape and their roles in technology development and diffusion. Bibliographic analysis revealed that almost half of Indian CRISPR research publications are review articles or book chapters. Patentscope analysis showed that only 13.7% of CRISPR-related patent applications are attributed to Indian nationals, indicating international dominance. The Indian CRISPR research ecosystem is primarily supported by the Department of Biotechnology, Government of India. Addressing lack of hands-on learning opportunities, minimal collaboration amongst limited researchers, and absence of dedicated institutes of excellence are crucial to accelerate CRISPR technology innovation in India. We believe these inferences can be extrapolated to other developing countries that spend a similar percentage of their gross domestic product on biotechnology research.

Keywords: CRISPR research and development, CRISPR research in India, Department of Biotechnology, emerging national innovation systems, innovation system challenges.

impacted the CRISPR market worldwide, particularly with CRISPR-based diagnostic tests. The global CRISPR gene editing market, valued at USD 1.28 billion in 2020, is projected to reach USD 4.52 billion by 2030, indicating a substantial growth trajectory at a compound annual growth rate (CAGR) of 20.38% (ref. 17). Despite these scientific and commercial advancements, debates surround CRISPR's applications and ownership[18,19].

In healthcare, CRISPR enables the development of therapies for genetic ailments, and diagnostics for early disease detection[20–22]. In agriculture, it is being used to enhance crop traits like higher yields and increased resilience to diseases and climate change[22–24]. Beyond specific domains, CRISPR facilitates advancements in gene repair, disease modelling, developing animal models, and cell imaging techniques, addressing grand challenges and supporting fundamental research[25–28]. However, the existing status of the Indian research community seems primitive as India is not featured in the list of the top 10 countries publishing in the field of gene editing, as concluded by a recent bibliometric analysis[16]. The most prominent outcome in the Indian CRISPR research ecosystem has been the development of a COVID-19 diagnostic test named 'FELUDA' by the Council of Scientific and Industrial Research (CSIR)-Institute of Genomics