spotlight

HOW TO MAKE SCIENCE BENEFIT SOCIETY

India's lack of a spin-off culture has created barriers, but entrepreneurial researchers can find economic solutions.

By David Adam

An employee at the Serum Institute of India works on the COVID-19 vaccine Covishield.

DHIRAJ SINGH/BLOOMBERG VIA GETTY

Every year, more than 6,000 farm workers in India die from exposure to the pesticides they hand-spray on their crops[1]. In 2018, Praveen Vemula published details[2] of a possible solution: a protective gel the farmers can apply to their skin to break down the most toxic substances.

Vemula, a biomaterials scientist at the Institute for Stem Cell Science and Regenerative Medicine in Bengaluru, had big plans for the discovery. He thought he could integrate the gel into fabric and produce a cheap and washable range of protective clothing. He wanted to set-up a spin-off company that could produce the clothes at a large scale, and market and distribute them across the country.

It was an Indian solution to an Indian problem, and would mimic how academic research is leveraged into social and economic development in other countries, including those in Europe and the United States.

But there was a problem. There was no support at his institute to make it happen. It had no policy to deal with the transfer of intellectual property, or to decide how much time he could spend working to commercialize his idea while still a salaried researcher. "All these policies were not there, especially when you're thinking about academic spin-offs," Vemula says. "And unless there are clear guidelines, it is very difficult to translate research."

The Indian government had issued some broad guidelines in 2009 on the commercialization of research, including the establishment of incubation centres. But "those are not uniformly implemented at the institutional level", he says. That presents a major barrier to researchers hoping to apply their findings.

This lack of translational research is one reason why Indian science has struggled to help raise living standards for most of the population, says Yamuna Krishnan, a biochemist who trained in India and now runs a lab at the University of Chicago, Illinois.

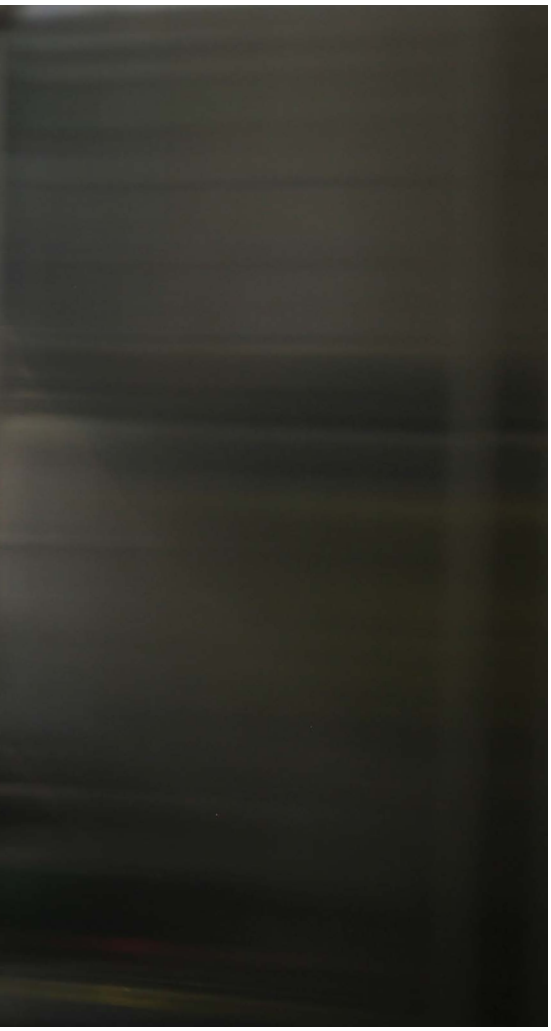
According to the World Bank, 10% of the population in 2019 lived below the poverty line (down from 22% in 2011), causing social problems, especially in rural areas. More than 12% of Indian schoolchildren drop out of secondary school, with girls more likely to do so than boys.

A return on investment, through innovation and a better quality of life, is why many countries invest so heavily in science, even though the extent of that return is difficult to quantify.

"The money that goes into scientific projects goes back into the Indian infrastructure," says Somak Raychaudhury, an astrophysicist and vice-chancellor of Ashoka University in Sonipat. "But in countries where industry is well prepared, the money more effectively goes into the economy." What needs to change for India to build a technology-transfer culture that can turn research investment into improvements in the quality of life?

Vemula solved his translational issue by drafting the policies himself and getting them approved by senior officials at the institute. He established his company, Sepio Health, in 2019 and expects to launch his first protective clothing next year. Colleagues at the institute are now following his lead and setting up their own spin-off companies, using the policies and paperwork that Vemula established.

"Now this entire process can be done within two weeks," he says. "From the day you approach the institute, within two weeks we



can review the entire process and give the permission" to set up a company.

It is an inspiring story, but not every scientist manages to navigate the system, says Krishnan. Many simply do not have the time, skills or willingness to find a way through. Krishnan set up her own spin-off company, Esya Labs, to commercialize her research on a drug-discovery assay in 2016. "It was so hopeless [in India] that I didn't even try. I knew I had to move if I was to make it happen," she says.

"It's taken so long for someone to do this, to break through all of the barriers that exist between doing high-quality benchtop science and then translating it down to the ground," she says of Vemula's initiative. "But what is it that India can do at this point to make science innovation reach people in a more streamlined fashion", as opposed to these one-off stories?

She has found a stark contrast in how universities in India and the United States approach the application of results. "An organization really needs to have very clear policies and frameworks to engage companies or another institution," she says.

Lacking a strong record in converting basic science into applications, India has struggled to develop a society and an economy based on innovation, says Shahid Jameel, an Indian virologist currently at the University of Oxford, UK.

Despite that failure, India has achieved some impressive figures. The country's Biotechnology Industry Research Assistance Council has reported[3] that India's bioeconomy grew by 14% in 2021 to more than US$80 billion.

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"India has done very well in some sectors of the life sciences, but that's largely because of its manufacturing capability. It's not because of being able to discover fundamental knowledge that can be then translated into products and processes," he says. "If India is a leader in making universal childhood vaccines, that's because companies have invested in that technology. But those vaccines were not discovered here."

Policymakers do not always understand that different research areas produce progress at different rates, he adds. The astonishing speed of development in information technology, for example, is impossible to replicate in the life sciences, which require longer-term, stable financial support.

That's lacking in India, Jameel says, where just 37% of investment in research and development comes from industry (see *Nature* **619**, 681–682; 2023) – much lower than the 80–90% in countries with technology-heavy economies, including Israel, South Korea and Japan.

India spent less than 0.7% of its gross domestic product (GDP) on research and development in 2020, the most recent year for which data are available. In the same year, China's research expenditure made up more than 2% of GDP, and Brazil, a smaller economy than India, also spent proportionally more.

In India, promised government research funds often dry up or arrive late, which makes it hard to attract and keep junior researchers. "If I were a graduate student on a government grant today, and if I didn't get my salary for six months to a year, how will I be motivated to do anything innovative?" Jameel asks.

The subsequent lack of innovation in many sectors slows bottom-up development across the economy, and instead ties it to targeted short-term and top-down investment. One reason why India has posted strong economic growth rates over the past decade, observers say, is that it has prioritized investment in some sectors, such as IT, and boosted the use of goods and services by a relatively small proportion of the population.

These policies have created a boom in the Indian middle class, which has grown by more than 6% a year since the mid 1990s and now accounts for 31% of the population.

That strategy has led to some impressive growth figures: the Indian economy has grown by more than 5% a year for most of the past decade, and is forecast to grow at a similar, or even higher, rate in the coming years. But it leaves hundreds of millions of people behind, says Venni Venkata Krishna, who studies India's science policy at the University of New South Wales in Sydney, Australia.

"Over the past decade, or even much earlier, the inequalities have increased tremendously," he says. The trickle-down of benefits from science and technology to underprivileged sections of the population hasn't really happened, he adds, leaving enormous numbers of people in India working in the country's informal sector, without fixed working hours and wages.

How can the government improve the dividend it gets from investing in science? One way is to build stronger links between institutions, particularly universities and government research institutes. They tend to work in academic silos, with little collaboration or exchange of ideas compared with in other countries, says Jayant Krishna, chair in US–India policy studies at the Center for Strategic and International Studies in Washington DC.

In informal discussions between senior academics and government science advisers, India has considered reorganizing these institutions into clusters, he adds, to generate critical mass, enable more cross-disciplinary research and encourage partnerships with private industry. But discussions between senior academics, advisers and government officials over even the basic outline for such a scheme have made little progress.

"There was no consensus" on whether such clusters should be arranged around scientific themes or geography, he says. "In India, you know, any such people have become used to working a certain way. Changes do not happen that easily."

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1. Boedeker, W., Watts, M., Clausing, P. & Marquez, E. *BMC Public Health* **20**, 1875 (2020).
2. Thorat, K. *et al. Sci. Adv.* **4**, 1780 (2018).
3. Suresh, N. & Chandan, S. R. *India Bioeconomy Report 2022* (Biotechnology Industry Research Assistance Council, 2022).