



Focus on quality, not just quantity

China publishes huge amounts of scientific research. Now it must make more of it worth reading, says **Changhui Peng**.

China's recent rise to scientific superpower has been striking. A report published earlier this year by London's Royal Society found that China now publishes the second highest number of scientific papers and that, by 2020, it could be the world's dominant producer of scientific research.

China has intensified its investment in research and development in recent years. Spending has grown by 20% annually since 1999, and has now reached more than US\$100 billion a year. The Chinese government has urged scientists to publish in highly respected English-language journals, offering promotions and other rewards as incentives; and many Chinese universities have attempted to boost their rankings in the Shanghai Jiao Tong University's world university table, which is weighted heavily towards articles published in *Science* and *Nature*.

However, despite the enormous progress made in China during the past few decades, the quality of its research seems not to have kept pace. The Royal Society report used the number of times a paper is cited in the scientific literature as a proxy for quality. It found that between 1999 and 2008, China's citation share rose from almost nothing to 4%. However, this is dwarfed by the 30% share held by the United States. And although China ranks second to the United States in terms of publication output, the report found that, in 2008, it ranked only joint ninth in citation numbers. This suggests that China's dramatic proliferation of scientific papers does not reflect quality research. China still has a long way to go to become a major player in the scientific arena and, to do so, I believe it must address these key areas.

First, data sharing. Wide distribution of information is key to scientific progress, yet traditionally, Chinese scientists have not systematically released data or research findings, even after publication. With so much emphasis on publication, data sharing is regarded as less important, and rules to encourage or compel such behaviour are inadequate. Moreover, institutions want to monopolize their data in the interest of their future scientific reports.

There have been widespread complaints from scientists inside and outside China about this lack of transparency. What data are made routinely available are often satellite measurements made for meteorology or large-scale background Earth-systems science records. Usually incomplete and unsystematic, these data are of little value to researchers and there is evidence that this drives down a paper's citation numbers.

Alongside better data access, China must do more to monitor and punish widespread academic misconduct, including plagiarism, which occurs as a consequence of the emphasis placed on publishing large numbers of papers. The CrossRef service, offered by the nonprofit association

CrossRef, could help Chinese publishers to identify plagiarism, by comparing the content of a submitted paper to a continuously updated database of published work.

The third area that needs improvement is international collaboration. Fuelled by a desire to work with the best people, as well as by advances in communication technologies and more affordable travel, international scientific collaborations are on the rise. According to the Royal Society report, the past 15 years has seen a 10% increase in the number of published articles that are internationally collaborative. There is also a strong correlation between citation number and the number of collaborating countries (up to a tipping point of ten countries).

There is already progress here, and China is beginning to open up. The Chinese Ministry of Science and Technology has signed treaties for scientific and technological cooperation with more than 100 countries. Under these treaties, the Chinese government is encouraging scientists to cooperate and exchange data with international organizations. China is also welcoming international scientists to come in and set up long-term cooperative initiatives. These efforts should be accelerated and their profile raised. Only by participating in more international scientific collaborations, such as the Intergovernmental Panel on Climate Change or the FLUXNET global network of micrometeorological tower sites, can China catch up with the United States and Europe.

The final area is the way in which China addresses complex and interrelated global issues — including climate change, Earth-systems modelling, carbon-capture technologies, biodiversity and resource security. To be a scientific superpower, China must encourage its scientists to play a more prominent part in addressing these pressing challenges. Chinese scientists should think globally and put themselves at the forefront of cutting-edge science. They must demonstrate leadership, developing new research initiatives and chairing international programmes. A good example is the Third Pole Environment programme, led by the Chinese Academy of Sciences' Institute of Tibetan Plateau Research in Beijing, which aims to pool international resources and expertise to study the interactions between ice, water, air, ecology and human behaviour.

The time has come for China to consider how best to boost the quality, rather than the quantity, of its scientific output. The steps I have outlined will provide a platform to strengthen the impact of China's research and contribute valuable science to the world's most important questions. ■

ALTHOUGH CHINA RANKS SECOND IN TERMS OF PUBLICATION OUTPUT, IT RANKS ONLY NINTH IN CITATION NUMBERS.

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