

- They can help in **resource mapping** of earth as they change their direction and spin based on the medium.
- **Understanding the universe:**
 - They are helpful in **understanding of dark matter** (which constitutes 85% of the universe), as they are one of the few particles that can pass through it.
- **Understanding the earth:**
 - **Rapid analysis of geo-neutrinos** (produced by radioactive decay of uranium, potassium and thorium in the earth's crust) could provide vital seismographic information & may help us detect early defect inside the earth.
- **Technological applications:**
 - They may have applications in medical imaging like X-ray machines, PET scans, MRI scans, etc.
 - They can **revolutionise communication systems** as neutrinos can pass right through the earth and thus, neutrino-based communication systems would be better than round the earth communication through cables, towers and satellites. Further, there would be no data transmission loss as they rarely interact with other particles.

The Indian Neutrino project will also give a boost to scientific studies in India and encourage students to take up Science and Research as profession. Furthermore, the project has been gaining urgency in recent years with China also announcing the construction of a similar neutrino observatory in Jiangmen province.

20. Among others, low R&D expenditure, is a key challenge facing the innovation ecosystem in India. Discuss.

Approach:

- Introduce by giving a brief status of India in current global ranking in context of innovation.
- Discuss in brief the challenges that are being created due to low R&D expenditure.
- While mentioning few other challenges, discuss the steps taken to overcome these challenges.
- Conclude by giving a way forward.

Answer:

Global Innovation Index (GII) has ranked India as the 57th most innovative nation in the world in 2018. India is gradually climbing up the ladder in innovations but still full potential needs to be realized for all round sustainable economic development in the wake of growing global competitions and changing scenarios.

Among various challenges low R&D expenditure is a major challenge that is being faced by the country's innovation ecosystem as:

- Though the **gross expenditure on R&D (GERD)** has shown a consistently increasing trend from around Rs. 18,000 crore in 2004–05 to around Rs. 61,000 crore in 2016–17 (Economic Survey, 2017–18). However, as a fraction of GDP, public expenditure on R&D has been stagnant at less than 1% of GDP for last decade.
- Even **among other BRICS countries**, only South Africa lags behind India in terms of R&D expenditure.
- Furthermore, while the **share of the private sector in R&D investment** in most technologically advanced countries is as high as 65 per cent to 75 per cent, it is only about 30 per cent in India.
- **Low R&D expenditure can be attributed to reasons** like the restricting nature of Intellectual Property Rights (IPR) regime, thus creating a non-conducive environment for the private sector to contribute.
- Low fund allocation even to the top universities and institutions for creating adequate infrastructures is also hampering academia-industry research linkages.

Other challenges that are being faced in this sector are:

- **High Patent pendency period** i.e. approximately 6-7 years due to bureaucratic hurdles is creating challenges for Intellectual Property intensive industries like pharmaceutical, software, biotechnology, automotive, movies, music, etc.