Science, Technology and Innovation Policy 2020: Experts' Recommendations during 'Across the Table' Online Series Discussions - I

Science, technology and innovation (STI) are key drivers of any country's economic growth and societal well-being. To strengthen its STI ecosystem, the Indian Government has initiated the process of formulating its 5th Science, Technology and Innovation Policy (STIP) 2020. It has been jointly carried out by the Office of the Principal Scientific Adviser to the Government of India (Office of PSA) and the Department of Science and Technology (DST). The objective is to create a robust, holistic and transformative STI policy shaped by **'bottom-up, decentralised, experts-driven, evidence-informed and inclusive'** approaches. To achieve this, an expansive four-track consultation process has been adopted. The track-I process involves 'public and expert consultation process' under which six unique modes have been floated online to ensure inclusive representation from all segments of the society. These modes include: In Conversation With, Across the Table, Policy Compass, Open Letter, Thoughts for India, and Ideathon. The 'Across the Table' mode was a series of 16-panel discussions built around 21 identified thematic groups which are available on the 'Science Policy Forum' portal for public discourse. Readers are encouraged to go through the http://thesciencepolicyforum.org/ and engage in the drafting process of STIP2020. It is an opportunity to recognise and address the weaknesses of our previous science policies and come up with a more robust STI policy framework. Here, an attempt has been made to collate the recommendations put forward by experts during 'Across the Table' mode, in a two-part series. The first part includes five-panel discussions in the current issue of *Science Diplomacy*. The discussions have been edited for brevity and clarity.

1. Research & Development Ecosystem

The panel discussion titled '**Research & Development Ecosystem**' was aimed at addressing weaknesses in the Indian R&D ecosystem and suggest course-corrections to improve and strengthen it. The recommendations have been summarised below:

Collaborations and Partnerships: Collaborations and networking are crucial for promoting R&D ecosystem. These linkages may include educational, and research institutions, universities, industries, non-governmental organisations (NGOs), philanthropists, and other national and international organizations financing R&D. Presently, only 1.2-1.3% of our research output involves industries and universities interaction. We need to establish more linkages for dialogues and collaborations between industries and universities. A 'triple helix' model between University-Industry-Government should be incentivised. This cross-fertilization would eventually result in new knowledge ecosystems that would enable research being translated into meaningful impacts for society.

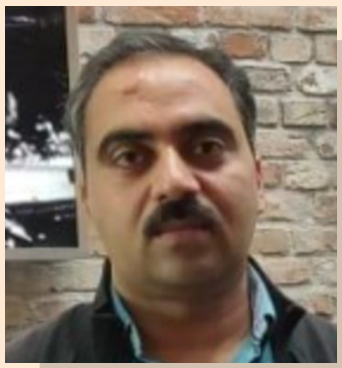
Augment R&D Infrastructure: Very few institutes in India can brag about the education infrastructure. Basic infrastructure is missing in universities. There is a lot of heterogeneity in R&D investment with a few regions and states getting a sizable chunk of it. The state universities, thus lag in research activities. The faculties' job is restricted to teaching without any research, which also impacts the quality of imparted education. The panel asserted to expand R&D ecosystem beyond the elite institutions and provide sufficient infrastructural support in developing appropriate research culture and capabilities in R&D institutes and universities located in tier 2 and tier 3 cities.



Prof. Gagandeep Kang
Christian Medical College, Vellore, T.N.



Prof. Sher Ali
Director, Centre for Interdisciplinary Research in Basic Sciences, Jamia Millia Islamia, N.D.



Prof. Vivek Kumar Singh
Professor, Department of Computer Science, Banaras Hindu University, U.P.



Dr Bhaktee Dongaonkar
Postdoctoral Researcher, National Centre for Biological Sciences, Bengaluru

Leadership Training: Early-career scientists and researchers should be provided with adequate independence to explore various possibilities. Their efforts should be reinforced with consistent funding, reliable infrastructure, manpower exchange, timely support and encouragement. Risk-taking attitude needs to be inculcated and supported. The emphasis was laid to create a right working environment that stimulates and encourages both academia and research. Greater representation of younger scientists in decision-making bodies should be preferred as per their areas of expertise. Give sabbatical to scientists at higher positions to spend a few months in other institutes, interact with students, expand a research program, establish new links, observe the administrative requirements and built a framework that could be beneficial for own institute.

Merit-Based Selection: Selections should be purely based on merit. It implies to each level starting with the higher education, faculty members, head of the institutes and selection-committees' members. Their selection should be transparent and based on their subject expertise and proven scientific excellence. The evidence-based selection should apply during promotions too. Indian Council of Agricultural Research (ICAR) is a good example where both types of selection process exist: entrance exam followed by an interview at the entry-level and subject or research-based selection through an interview at higher-level. Efforts should be taken to harness the local talent and promoting them. Age restrictions imposed on academic or research positions should be disposed of, a point highlighted in the 'Equity and Inclusion' segment as well.

STI Indicators: These indicators help in characterising and analysing a country's policy implementation, rules and regulations, the status of institutions, their infrastructure and capabilities. The panel accentuated on designing the right indicators which present a complete and true picture of India's R&D ecosystem. So

far, it is restricted to the number of PhDs, projects funded, publications, patents, citations, etc. The used indicators by other international organizations such as the Organisation for Economic Co-operation and Development (OECD), the World Bank, etc. are crude and present a partial picture. Thus, there is a need for developing country-specific STI indicators for evidence-based STI policy up-gradation.

Fiscal Support: The government should increase the budget in R&D. Presently, the funding support to R&D in India is significantly lower than other developed nations (0.7% for India vs 2.1% for China and 2.8% for the USA). New strategies should be placed to attract R&D grants from various sources such as non-governmental organisations, non-profit organisations, private sectors, state governments, philanthropic groups, charitable foundations and international funding agencies. Perhaps, a few extraordinary incentive mechanisms could be created to encourage private sector companies to fund R&D. Creating services for private companies at research institutions should be encouraged. This will bring funds to boost infrastructure. A few institutions have taken initiatives in this direction but more diverse services need to be generated. Corporate social responsibility (CSR) fund is a unique initiative to drive their participation and support for strengthening R&D institutions in India.

Ease of Doing Science: Consistent efforts are required to ensure the 'Ease of doing Science'. Government rules should be more flexible, and processes should be automated or digitised ensuring less paperwork, speed, transparency and reliability. Over the years, researchers have faced financial problems due to non-disbursal of funds at regular intervals. The responsibility of those monitoring fund disbursal and annual assessments in funding agencies should be fixed.

Multidisciplinary Education: Multidisciplinary education is the future. There is a need to set-up more diverse kind of institutes. Interdisciplinary and transdisciplinary research should be promoted. More start-up incubators, accelerators and corporate venturing should be established to advance India's STI ecosystem.

2. Equity and Inclusion

The objective of this panel discussion was to evaluate the significance of diversity in augmenting STI and harness the full potential of the available workforce.

Prof. Godbole addressed the issue of gender disparity and laid stress on maintaining gender equality. She exhorted of India's version of the Athena SWAN (Scientific Women's Academic Network) Charter that is used around the world to support and advance gender equality in higher education and research institutions. STIP2020 should aim to increase retention of women after PhD to fully utilize their enormous potential in Science, Technology, Engineering and Mathematics (STEM). Age barrier at every level should be abolished. Gender-neutral policies, including adequate parental leave for both men and women, should be devised. Introduce measures such as setting up day-care centres in institutions, tenure extension policies for women who need it due to childbirth and flexible working hours. Getting rid of implicit biases against women in academia is a must. Promoting and encouraging women in leadership positions are required. A more inclusive policy demand equitable and effective participation. Prof. Godbole also elaborated on the need to have last-mile connectivity for greater integration. She envisaged creating a mechanism enabling government agencies to work with NGOs as the latter has better connectivity on the ground. Bringing in the local corporate world through CSR could create channels for knowledge and resource exchange.

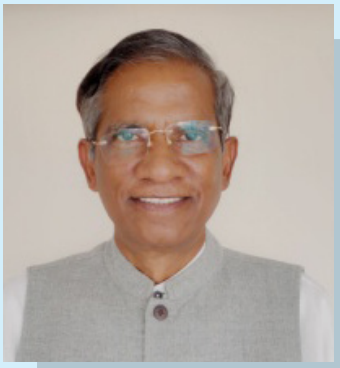
Prof. Kattimani stressed upon the need to include indigenous and traditional knowledge holders into mainstream science to make the best use of their competence. Combining the grassroots innovations with newer technologies such as information and communications technology (ICT) could help to unleash their commercial value, by proving their uniqueness and genuineness. He also suggested to set-up related incubation centres near villages to have functional connectivity and an enabling environment that can strengthen the



Prof. Rohini Godbole
Professor Emeritus, Indian Institute of Science, Bengaluru



Ms Jyotsna Sitling
Principal Chief Conservator of Forests – Van Panchayat, Govt. of Uttarakhand

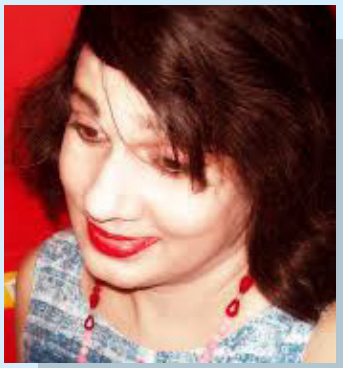


Prof. T.V. Kattimani
Vice-Chancellor, Central Tribal University of Andhra Pradesh

grassroots innovation ecosystem. He underlined the need to devise a mechanism to connect the traditional knowledge holders with scientific institutes to get that information dispersed or translated for the general public. More investment should be diverted toward the base of the pyramid of the scientists. At present, more money is spent on the top of the pyramid.



Dr Sanjay Mishra
Head, KIRAN, INSPIRE-MANAK, Department of Science and Technology, Govt. of India



Prof. Dr A. Mani
Senior Member, International Rough Set Society, Visiting Faculty, HBCSE, TIFR, Mumbai

Dr Mishra highlighted the under-representation of women in the workplace. He elaborated on bringing out diversity in the workplace and said, 'Diversity is a virtue, not a weakness'. More diverse is the team, better is the performance and productivity. Not only gender but ethnic, regional, geographical and linguistic diversity should also be considered. Removal of such disparities will bring out positive change and aid in providing a more robust ecosystem. Science should be available in local and regional languages. The definition of science should be expanded to include social sciences, anthropology, etc. Therefore, a suitable system should be crafted to facilitate and reap the benefits of diversity in STI.

Ms Sitling spoke about knowledge access, assurance and affordability. Ensuring affordable access to information can open up new avenues and help overcome many pressing societal problems. Innovation can be a tool to achieve social equity. She proposed to develop a newer database for R&D and patenting. The innovations' tracking indicators are not very sensitive. Hence, an advanced metric is required to monitor the strategies and roadmap of future science policies.

Dr Mani pointed out the significance of gender education. Creating awareness via gender sensitisation workshops for staff and faculty members should be conducted regularly at all levels. She pressed the idea of the creation of an 'Office for Equity and Inclusion' in every institution. These will act as hubs connecting all women in the institution and promoting stable mentorships and support networks.

3. STI Policy Governance and Program Linkages

This panel deliberated on a critical issue underlining how policies should be established, implemented, monitored and reviewed routinely. It is imperative to have an interlinked and structured mechanism where the roles and responsibilities are clearly defined for an effective policy framework.

STI Statistics: 'Data is the new oil' stated Ms Sinha, Secretary S&T. This phrase was coined in 2006 by Mathematician Clive Humby, who further added that, like oil, data is valuable, but if unrefined it cannot be used. Thus, there is a huge potential in extracting information from the scientific data which can be leveraged for profits. Training in STI statistics must be provided to benefit from the huge data being generated each day. A strong program for building data architecture has to be established. It may even require setting up an institution engaging existing statistical institutes and hire human resources (data scientist, data engineers, software engineers), research and technological resources. She also asserted the need for a national compendium or inventory of not only PhDs, postdocs but science journals, ancient literature, monographs, etc.

Science Outreach and Communication: Orientation of administrators in science communication should become an integral part of the orientation programme of all training institutes which produce academicians, science administrators and communicators. Science writing is not easy and is still not actively practised by most of them. Therefore, more investment is desired in enhancing science communication skills among scientists, administrators, and academicians. Online courses should be designed as per the demand of stakeholders. Foster necessary ecosystem by providing incentives and awards to those who are involved with science communication and outreach.



Dr Hiro Bhojwani
Former Head, Research Planning & Business Development, CSIR



Ms Mugdha Sinha
Secretary S&T, Govt. of Rajasthan



Dr Jatinder Kaur Arora
Executive Director, Punjab State Council for Science and Technology



Prof. Sujit Bhattacharya
Professor, AcSIR; Chief Scientist, CSIR- NISTADS

Science, Technology and Innovation Councils: With an aim of inclusive growth, the councils should include representation from various stakeholders such as eminent scientists, academicians, science administrators, chief secretaries of states, industry members, leading professionals, bureaucrats from the centre as well as from states. State boards need to be empowered and encouraged to contribute more in the innovation process. Rajasthan has many cohorts such as biotech cohort, IPR cohort, etc. that allows better connectivity. Other states should also focus on developing such cohorts. State councils should be given the liberty to customise as per states' needs. An informed strategy and forecasting mechanism (autogeneration of problems to be addressed) should be devised.

Funding State S&T Innovation Councils: Ministry of Science & Technology, GoI has suggested finance commission to earmark 2.5% of state allocation for R&D. The centre should invest an additional 2.5% as an incentive to state councils to motivate them to take up STI seriously. If funds start flowing, state S&T councils can upgrade themselves by undertaking bigger projects.

Coordinated Approach: At present, lack of coordination among various ministries, and departments is a major constraint as they are working in silos. There has to be vertical and horizontal integration between the various actors at all levels (central, state and regional). Coordination can be achieved in implementation processes through joint programming. A proper governance mechanism should be established where the efforts are aggregated at the central level and should percolate down to the state level.

Connected and Competitive Strategy: State innovation councils should be more connected. Providing a single platform for sharing state activities' data would help in motivating and promoting states to compete and do better. Competitive collaborations between states are required. Regular sessions between state representatives and secretaries of DST, Department of Biotechnology (DBT), etc. can help in seamless integration and constant exchange of good practices, ideas and mutual learning. States need to be truly plugged in the national circuit. Hence, an institutional network is to be created to solve common problems relating to issues of regional concern, such as stubble burning, peaceful sharing of water resources and ways to achieve sustainable development.

Fostering Linkages: Both formal institutional linkages and informal networks between state councils and the centre should be strengthened. A well-structured coordinating body to see how the programs are linked at national, state, sectoral and regional levels should be set up. More efforts should be concentrated on establishing linkages via joint planning, joint implementation, division of tasks, and sharing of information and resources.

Creating Awareness: The science policies should be recognised as national policies for all citizens. They should be outcome-based and designed for a small duration (five years). Instead of long policies, small output-driven schemes should be advocated. Policy drafting should be simple, readable, understandable and action-oriented. Policymakers and parliamentarians need to be conversant with developments in STI, and their applications for the benefit of society. Regular sessions between scientists and government officials, ministers and legislators can help in creating awareness among all the stakeholders.

Best Practices: Entrepreneurship development institutes should be linked with the state and district innovation councils. District innovation councils should organise boot camps to identify local solutions and promote talent. Create linkages with bottom-up level. Expand the concept of innovation cities to the less-developed regions.

Paradiplomacy: At present, there is no integration at the international and state levels. There is a great need to establish partnerships directly between international bodies and state, regional and local governments. States must harness their abilities to create linkages with the foreign agencies. It is high time to establish an institute in the country for science diplomacy.

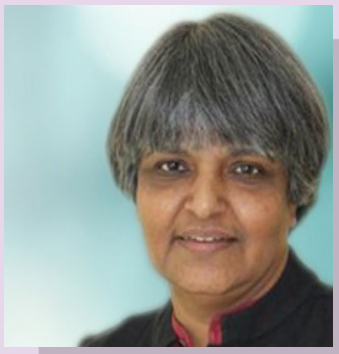
4. Skilled Human Resources and Capacity Building

With an aim to devise concrete strategies for advancing highly qualified and skilled human resources, the following action plan is recommended:

Research Manpower: With one of the lowest densities of scientists and engineers in the world, our focus should be on enabling talented young scholars to pursue education and training from the undergraduate level itself. For high-quality science education and R&D ecosystem, a continuous supply of scientifically-



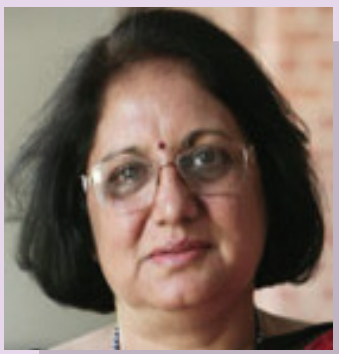
Prof. Pankaj Jalote
Distinguished Professor & Former Director, Indraprastha Institute of Information Technology (IIIT), N.D.



Dr Rupamanjari Ghosh
Vice-Chancellor, Shiv Nadar University, U.P.



Dr Shakila T. Shamsu
Former OSD (NEP), Secretary to the Committee to Draft National Education Policy, MHRD



Prof. Pratibha Jolly
Former Principal, Miranda House, University of Delhi



Prof. Gautam Menon
Professor, Ashoka University, Haryana

skilled people is mandatory. There is an urgent need to create a pool of STEM graduates, qualified PhDs and technologists.

Funding Support: To ensure highly qualified, innovative scientists and technologists, existing research institutions have to be supported and strengthened. Not only research institutions but universities should also be provided special support, enabling them to become centres of leadership and excellence. That would lead to a steady stream of qualified and enthusiastic young scientists. The funding should allow students and researchers to participate in under-graduate research attachments and doctoral and postdoctoral stints in foreign countries. It is crucial to the pursuit of excellent science as it introduces new networks and collaborations. Translational research ideas should be funded not only for permanent scientists but for experienced researchers, postdocs, too. Many talented researchers with great translational ideas fail to apply for big grants due to the lack of permanent positions. The translational research funding to the researchers without imposing the age-limit for at least five years can certainly bring new projects aiming to solve societal problems.

World-Class Infrastructure: India needs more world-class universities which are critical for breeding talent and driving innovation and economic competitiveness. Create good quality research universities, especially in states by providing them with autonomy, financial stability, modern equipment and access to information technologies. Good leadership and funding are crucial in building world-class universities.

Reform Educational Systems: The education system in India does not encourage inventiveness and creativity and hence, needs major reforms and changes. Those reforms should begin at primary level and then move on to secondary and senior secondary levels. Entire pedagogy has to be ameliorated to ensure all-round development of a child and to improve the quality of school education. Improving basic education,

stimulating young people to seek scientific careers and better distributing the scientific enterprise across the country is the need of the hour. Students should be trained for a range of career options with skill-sets that allow them to choose non-academic career paths. It is imperative to reorder curriculum broadening the scope of university education. The spiral curriculum could be one of the multiproned approaches. Emphasis should be given to the T-shaped education system imparting both depth and breadth of knowledge. In the present COVID-19 scenario, hybrid campuses offering a blend of online and offline courses should be explored. Recently, India's New Education Policy was launched on 29 July 2020.

Enterprise Education: It is the provision of learning opportunities which help students develop the attitude, knowledge and marketable skills of the entrepreneur. The government should formulate a range of initiatives and curriculum changes to promote and encourage enterprise education. The incorporation of such efforts into enterprise education in all phases beginning at primary school level would help address the need of a trained, skilled workforce.

Interdisciplinarity: Interdisciplinary education holds immense importance in today's world. We need to train our students in multidisciplinary fields to provide them with a global view of the world. To achieve this, the capacity building of teachers in the latest pedagogy and an exploratory approach to teaching and learning is desired. Refresher courses and continuing education programmes for teachers need to be refined to keep them conversant with the latest scientific advances and teaching practices. They should be regularly trained and updated in the latest educational trends' world over. The teachers should be encouraged by recognising and rewarding their efforts in academic settings.

Enhance Skills and Apprenticeships: Critical thinking and problem-solving approach skills are vital as they empower students to find effective solutions for social, scientific, and practical problems. Hence, skill-based learning should be encouraged. We also need to impart training that allows students to become problem-solvers, multi-taskers, systems-level thinkers, expert researchers, managers, communicators, and much more. The policy should aim to provide best practices for incorporating critical thinking instructional methods among students. By actively engaging students in project-based or collaborative activities can nurture an innovative mindset.

Integrated Network: Build a conducive space for enhanced participation of all stakeholders; private sectors, R&D, industry, international agencies and others. Dedicated efforts to strengthen linkages between industries and Micro, Small and Medium Enterprises (MSMEs) with research institutions should be made. Engage the non-governmental sectors also through in-house and extramural research, training, recruitment and related modes of support. Strong policy interventions are prerequisite to support strong and equitable partnerships. The latter has to be based on mutual strengths. It should also focus on facilitating international partnerships.

Scaling Up of Professional Education: Community colleges offer low-cost high-quality education locally. It amalgamates both skill development and traditional coursework, thereby enabling learners to shift directly to employment sector or higher education sector. It provides a flexible and open education platform which caters to community based life-long learning needs. It allows the students to have multiple exits after attaining a particular level of competency. There should be a provision of lateral exits and skills for Ph.Ds. Policy needs to focus on skill development of school dropouts too. Cluster-innovation centres are a good example where scholars are being taught industry-relevant skills. Concerted efforts should be made to successfully replicate such centres of excellence.

Interconnectedness: Facilitate fellowships, associateships and training programmes that keep scientists, technologists, technicians and students up-to-date with the latest information and connect with other research and educational centres across the world. More engagements and exchange of ideas at all levels of the education system with society should be exercised. Inspiring imaginations also play a crucial role.

5. STI Governance and System Interconnectedness

This panel deliberated on how STI governance can address the system interconnectedness under holistic STI ecosystem.

The main challenge to be addressed in STI governance is the lack of **coordination and connectedness** between academia, industry, different government agencies (including central, state and local councils) and other stakeholders. Even different ministries do not have a proper mechanism to interact. By enhancing ties between various stakeholders could help in strengthening the STI ecosystem in India. Hence, the panelists stressed the need to improve coordination and networking at different levels:

a. Interconnectedness within Government (especially, inter-ministerial connectedness)

b. Public-Private Partnership

c. S&T connect with social sciences

d. Science-industry linkages

e. Interlinkages between scientists and administration



Ms Deepanwita Chattopadhyay
Chairman & CEO, IKP Knowledge Park, Hyderabad



Dr Satya Prakash Dash
Former Head, Strategic Partnerships & Entrepreneurship Development, BIRAC



Prof. Shubha Tole
Professor, Dept. of Biological Sciences, TIFR, Mumbai



Dr Soumitra Pathare
Director, Centre for Mental Health Law and Policy, ILS, Pune

Another area demanding attention is a proper **evaluation and monitoring system**. There is no regulatory body for the timely disbursal of the research funds or fellowships. Researchers face complex funding challenges because of lack of timely financial support and sound infrastructure. Dealing with these problems affects their research quality. Most of the agencies either do not have grievance portal or they fail to respond to such grievances. Thus, there is a dire need of a new framework which is not only more transparent and accountable but agile too. Overcoming this growing apathy would require major changes both in the formulation of STIP2020, and the distribution of roles between different actors. The example of DBT/Wellcome Trust India Alliance (India Alliance) was discussed which has a very good system of grant governance and delivery. Such a mechanism can be adopted by all the government funding agencies for the timely delivery of the funds. Introducing diversity of solutions has to be taken into account.

Shoddy implementation of policies is a major constraint holding back the country's STI development. Efforts should be made bringing in more transparency, flexibility and accountability. It is a dire necessity to modify the outdated rules and regulations that impede the file processing. It is imperative to make the system simplified and nimble. A closer and better alignment of STI governance structures and functions (e.g. policy advice, steering and funding, coordination, and evaluation and monitoring) at all levels is the need of the hour. Dr Pathare remarked that in general, the errors of omissions are not punished, but errors of commissions are. This has to be changed and a more robust system has to be put in place. Those delaying file processing and timely fund release should be held accountable. System innovation is also a part of technology innovation.

To accelerate the STI development, the aim should be on **human resources**. Selections should only be based on merit and not confined by any biases towards religion, region, gender, caste or language. Nepotism, favouritism and cronyism should be discouraged. The efforts should be focused on diversity. To achieve gender equality, all women and girls need to be empowered. According to Prof Tole, we need to catch them young (10-12 yrs old) and have to be thoroughly funded. The upcoming policy should be imbued with a spirit of gender equality. The endeavours to include other vulnerable or minority groups to 'leave no-one behind' should also be taken into consideration. Ms Deepanwita spoke about publicizing and sharing success stories of women scientists that can serve as role models for motivating women's participation in science. It would be a true example of 'success breeds success'. The policy should aim to achieve socially inclusive development by increasing diversity in the workplace.

Creating an appropriate ecosystem conducive to foster **innovation systems** is vital. The grassroots innovations which are of small-scale yet, need to be promoted to stay ahead, particularly in terms of economic growth. These innovations should be linked with industries and incubation centres for green leapfrogging. The startups as well as MSMEs should be supported through seed funding, increased financial support, mentoring, etc. Efforts should be made to rope in non-profit organizations.

The session concluded with the following recommendations: (1) the connectedness between academia, industry, different government agencies and other stakeholders; (2) stronger evaluation and monitoring system with transparency, efficiency and certainty of processes; (3) more diversity that is inclusive of gender and citizens; (4) more resources and support to encourage Public-Private Partnerships; (5) closer alignment of national-level STI governance structures; and (6) connect with social science.