

Science and Technology Perspectives for India's Foreign Policy

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In today's inter-connected world, nation states develop their foreign policies to define their relationships with other countries, and for addressing all issues of international relevance. Foreign policy provides the broad framework that helps pursue a nation's national interest in global affairs at the bilateral, regional, and multilateral levels. Thus, a nation state tries to negotiate and influence the behaviour of other states through the instruments of its foreign policy. Importantly, today a nation's foreign policy needs to position the self-interest of the country in the emerging global economy. Contrasting priorities and self-interests of different nation states become the basis for disagreements. Diplomacy is a powerful tool of great relevance when there is disagreement among nation states. Persuasion through dialogue and engagement is the major method used in international diplomacy. Diplomats are expected to display an extraordinary ability in the art of persuasion in order for them to become successful negotiators.

Tools of Diplomacy in International Relationships

In formulating foreign policies, nation states employ various tools. While Economic Diplomacy, Defence Diplomacy and Public Diplomacy are well articulated tools for promoting international relationships, this essay presents a Science and Technology perspective on India's foreign policy.

Economic Diplomacy: Nation states have employed economic assistance in the form of financial transactions such as loans, aid, and donations for developing long term ties and relationships. The use of economic assistance

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as a diplomatic tool is long known, and several countries have deployed the tool effectively in exerting influence over other nations. In this model of economic diplomacy, the donor and recipient are engaged in a transactional relationship. The instrument of cooperation in economic diplomacy is generally intergovernmental agreements involving financial transactions.

Defence Diplomacy: Nation states have employed assistance in defence preparedness and the protection of a country as a powerful tool in developing their international relationships. Defence diplomacy is a widely adopted tool in the foreign policies of many countries in the world. It includes both passive and active forms of expressions. Defence related trade among various countries is another expression of Defence Diplomacy. Political alignments among nations and stated positions are integral parts of defining Defence Diplomacy. Intergovernmental negotiations and agreements form the most widely used instruments.

Public Diplomacy: Public diplomacy is emerging as a soft power in international ties in the emerging world order. Goodwill created among citizens of other nations through transparent actions is emerging as a new tool in international cooperation. Education, shared culture, and health care are among the ideal areas for Public Diplomacy in the modern world. In these areas, along with inter-governmental ties, other agents of cooperation are also leveraged. Public diplomacy through people-to-people contacts is rapidly becoming a powerful tool in the development of a nation's foreign policy.

Foreign Policy Implications in the Changing Political Geography

The realignment of power in the 21st century is becoming a significant reality day by day. With the influence of western powers waning to some extent, and an increasingly assertive role being played by rising powers like China and India in the global context, the geopolitical climate of the world is showing perceptible changes. Power equations are changing with the new economic world order. This has most recently been hastened by the global economic downturn that comparatively had less impact on the Chinese and Indian economies as compared to those in North America and Europe. Consequently, foreign policy equations and engagements are changing rapidly on account of the evolving economic scenario of the world. With a powerful economic base and a strong defence preparedness, China is emerging as a major power centre in the world. The developed world is trying to leverage its knowledge base and intellectual properties as new instruments of retaining their global influence and power over emerging economies like China and India.

India in Changing Global Power Equations: Emerging Opportunities

India is the second most populous country with a vibrant democracy. It is also one of the fastest growing economies in the world, and is expected to become the top three economies in the foreseeable future. For this reason, India cannot afford to remain only as a regional player. Since India's potential to emerge as a global power is now widely realized its growing influence in the international affairs has also been globally acknowledged.

India's economic growth and the tacit recognition of its de-facto nuclear status (after the Indo-US nuclear deal) by global powers have altered external perceptions of the country. India is viewed as an emerging power with expanding global clout; it is seen as a self-reliant peaceful nuclear and space technology capable nation. In this scenario, the amplification of its soft scientific and technological prowess through public diplomacy has become crucial for the country. As a new claimant to a place at the high table of global diplomacy, India has huge stakes in the arena of world politics. Maintaining and enhancing its influence remains a top priority for the country in the light of the changing world order. In the 21st century, the need for nation states to use soft power for enhancing their attractiveness in the international arena is ever increasing.

Public Diplomacy as a Tool for India's Foreign Policy

India should by design now expand people-to-people contacts across the globe through increasing its educational and professional exchange programs with foreign universities and organisations. At the same time, the country would do well in inviting prominent members of the civil society of other countries to promote a better understanding of Indian culture, interests, and values. Presenting India in a favourable light among informed citizens of the world should be its top priority.

Innovativeness, foresight, a marketing blitz, strategic planning, and psychological management are imperative for any successful public diplomacy effort. India needs to invest handsomely in public diplomacy, thus promoting 'Destination India' as an effective tool for connecting with nations, thereby providing a strategic leverage in foreign policy.

India enjoys a wealth of soft power resources in the form of her rich culture and history, democratic credentials, scientific and technological advancement, and a large as well as influential Diaspora. In the comity of nations, India has rapidly moved from the 13th (in 2005) to the 7th position

(in 2013) in terms of scientific output measured by peer reviewed international publications. The powerful alumni of the Indian Institutes of Technology have revealed the soft power of India to the world, and its strengths in the ICT space are well acknowledged.

The 'India–Future of Change' (IFC) initiative seeks to emphasise India's position as a catalyst of change. The IFC is a five-year initiative. It promises to take India to the world and get students and professional across geographies to compete, collaborate, and strengthen ties between India and the world. The IFC initiative signifies an innovative effort in enhancing our global footprint. It aims to communicate the emerging realities to a global audience and manage a collaborative dialogue with the world. However, Indian foreign policy statements often allude to the use of 'science and technology' in international cooperation in a limited number of places without referencing its untapped potential as a knowledge economy in the 21st century as a tool in building diplomatic ties.

Soft Power Advantage: Science and Technology in Public Diplomacy

Science is global, and is unfettered by geo-political boundaries. The pursuit of science is primarily passion and scholarship driven. Scientists are truly global citizens. The ability of the scientific community to transcend the barriers and divides of nationality and geography are well known globally. The pursuit of truth and advanced knowledge is a shared culture of most performing scientists in the world. It is becoming evident that the future empires of the world would be built around those who control knowledge. As an advanced form of knowledge, science offers an enormous soft power advantage in the emerging global knowledge economy.

Technology, on the other hand, is not context neutral. Neither is technology scale neutral. It is generally driven by market forces. On a diplomatic level, it has been often used as a tool of hard power with the employment of 'technology denial' tactics. Technology is also more directly coupled with trade rather than with science. Technology–Trade relationships are direct in emerging technology areas. Technology is also an important factor in the creation of jobs and societal value. Whereas economic diplomacy as a tool offers short term advantages, technology diplomacy can be employed as a soft power tool in empowering communities. Sharing technologies for increasing the living choices of the people as well as enhancing social and public good offers an enormous advantage in foreign policy. This soft power of technology has not been used effectively by many nations. Science and

Technology offer additional tools for leveraging soft power advantage in the foreign policy space in the emerging global knowledge economy.

Global Innovation Models: Potential Zone of Conflict in International Cooperation

Innovation is generally described as the first use of knowledge in the creation of wealth or societal value. Innovation, in the modern world, is competition driven. It seeks first mover advantage in the global market space, especially in the liberalized global economy and a dynamic market space. In the changing power equations of the world, access to innovations in the Intellectual Property Regulatory Regimes of the WTO is becoming a major factor. Access to innovations is likely to become a zone of conflict between the developed and the emerging economies. Currently used models of research—that is, those which need high investments of expertise and financial resources for developing innovations—do not offer the possibility of sharing the benefits of such intellectual properties with poorer nations. Thus, competition driven innovations become a form of hard power from the perspective of foreign policy.

Whereas technology can offer itself as a tool of soft power for public diplomacy, currently used global models of innovation across the developed (and many emerging economies) do not readily lend themselves to an inclusive social innovation agenda. India's innovation model offers a viable alternative for using innovation as a tool of soft power in foreign policy.

India's Innovation Model: a Soft Power in Foreign Policy Development

Whereas in most developed and emerged economies of the world, the private sector is the major investor in Research and Development (R&D), the Indian scenario is different. In this country, it is the government which is the major investor in Research and Development, with a 66 per cent share of National Gross Expenditure into R&D. Such a large share of public investment into Research and Development ensures that its benefits focus on public and social good. Moreover, India is one of the few countries among the developed and emerging economies to invest in grass-root and Open Source innovation systems. Affordability, availability, and accessibility of innovations have formed the focus of India's innovation model. Thus, this model also encompasses inclusiveness in addition to global competitiveness. There are several examples

of India's innovation models and products which have rendered service to the un-served markets of the world. This is the soft power advantage of India's innovation system, and since it is purpose driven rather than process driven, it can be powerfully leveraged in foreign policy perspectives with the developing world.

Technology Diplomacy: Public investment in Research and Development in India are increasing. There is potential for the country to make investments in, and build strategic alliances with, select countries through the tools of science and technology. Moreover, it may be a gainful proposition to also invest resources and science and technology outputs with long term advantages asymmetrically in some developing countries. Giving may be gaining in some select international partnerships; indeed, *giving through technology and affordable innovations* may amount to long term investments which are advantageous to India.

Technology Synergy: It is now becoming possible for India to invest in equal and reciprocal partnerships with some countries by virtue of the advantages of the Indian science and technology sector. When India is in a position to invest, we should be able to negotiate terms and conditions of sharing of intellectual properties generated out of joint research and development, using the principles of co-creation through collaboration. Such investments would add to national prestige on the one hand, and contribute to the global competitiveness of the technology base of the country on the other. *Symmetrical partnerships, with co-investments under the reciprocity and parity principle* into frontier areas of the science sector with some developed economies on a selective and proactive basis would be a high value proposition.

Technology Acquisition: International partnerships for acquiring technologies in frontier and cutting edge areas form an important area calling for attention in India's foreign policies. There is an emerging opportunity to build partnerships with advanced innovation ecosystems in the world to rapidly develop our own indigenous innovation ecosystems. There are some nations with advanced innovation capabilities but with a limited indigenous market for innovative products. With an already large and still growing market for products of high technology under-pinned by affordability, India is an ideal nation for technology partnership. *Acquiring technology with terms for indigenous manufacture*, coupled with an ecosystem for rapidly developing cost optimized solutions under partnerships seems a good and viable way forward.

Science, Technology and Innovation: Soft power for Indian Diplomacy

India offers the advantages of a) a growing market for consumer goods based on advanced technologies; b) established and well developed R&D institutions; c) manufacturing and cost optimization capability for products based on advanced technologies; d) a legal framework for dealing with IPR issues; and e) a demographic dividend. Thus, the soft power advantage of technology and the Indian model of innovation for cost-optimized solutions could be effectively leveraged in foreign policy development.

Parallel and Complementary Paths for International Cooperation

Multiple models are required for shaping international cooperation in Science and Technology between nations. Whereas the public diplomacy component of S&T demands bottom up models for building cooperation among scientists and engineers, strategic partnerships for co-developing and leveraging STI outputs would demand top down planning and decision making models. It is generally found that several advanced economies have deployed their external affairs ministries and diplomats for engaging in bilateral S&T cooperation with countries like India in the past. Only in recent times, there have been some indications of change among bilateral partners of India. S&T cooperation between India and several advanced economies is emerging as a soft power tool in the development of strategic cooperation.

India has adopted two parallel but complementary paths for developing international cooperation and ties during the last few years. Bilateral cooperation with countries demands a) bottom up engagement; b) joint project based activities based on co-funding and co-investments; and c) reciprocal mobility of scientists. India has signed bilateral agreements with more than 80 countries so far. Amongst them, more than 42 are in an active state of collaboration, and 10 amongst them in a super-active state of engagement.

India has adopted special models for developing and engaging in multilateral and regional S&T cooperation. This model recognizes the basic differences in approach needed for multilateral and regional cooperation in contrast with bilateral engagements. Multilateral and regional S&T cooperation demands a) top down planning; b) the selection of national priority areas of common interest when partnering nations for cooperation; c) programme rather than project type approaches, with long gestation time for maturation; d) inter-governmental ratification or agreements prior to active engagement in some cases; and e) a shared vision and commitment to scientifically address regional and global challenges.

Three Models Adopted by India for S&T Cooperation

India has adopted three complementary models for leveraging 'collaborative advantage' in shaping its S&T engagement with other countries during the last few years. They are a) Technology Diplomacy; b) Technology Synergy; and c) Technology Acquisition.

Technology Diplomacy model involves sharing of benefits from the Indian STI system without matching contributions from the international partners. An example of this kind of cooperation is the establishment of Africa S&T Fund, Pan-Africa doctoral fellowships, and several others with developing countries—like the ITEC program of the MEA.

The technology synergy model is built on the principles of reciprocity and parity. The sharing of objectives, co-investments, and the co-generation of shared values has formed the basis of such synergy based cooperation. The guiding motivation for such engagement is to bring 'value additions' to the national R&D pursuits and programmes. Typical examples of such bilateral cooperation are those with Australia, Canada, France, Germany, Japan, Russia, the USA and the UK. A good example of multilateral and regional cooperation of India in the S&T sector is with the EU. Current co-investments of India in technology synergy partnerships exceed US\$ 500 million.

Already, there is evidence for the co-generation of intellectual properties emanating from such investments. India has co-invested in the establishment of large R&D facilities abroad with other partnering nations. India has built or leased R&D facilities in large R&D infrastructure abroad. Good examples are the Indian beam line facility in Synchrotron KEK, Japan; the leasing of 13 beam lines in FAIR at Darmstadt; DESY Synchrotron facility at Hamburg; the Electra beam line in Italy; CERN in Geneva; and the planned contributions as a consortia member in the Thirty Meter Telescope (TMT) in Hawaii. In gaining access to these facilities, India leveraged bilateral strategic collaboration with respective partnering countries. Lately, several targeted R&D programmes have been launched with countries like France, Finland, Israel, Netherland, New Zealand, Sweden, South Korea, Russia, etc.

Technology Development and Acquisition is an important dimension of international strategic cooperation under the framework of the foreign policies of nations. Hitherto, such acquisitions have been limited to technologies for defence and strategic sectors. They form part of defence diplomacy. There are other untapped opportunities for developing technology acquisition models

for meeting the needs of non-strategic sectors as well. The future challenges of nations are likely to be related to the security of food and nutrition, energy and environment, and health care. India would, therefore, need to invest wisely in developing and acquiring technologies for securing the needs of food and nutrition as well as energy and environment. A recent example of consortia based collaboration in the joint development of technologies in the energy sector is that with the USA. It involves about US\$ 100 million joint investments into virtual Joint Clean Energy R&D Centres (JCERDC). The recent establishment of the Global Innovation Technology Alliance (GITA) between TDB (of DST) and CII has provided a unique platform for India to engage in active Industrial and Applied R&D with chosen countries like Canada, Finland, Israel, Spain, Sweden, South Korea, and the UK. These initiatives are aimed at creating new IP, processes, and products.

Status of India's Current S&T Cooperation

India's current S&T cooperation involves several active bilateral and multilateral as well as regional partnerships. They include a) High Intensity Cooperation: 10 countries and 3 multilateral consortia; and b) Medium level Cooperation: 25 countries and 6 multilateral consortia. The total value of the current S&T engagement exceeds US\$ 700 million which includes the investments made by DST/ DBT/ MoES/ICMR/ICAR/CSIR.

The current status of India's S&T cooperation is positive and improving, with several joint IPRs starting to flow, and the country emerging as one of the major players in international S&T cooperation with UK, Germany, Australia, USA, and the European Union. Exclusive bi-national R&D centres with France, Germany, Russia, and USA have been established as unique instruments for promoting bilateral STI collaborations by adopting flexible and novel ways. The Centres with Germany and Russia are solely focused on promoting industrial R&D. Programs to promote innovation and techno-entrepreneurship have been launched with Finland, USA, and the UK, with Israel in the pipeline.

India's Look East policy is yet to gain momentum in the scientific arena. However, with the support of Ministry of Science and Technology, Government of India, the Indian National Science Academy (INSA) has taken initiatives to develop regional cooperation with South Asian Science Academies. Strengthening ties in neighbouring countries under multi-lateral and regional engagement by leveraging the soft power of science and technology is a new strand in cooperation for India.

Leveraging the soft prowess of S&T for engaging with neighbouring countries—including China—has to be systematically cultivated and supported as a relationship and trust building exercise. Similarly, a new strand in S&T cooperation for strengthening ties with the neighbouring countries under the regional engagement framework could be effectively employed, particularly while scientifically addressing issues of common concern like disease, health, energy, food, etc.

Thus, there are many opportunities to leverage science and technology as a tool in diplomacy, and in the building of strategic alliances and partnerships with both developing and developed economies. The Indian science sector could play a vital role in using this as a major driver for Indian science diplomacy. Technology Diplomacy, Technology Synergy, and Technology Acquisition could form the three pillars in the Indian strategy for developing science diplomacy as a tool to strengthen our external relations in bilateral, regional, and multilateral contexts.

Developing Science Diplomacy as a Tool in Foreign Policy of India

In order to develop science policy as a tool in Foreign Policy, it is recommended that:

- Given that India currently positions science counsellors only in four countries, an effort should be made to create more science counsellor positions in carefully selected countries and regions seems necessary.
- The creation of a 'Think Tank' mechanism for developing strategic relationships based on mutual benefits will also be required.
- An institutional mechanism is needed for undertaking due diligence of our technology partners based on a strong science diplomacy policy.
- Technology diplomacy, Technology synergy, and Technology acquisition models may need further elaboration through institutionalized synergy between MOST and MEA.
- A structured exposure by FSI/MEA to India's career diplomats regarding the nuances of S&T development and science diplomacy is required.
- Long term fellowship schemes for developing countries to undertake doctoral and post-doctoral research in R&D institutions in India need to be established. This can be administered nationally, with a provision for substantial number of fellowships every year.

- The creation of a Technology Fund for the promotion of technology partnerships between developing countries is also needed. This may be built over a period of five years through synergy between the MEA and the Ministry of Science and Technology.
- Special packages for developing countries for strengthening their own R&D institutions through the sharing of technology and experience in select areas of mutual interest should be developed.
- Assistance should be given to least developed countries to emerging science-led-development policies by making sizeable allocations under a technology up-gradation fund. This can be implemented through collaboration between MEA and the Ministry of Science and Technology.
- The establishment of an institutional mechanism for undertaking scientific assessment and the scouting of technology with the ability to support need based contract R&D is also required.
- A bilateral fund based on the principle of reciprocity and co-investment of matching funds and equitable sharing of intellectual properties should also be established.
- Suitable advisory, oversight, and monitoring mechanisms should be put in place.
- Linking the various aspirations in the 2013 STI policy of the Government of India in areas of national and social importance—particularly relating to water, climate change, environment, energy, food, and health security challenges—should find inclusion in our Foreign Policy paradigm.
- An institutional mechanism for undertaking the scientific assessment of opportunities for technology synergy partner countries should be established.

Science offers a handy and soft tool for building diplomatic relationships with strategic allies in the modern world. The Indian science sector has reached such a stage of development that it can play a more effective and critical role for India's foreign policy makers. An institutionalized alliance between the Ministry of External Affairs and the Ministry of Science and Technology is the best way forward. This will ensure suitable advisory, oversight, and monitoring mechanisms that will allow a seamless flow between STI plans and policies with foreign policy imperatives.

India in the Global R&D Landscape

The research and development intensity of various nations in the world is generally indicated by two parameters: Full Time Equivalent Scientists per million population (FTE), and Gross Expenditure on R&D as a percentage of Gross Domestic Product (GERD/GDP). Employing 4000 FTEs/million and 2 per cent GERD/GDP as criteria, India figures in the low investment and low density quadrant, with less than 150 FTEs/million, and less than 1 per cent GERD/GDP.

It is necessary to plan and increase the number of FTE and GERD/GDP in the self-interest of India. However, in spite of the relatively low resource setting in R&D, India enjoys a niche position as a partner for International S&T cooperation. This is because our scientific output—measured both through publications and patents—have seen perceptible growth over the last decade. Thus, new perspectives on Indian foreign policy could well include Science, Technology and Innovation as a leveraging tool in science diplomacy.

In nations figuring in the Top Quadrant of High density and High investment setting (like the USA and Japan), the private sector is the major investor in R&D. Large scale investments into R&D demand that the return from high investments and high cost expertise is gained in a relatively short time. With the need for a return on investments of the order of 20 per cent per annum, innovations of the R&D sector in such high investment economies are generally priced out of the reach of several citizens of weaker economies. Countries like the UK, Germany, France, and Canada make medium level investments. Countries making high investments in the innovation sector generally focus on returns in shorter intervals of time. The Public and Social good components of R&D in such countries would be a smaller component of the R&D agenda.

China is rapidly moving into the medium research intensity group, with a significant share of Business Expenditure on R&D. With a relatively larger share of public investments into R&D, India is generally more focused on public and social good priorities. Thus, with a relatively high record of rendering innovations affordable, and with a relatively low resource setting but with high return on R&D investments, India is in a unique position to leverage science as a diplomatic tool.

Two Strategies for Leveraging Science as a Diplomatic Tool

Strategy 1

Leveraging the Grass Root Innovation Sector through Affordable Innovations

India's Open Source and Social Inclusion models, with a rich base of traditional knowledge and grass root innovation structure, are in an ideal position to be presented as an alternative system. A significant share of the global market is un-served by the current global R&D structures on account of affordability. India could position herself in the un-served global market by leveraging its grass root innovation system with a large penetration base. This would, however, require some integration between the various players in the innovation to market chain. It is in India's self-interest to create national capacity to serve the unmet needs of the global market, and offer such a capacity as a diplomatic tool for building international ties.

Strategy 2

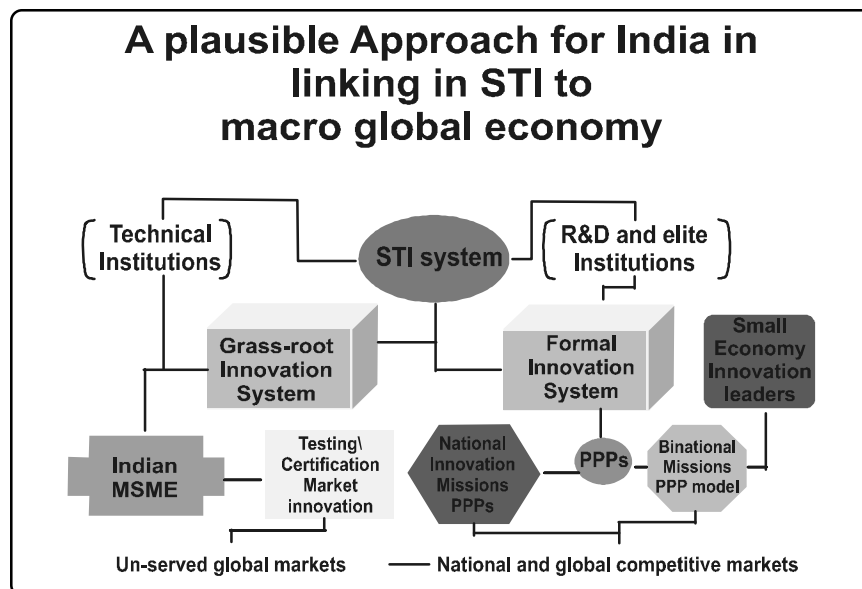
High-Technology Partnerships with Smaller Economies for National Needs and Global Competitiveness

India's share in high technology products in the global market is relatively low, and its import of high technology products is increasing. A sustainable strategy for developing the high-technology needs of India is required. There are some smaller economies with high investments in R&D, with limited domestic market and relatively smaller work force. Such economies need access to a sustainable and larger sized market. If products of their innovations were to meet a relatively larger sized market, scaling down prices would become feasible. On the other hand, India enjoys the benefit of investment in some of the most cost effective and high expertise R&D systems—as for example in the Indian Institutes of Technology, the Council of Scientific and Industrial Research, the Indian Council of Agricultural Research, the Indian Council of Medical Research, and other National laboratories. Thus, many untapped opportunities for leveraging gainful foreign collaborations with those innovative economies which have limited in-country markets—like Israel, Finland, and Switzerland—still remain.

Partnering with small economies and their innovators for high end national markets and with time global markets after cost optimization, with CSIR/IITs etc. as Indian partners deploying Bi-national missions for product/market segment is a strategy that merits detailed study and follow-up action.

The two pronged strategy suggested for developing an innovation system

for positioning India is presented below.



Science & Technology Cooperation with Africa: In Indian Foreign Policy Space

The Indian sub-continent and the African continent are ideally suited for deploying Micro as well as Small and Medium Enterprises as levers of economic change and the distributors of wealth. There are several opportunities for synergy and the co-generation of values through science. The India–Africa S&T Initiative under the C.V. Raman Fellowships for African researchers, provisions for institutional strengthening through a twinning arrangement, as well as the linking of innovation ecosystems through technology transfer programs has already provided the foundation. India has also announced a PAN-Africa doctoral fellowship scheme as a public diplomacy tool. The Indian grass root innovation model matches the profiled requirements and aspirations of several African nations.

The realities of STI bases in India and Africa are similar: a) a small sized FTE base of indigenous R&D manpower and brain drain are common challenges; b) limited investment base from the private sector; c) a large base of traditional knowledge not tapped for societal benefits and market advantages; d) the challenge of reaching the un-reached; and e) essentiality for inclusive innovations.

India needs to develop special strategies for increasing her presence in the global knowledge economies. S&T cooperation offers potential tools for enhancing India's image and foot print among the comity of nations. Africa is an interesting starting point for mounting a major S&T engagement as a part of our national foreign policy pursuits. Interestingly, some developed countries are already seeing the advantage in partnering with India in targeting the African market space.

Conclusion

The global positioning of the Indian STI system calls for the planned expansion of FTEs and investment per FTEs in different segments of the sector. India should embark upon strategic alliances with smaller economies in the innovation space. Grass roots innovation for serving the unmet needs of the world could give India leadership status. India's friendship with developing nations can be more easily built by sharing technological experience, rendering alternate innovation models, and delivering affordable solutions to important social challenges.

The soft power of science and technology in public diplomacy in the global knowledge economy could well become a handy tool. Science diplomacy offers itself as a tool to reckon with for India's foreign policy on the basis of our scientific and technological strength. The foreign policy of India could include building strategic Science, Technology, and Innovation alliances for the country with highly innovative but small economies. The Indian science sector seems to be ready now than ever before for this win-win formula.
