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Abstract

India has used science and technology for social development right from the beginning of planned development. The first time when television programmes were beamed through satellite, it was for education and not just entertainment. No other country perhaps began the satellite-based transmission in this manner. Likewise, green, white and blue revolution essentially happened through application of science and technology along with appropriate policy and institutional interventions. Having said that, it must be acknowledged that a very large part of Indian population feels excluded from the benefits of S&T applications. This feeling of exclusion has to be overcome if the goal of inclusive development in the Decade of Innovation has to be met. Several strategies recommended in the paper deal with [a] inclusive health [b] biodiversity based knowledge systems and grassroots innovations [c] mining the minds of masses for sourcing and sinking ideas [d] launching CHUNAUTI [Challenges for unfolding and augmenting technological innovations for social development] , [e] engagement with youth [f] handlooms and handicrafts innovation and diffusion, [g] indicators of sustainability science, [h] linking modern S&T with traditional arts and other artisanal goods, [i] sustainable land use and climate change, [j] learning from centenarians, [k] mobilizing employment programmes for mapping the mind and resources and [l] extending core support to S&T institutions for social inclusion and development.

Science and Technology for Inclusive Social Development in 12th Five Year Plan

Anil K Gupta¹

There are many programmes which have had considerable impact and yet the societal expectations remain largely unmet. Part of the dissatisfaction may have arisen from the scattered and fragmented nature of activities. Partly, as a result of economic growth and somewhat better living conditions, the aspirations have naturally arisen further. In any case, the continued vulnerability of people in disadvantaged regions and sectors poses a very big challenge before the development planners. The purpose during the 12th Five Year Plan thus is to make significant dent on the problem of poverty, environmental vulnerability and social equity. This will be achieved through large concerted programmes with strongly monitored deliverables involving inclusive innovations, institutions and initiatives.

The key strategies are:

1. Inclusive health:

- 1.1. Due to intensive agriculture, the soil nutrients have been mined heavily leading to deficiency of the micronutrients in the food chain causing several widespread health problems. There is a need to mount an All India Coordinated Research Project on soil, plant, and human health so that science of sustainable, affordable preventive health can be established and disseminated. It can also trigger functional food and nutraceutical development, ensure better income for the farmers in dry regions (where because of low rain, the nutrients don't drain and the food may thus be richer in the same).
- 1.2. Many traditional foods provide rich source of nutrition but the available knowledge has been very limited. So much so that many communities having access to such foods are getting dissuaded to continue their consumption due to various sanskritisation processes. We may have to set up service lab in collaboration with ICMR institutions such as NIN (National Institute of Nutrition) and DST institutions like NIF (National

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Innovation Foundation) and SEED programmes to characterize such foods and share the information with the local communities. Some of these foods should also become part of mid day meal scheme. The fact that almost half the children in India are malnourished, one has to explore new approaches the outcomes of which are affordable and accessible.

- 1.3. Validation of folkloric traditional health claims, which are not codified or included in the classical literature, has to be taken up in a time bound manner so that affordable medicines and therapies can be developed. In some cases, the continuing practices can be formally recommended after validation so that decentralized self-help health care can be ensured. A network of postgraduate institutions of botany, pharmacy and chemistry will have to be linked with similar network of ICMR institutions to create inter-sectoral synergy in the matter.
- 1.4. Developing technologies for mass mineral or herbal nutrition for immunization of children and preventive health care of workers under NREGA. Aim should be to get one self-help kit developed through SHGs or MSME in collaboration with AYUSH delivered to every worker under NREGA. Even a herbal soap for every worker will reduce the infections caused by insufficient personal hygiene. Making such soaps will generate jobs and market for neem and other such seeds.
- 1.5. Certification of healthy, science based practices of child delivery can give a boost to reduction in the mortality and morbidity in the process. The knowledgeable dais [mid wife] advocate many practices which are different from the prevalent medical advice but may have merit on scientific basis such as cutting of umbilical cord after ten minutes or so (when pulsation has stopped), delivery in dimly lit room instead of bright lit room affecting the eyes of the infant and delivery in reclining or squatting position rather than lying down position. DST, IGNOU, DHR could collaborate in achieving this purpose.
- 1.6. Low cost diagnostics and devices for water and food quality testing based on mobile telephones have to be developed to drastically reduce the incidence of water borne diseases and increase incentives for sanitation and hygiene in cooked food at home or on the street. With more than 800 million cell phones if even half or one third are assumed to be in rural areas, one can expect a huge market for the purpose. A

competition can be organized for encouraging young technology students to develop such devices through platforms like www.techpedia.in created by SRISTI (Society for Research and Initiatives for Sustainable Technologies and Institutions).

2. BIODIVERSITY BASED KNOWLEDGE SYSTEMS AND GRASSROOTS INNOVATIONS:

- 2.1. *In-situ* value addition: One of the major reasons for persistent poverty, social strife and despondency among local tribal and other communities living in and around forest regions is almost lack of *in-situ* value addition in various biodiversity based materials. Some people suggest that the relationship of the state with these regions is almost like internal colonialism. Several steps have been taken in the past by DST to develop technologies for vegetative dyes, oil of non-edible and edible tree based oil seeds, etc. However, complete value chain remains to be established.
- 2.2. In 12th Five Year Plan, one should aim at 50 per cent reduction in the tradeoff raw material unless valorized locally. It will require development of post harvest processing machinery, fractional distillation apparatus for generating library of phytochemicals and herbal extracts, electronic catalogues and a vigorous partnership with private sector to generate value added supply chain. NIF can try to leverage its MOU with Futures Group to create market for value added innovative products developed through this programme.
- 2.3. NIF should aim at validation and value addition in at least 2000 distinctive claims of local communities per year at the rate of minimum investment of approximately Rs.10 lacs. This would imply an expenditure of about 200 crores. This will include energy and other mechanical and electrical technological innovations as well.
- 2.4. NIF should aim at filing at least 2500 patents per year, some as defensive patents, costing around 7.5 crore per annum.
- 2.5. A Grassroots Innovation Fund [GIF] may be created to promote entrepreneurship, demonstration of public good technologies and dissemination for creating wider awareness and availability of innovation based products and services. A fund of Rs. 20 crore per annum may be allocated for promoting innovations by and for grassroots applications.

- 2.6. Dissemination of socially useful public domain technologies developed by the grassroots innovators (and may be others in due course) through mass channels like postal or railway department as mentioned next; but also through Krishi Vigyan Kendra network of ICAR. Unless large scale demonstration/trials take place, demand for even proven affordable technologies cannot be generated. Similarly programmes/campaign on radio/TV/print media may be planned for creating wider social awareness and results on the ground. Resources for widespread demonstration and trials don't exist. Assumption is that some solutions exist, but resources don't, hence the need for a vigorous beginning (Rs 25 crore for this comprehensive programmes may be needed every year to make some measurable and significant impact).
- 2.7. Creating Public Goods-Technology Acquisition Fund: an innovative window of social innovation is beings started this year by NIF which it intends to continue in coming 12 FYP. Sometimes, an innovator may not have sufficient resources to scale up his/her innovations or inventions (in private, public or informal sector). Yet some of these innovations *may need to be diffused for a larger social cause*. For instance improvements in design of a kerosene stove which saves energy may be very vital for national interest but the concerned innovator (as is the case with most of the innovators with NIF who have improved stove design) may have neither the incentive nor the capacity or both, to diffuse the design among large number of small scale manufacturers. Creation of a Technological Acquisition Fund may be helpful to acquire the licensing rights of such innovations and inventions for eventual out licensing these at low or no cost to small scale manufacturers under technological up-gradation program. Ideally the rationale behind having a Technology Acquisition Fund is to compensate those knowledge providers whose knowledge has potential for economic value addition. Later, this knowledge pool could be governed by open source philosophy so long as people meet their livelihood needs. TAF can also be used to pool available traditional knowledge practices and then create new innovations for public good with or without value addition but after rigorous scientific validation (Rupees Five crores per year) .

3. Mining the minds of masses: Massive engagement with masses for sourcing and sinking ideas

- 3.1. About 15 to 20 million people travel by train every day and yet we have not harnessed their imagination for generating ideas to solve problems of everyday life. Nor have we shared with them the ideas that they can use without much transaction costs and expert knowledge. It is proposed that a partnership is forged with Indian Railways to *source and spread ideas for larger social good*.
- 3.2. There are one lac post offices and about 6.5 lac inhabited villages. There is no better way of mapping the creativity of the masses than engaging with the postmaster and postman, the most credible grassroots functionary. All the open source technologies can be shared through wall newspaper, Bluetooth, broadcasting stations using mobile networks, door-to-door survey by the postmen and women with incentives for every accepted innovation and /or traditional knowledge practice. Never before a civilisational society has attempted a bigger engagement with grassroots. Since this is aimed at triggering experimental ethic and entrepreneurial culture, the role of government is to enrich the choices of local communities to try things out at their level with very low cost of failure.
- 3.3. Children in the schools have not been mobilized in a massive manner to imagine and innovate. The IGNITE competitions organized by NIF for last four years have revealed outstanding examples of ideas and innovations by school children, many of which have become products and some are likely to go to market soon. *Inverted model of innovation* implies children imagine and innovate, engineers and designers fabricate and companies commercialize. There is sufficient evidence in the country now to make this happen in a big way. INSPIRE Programme can be one channel through which in every workshop, we can organize half a day session on generation of new ideas and NIF can process these ideas. In addition, educational departments can be mobilized to spread the word about IGNITE competition in various state schools. One can also share innovations through children wall magazine and innovation comic books [may be in collaboration with Amarchitra katha with which NIF is likely to partner].
- 3.4. In every workshop of INSPIRE, an idea generation workshop of one or two hours could be organized so that seventy thousand students are encouraged to generate at least

one idea each. There is no doubt that it will give a great boost to Ignite contest being organized by NIF. When some of the ideas of these students get productized, patented and developed further to go to social and commercial markets, their confidence in S and T system of our country might further increase. In turn, this will help achieve the goals of INSPIRE program. Likewise, about 0.2 million students who get scholarship under this program could also be reached to send an idea each.

- 3.5. HBN magazine for INSPIRE: to help young learners learn from each other, re-invigorate cross pollination among them, Honey Bee magazine for children could be designed for each INSPIRE Participant. This will give voice and visibility to young INSPIRE participants. This will also keep them informed about global young inventors and scientists.
 - 3.6. Redesigning and reinventing National Service Scheme or creating new scheme for National Innovation Promotion Service involving college students to scout, spawn and support innovations for social good.
4. **CHUNAUTI:** *Challenges for **un**folding and **aug**menting technological **i**nnovation for society*
- 4.1. The Decade of Innovation will not meet its full objectives unless India decides not to live with problems, which have remained unsolved for centuries/decades. Unless we decide to address S&T problems of working class, farmers, artisans, etc., we cannot improve productivity and thus the wages or unfold entrepreneurial energy. Mahatma Gandhi had offered an award of 7000 pounds in 1929 to improve the design of spinning wheel within the output and performance parameters broadly defined. The present value of this award of Rs.1 lac, then would be about Rs.10 crores. It is time that we give *Chunauti*/challenges with attractive awards and try to get certain basic problems of our society solved once for all. Isn't it a pity that despite all the research on improved chulha [cooking oven] millions of women continue to use a simple three bricks or three stones resting oven for cooking food. In a country where fuel is so scarce having less than 25 per cent combustion efficiency is a social crime. It can be stated without much risk of exaggeration that problems, which affect women, have a much slower rate of technological change than the ones affecting men. It seems that even grassroots innovators have not been distinctively biased in favour of problems faced by women. Likewise, the problems of other disadvantaged groups including physically challenged

people need to be addressed by mobilizing not only grassroots innovations but also the best of the institutional science and even high tech options. **CHUNAUTI** will be a new programme jointly initiated by SEED and NIF involving a jury of outstanding public spirited scientists and technologists [some could be from other countries as well] which will judge entries mobilized through global competition offering at least Rs.50 lac to 1 crore or more prizes of 25 lacs each, for the winners and recognition and reward for runners-ups. India may decide these designs to be put in public domain or *Technology Commons* so that people to people learning is facilitated without letting firms extract undue rent from the same. Many of these solutions will be useful for third world countries. Such a contribution would obviously spread Indian influence and role in the developing countries in an unprecedented manner. A list of selected challenges circulated at National Innovation Council meeting is attached in annexure one.

4.2. CHUNAUTI will use several platforms. We can have global CHUNAUTI, national CHUNAUTI and CHUNAUTI for the youth [Yuva CHUNAUTI].

5. Engagement with youth:

5.1. Unfolding Dynamism of Youth for Innovation Based Enterprise Management (UDYIEM): This initiative will tap the potential of youth through techpedia.in, a SRISTI initiative for engaging youth with solving technological problems and starting social or economic enterprises where possible. This will become a highly responsive, fast track, non-beaucratized, trust based platform for giving wings to the purpose with passion among the young S&T community members. A note on the subject prepared in 1989 is enclosed in annexure two.

5.2. Gujarat Technical University has introduced a four credit course in third year for defining the problem of MSME, informal sector or grassroots innovators and 12 credit in the final year for solving it. Techpedia.in, SRISTI is a partner in this initiative. Unless we improve the innovative potential of MSME, major transformation in employment and livelihood situation will not take place. We should have dedicated funds for filing patents on behalf of students with a small equity [five per cent] being retained by the entity/SPV/joint sector company. The incubation support as well as mentoring support for the project and project-based enterprises can be mobilized through national

mentoring network [NMN]. Academy of Engineering and other professional associations can be mobilized for mentoring the technology youth engaged in inclusive innovations for inclusive development. Every engineering student must take up at least one project in the final year on a real life problem of informal sector or MSME. www.Techpedia.in has created a template, which can be scaled up for the purpose.

- 5.3. The creation of open source S&T lessons can also be attempted through youth platform so that an Indian language open source educational material library can be made in which bright students will contribute lessons with animation, video and other formats. What Khanacademy.org has achieved in US can easily be replicated and modified with multimedia, multi language capabilities.
- 5.4. National network of S&T departments: All the postgraduate and under graduate life science departments can be networked to map, track and where possible experimentally validate or value add in the knowledge around biological resources. If every student does at least one experiment during his under graduate and postgraduate programme to find the science underlying a traditional knowledge or a contemporary innovation, an extraordinary linkage between formal and informal science can be ensured.
- 5.5. Likewise, other science departments, whether physics, chemistry or mathematics can also contribute to explain, and expound on the various materials and manufacturing processes in small and informal sectors.
- 5.6. There is a National Council for S and T for Rural applications. This council apparently needs a statewide platform to link S and T departments with social needs and problems so that agenda for S and T research and innovations can be socially inclusive and responsive. The performance of S and T funding must thus be tracked or monitored more precisely in response to real challenges and problems of society. The earlier suggestion about all India network of S and T departments can thus need not focus only on grassroots problems but also look at other local and national agendas defined in programmatic manner. Without in any way diluting or chipping away the locally determined priorities, the concern is to create a bottom up agenda development process. The students should interact with MSME/society and identify the problems,

discuss at departmental level and then escalate these to state level councils and process of support should take place. I am not sure whether every request for support should come only through such a channel. If some departments come together and want to pursue a network research for solving a rural problem, should not they be enabled to submit a project to the national council?

6. **Handloom innovation and diffusion:**

6.1. Millions of people eke out their living through handloom activities all over the country. In northeast and J&K, it has a very important role in generating livelihoods. There are many parts of northeast where almost every house has a loom. However, the innovations in handloom and also low cost affordable power loom have not received adequate attention. NIF and other organisations have a large collection of innovations from Manipur, Assam and other parts of northeast, Tamil Nadu, Andhra Pradesh, and other regions. These need to be valorized, disseminated and where necessary subsidized to improve productivity in this sector. The earlier work of SEED, DST on vegetative dyes can be dovetailed with yarn dyeing and weaving innovations so that emerging market for green fabrics can be harnessed to stimulate more innovations in this sector. Private sector will have to be involved in driving some of these innovations to market.

7. **Indicators of sustainability science:**

7.1. Local language databases of biodiversity, ecological and climate change indicators, pedagogic tools, etc., need to be developed for expanding the participation of common people in S&T pursuits.

7.2. Some of the questions which can help us assess the performance of S&T indicators for inclusive development through local innovations are²:

How much resources are allocated in S & T budget to add value to the unique traditional knowledge as well as green grassroots innovations to make development process more inclusive?

² Gupta, Anil K., [2011] Indicators for the Assessment of the local and indigenous innovation, Invited paper for the Roundtable Meeting on Science, Technology and Innovation Global Assessment Programme (STIGAP), organized by UNESCO, July 4-5, 2011, Paris, France

What kind of incubation support systems have been created, how many papers have been published in science journals expanding upon the leads taken from the ground? How often have the knowledge providers and grassroots innovators been acknowledged or included as co authors in the scientific publications based on the lead provided by them?

How many patents have been filed by public or private institutions in the name of grassroots innovators with the property rights assigned to them? To what extent the IP system has been modified to enable people to people sharing of information while people to firm being mediated on the licensing basis?

How many experiments or research programmes have been started, stopped or modified on the basis of feedback from grassroots innovators? Whether the list of programmes initiated on the basis of grassroots innovations have led to new partnerships across sectors and institutions to reflect the new priorities of inclusive development?

Whether challenge awards have been announced to address Millennium Development Goals through inclusive innovations at grassroots.

Whether science and technology students are required to do a final year undergraduate or post graduate project on a problem affecting disadvantaged communities and/or their innovations to solve the same?

How many post graduate theses have been done blending formal and informal science? Are there any special awards for such theses to incentivize engagement of young minds with the problems of masses?

Are there any lessons based on green grassroots innovations included in the school text books and curriculum of higher education?

Are grassroots innovators allowed to use the workshop facilities available in the formal S&T system to experiment on their ideas?

How much fund is allocated for investment in the development of ideas and innovations at grassroots by themselves, R&D institutions and private sector?

Are there any dedicated labs mandated to add value to peoples' unique knowledge and if so, what has been the outcome?

How much time is allocated on the public media for creating awareness about grassroots innovations?

Since risk capital plays an important role in generating entrepreneurial opportunities for the common people, how many micro venture innovation funds [MVIF] unlike micro finance funds have been created for different sectors and spaces?

How much subsidy/investments have been allocated for large scale trial, demonstration and on-farm use of grassroots innovations?

Have mobile or stationary multimedia, multi language exhibitions of innovations been created to help people learn in their own mother tongue, even if they are illiterate and not just from local but also exotic innovations. Three barriers to learning, i.e., language, literacy, and localism can be overcome only through multimedia, multi language interfaces and databases.

Given the widespread problem of nutritional deficiency among the children [50 per cent children in India under the age of five are malnourished], special focus is needed, traditional foods, innovations in food processing, storage and blending to overcome this problem apart from taking care of clean water and many other associated factors. The indicators that point attention to specific interventions in promoting innovations dealing with as widespread a problem as this need to be developed by looking at inter-sectoral S&T investments, programmes and messages.

8. Linking modern S&T with traditional crafts and other artisanal goods:

- 8.1. One reason why many crafts and artisanal goods are losing out in the market place, is the absence of the embedding modern technologies to give a new age experience to the customers. For instance, the terracotta elephants made in Edka village of Narayanpur, Bastar, Chattisgarh are losing out customers due to conflicts and also lack of demand from modern consumers. If sound triggered chips could be integrated in these elephants, single clap will trigger elephant's trumpeting, two claps will trigger the story of the village and three claps may trigger the story of terracotta clay history. Modern electronics can thus be easily embedded in traditional crafts.
- 8.2. The tools used by the artisans, whether leather worker, utensil makers, wooden craft people, have not been modernized. The dust from the wood cutting table is not sucked through a suction hole on the table, thus creating occupational hazards for the workers. A Large number of such activities have never been benchmarked from energy, ergonomics, occupational health and efficiency, etc., and this has to be taken up during 12th Five Year Plan in collaboration with other ministries, if necessary.

9. Sustainable land use and climate change:

- 9.1. As mentioned earlier, there is a major problem of mining of soil nutrients. The electronic probes which can measure trace levels of nutrients in the soil have to be developed. When integrated with GPS system, these probes can create a 10 x 10 meter grid wise GIS nutrient maps for each farm and thus not only save use of chemical fertilizers but also help in applying farm yard manure more judiciously on the basis of deficiency map. The precision agriculture is the need of the hour for sustainable soil fertility management and DST institutions have to collaborate with ICAR to develop solutions for this long pending problem.
- 9.2. There is a need for an All India Coordinated Research Project on documentation of community perception of climate change, identification of indicators both ecological and physical, and systematic validation of these indicators. This will help in generating resilience and also learn from creative coping strategies evolved by the people.

10. Study of life experiences of around 100 year old people from knowledge, technology and lifestyle perspective:

10.1. In Indian culture, one of the most blissful wishes is to bless someone to live for 100 years. Ironically, when somebody lives for 100 years, we don't care. SRISTI had started a small study of documenting the experiences of centenarian grandmothers. Given all the lifestyle problems, only people who have right to advise about sustainable lifestyle and consumption are the centenarians. A country wide study of their experiences with regard to climate change, health, socio-economic changes and other aspects of their knowledge system could be very precious for coping with uncertainties in future.

11. Mobilizing NREGA for documenting traditional knowledge about climate change, eco-system properties, health, culture, etc.

11.1. If only five days of every worker out of 250 million people provided employment for 100 days, could be used for mapping their knowledge about technology, institutions and culture of survival, an extraordinary mapping of mind may take place. The S&T messages for improving productivity and quality of life can also be disseminated in the process. Mobile based system of dissemination and scouting can be identified for large scale, user driven content creation.

12. Core Support to S and T institutions for social inclusion and development

12.1. The core support to various institutions must continue during 12 FYP and mechanism to increase the input of S and T in their working should be developed.

NIF and the SEED Programme of DST will be very keen to create an eco system to stimulate innovation, generate widespread awareness about the available technologies and benchmark the challenges that need to be addressed through **CHUNAUTI** programme. The 12th Five Year Plan for social application of S&T innovations in formal and informal sector will require a basic transformation of scale, scope and speed of technological change.