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Pursuit of Inclusive and Sustainable Technology Development for Rural Population: Role of RuTAG at IIT Delhi

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Abstract: Countries around the world faces economic, social and environmental challenges in their pursuit towards inclusive and sustainable development. Interestingly, the promotion of sustainable technologies and development remain abstract with vague ethos and understanding. With an aim to strengthen grass root technological innovation and harvest outstanding traditional knowledge for sustainable development, Government of India launched National Innovation Foundation in 2000. In order to integrate higher level of science and technology intervention in the existing technologies at the grassroots, their dissemination, and need based rural development, Principal Scientific Adviser to the Government of India started Rural Technology Action Group (RuTAG) in 2004 at seven Indian Institute of Technologies. The present study gives a philosophical and comprehensive understanding about inclusive sustainable development, United Nation's Sustainable Development Goals (SDGs), Science and Policy Resolution (SPR), and Science and Technology Innovation (STI) in India, various rural programmes, and the significance of Rural Technology Action Group (RuTAG) and its initiatives.

Keywords: sustainable development; demand driven; rural technologies

1. Introduction

Most of the countries around the world face challenges in economic, social and environmental related issues in their pursuit towards inclusive and sustainable development. Requisite ethos and understanding of need, design, development, transfer, and dissemination of sustainable technologies remain vague for sustainable development. As a result, 'sustainability' aspect of the sustainable development always stays at entry level. There is no universal solution to the sustainable development problems considering capabilities, capacities, and policies of each nation. Therefore, transforming the vision of inclusive and sustainable development into reality remains a challenge [1]. Salomyn [2] reported that with rising income inequality especially within and across developing countries, economic progress could not alleviate disparities, rather to have exacerbated it. Gent [3] stated that an increase in Gross Domestic Product (GDP) may not bring equal benefit to all citizens. Though the measure of GDP is useful in measuring the economic growth, it lacks showing how the wealth of a country is distributed. Therefore, the role of inclusiveness is significant in sustainable development as growth and development are not uniformly distributed across all sectors and regions of a country. Officially, sustainable development implies to the development that satisfies the needs of the present generations without compromising the capability of future generations to meet their own needs [4].

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The United Nations' (UN)17 Sustainable Development Goals (SDGs), as shown in Fig.1, adopted by global leaders in 2015 with an agenda to foster the idea of inclusive development is the ultimate pledge to leave no one behind [2].

Fig.1: Sustainable Development Goals (*Source*:[5,6])

The adoption of the SDGs illustrates the paradigm shift in development thinking over the last few decades. Creating the conditions for inclusive and sustainable growth has become the priority of all nations. It has been recognised and established universally that Science, Technology, and Innovation (STI) are the main drivers behind inclusive and sustainable development. UN and other organisations have been pursing governments across the globe to implement sustainable development goals [7]. Apart from strengthening and empowering governments and their governance, the major emphasis of the framework of SDGs, is to mobilize the academic talent by increasing the high-quality institutions and infrastructure which will catalyse and expose its citizens to critical thinking, trouble shooting, innovation, as well as science and technology curriculum. An integrated regional university network is proposed for the implementation of the SDGs, which will amplify the development thinking among millennial [7].

2. India's Vision towards Sustainable Development

India has been progressing gradually in achieving all the SDGs. National Institution for Transforming India (NITI) Aayog have been assigned to direct the implementation of SDGs in the country [8]. The Ministry of Statistics & Programme Implementation (MoSPI) has developed National Indicator Framework (NIF) consisting of 306 statistical indictors to help in statistical monitoring of SDGs and their targets [9]. Also, MoSPI has developed a dashboard on SDGs to monitor the progress of SDGs from national level up to district level as illustrated in Fig. 2. Moreover, India's longstanding tradition and heritage are mirrored in the SDGs, and hence, the SDGs resonate the development agenda of India. India's current Prime Minister himself stated in his speech at the United Nations Sustainable Development Summit in September 2015 that much of India's development agenda is mirrored in the SDGs, and India's national plans are ambitious and purposeful. Sustainable development of one-sixth of humanity would be of great consequence to the world and planet [8].

Scientific Policy Resolution (SPR) which was established in 1958 lays the foundation for drafting all scientific policies in India. Technology Policy Statement (TPS-1983), Science and Technology Policy (STP-2003), and Science, Technology and Innovation Policy (STI-2013) emphasised to proliferate science and technology to improve the weakest section of the population and development of backwards regions [10]. Scientific Policy Resolution anticipated for training science and technical manpower to accomplish the country's needs in science, education, agriculture, industry, and defence. It emphasises to cultivate science, and scientific research in all its pure, applied and educational aspects. The SPR lead to development of many scientific organisations such as Defence Research and Development Organisation (DRDO-1958), the Department of Science & Technology (DST-1971), the Department of Electronics (DOE-1971), the Department of Space (DOS-1972), and the Department of Environment (DOE-1980) [10].

Fig. 2: SDG India Index and Dashboard 2019-2020 (*Source*: [10])

3. Rural India and its Sustainable Development

As per Census 2011, the 15th Census of India since 1872, there are 6, 40, 867 villages in India. Census 2011 projected India's rural and urban population distribution as 68.84% and 31.16% respectively. With 12% increase in the level of urbanization the rural population declined almost 5% with reference to Census 2001. According to Census 2011, the sex ratio of rural and urban are 947 and 926, respectively. Overall sex ratio of India was 900 in 2011. Interestingly, rural-urban literacy rate is 68.8% and 85%, respectively. Literacy rate of male in rural-urban area is 78.6% and 89.7%, respectively, whereas literacy rate of female in rural-urban area is 58.8% and 79.9%, respectively [12]. The data from 1970-71 to 2011-12 shows a continuous decline in the contribution of rural areas to the Indian economy from 62.4% to 46.9%. It is evident from Table 1 that the rural share in the entire national income has been declining sharply since 1970-71 when 84.1% of the total rural workforce produced 62.4% of the total Net Domestic Product (NDP). It can also be substantiated that the major

share of the overall economic growth in the country was contributed by the capital-intensive sectors in urban areas without generating substantial employment from1970-71 to 2011-12. Since 1970 to 2012 India's rural economy has grown from Rs.229 billion to Rs. 34,167 billion with employment expansion from 191 million to 336 million. In spite of seven times increase in output in rural India during the said period, the employment remains stagnant. The growth rates in output and employment for the said period indicate substantial changes across sectors such as agriculture, manufacturing, construction, services, and non-agriculture [13].

Table1: Contribution of Rural areas in Economy and Workforce from 1970-71 to 2011-12 (*Source*: [7])

Year	Economy (%)	Workforce (%)
1970-71	62.4	84.1
1980-81	58.9	80.8
1993-94	54.3	77.8
1999-00	48.1	76.1
2004-05	48.1	74.6
2011-12	46.9	70.9

4. Rural Development Programs

Government of India (GOI) has been fostering and promoting the scientific spirits in the country. Various ministries and departments are promulgating Science and Technology Innovation (STI) through their programmes for poverty eradication and capacity enhancement to masses as depicted in Fig.3.

Also, several other ministries/departments (agriculture; sanitation, drinking water supply, etc.) are transforming lives at the grassroots by implementing schemes and programs at the block/village level, through local bodies and Panchayati Raj Institutions (PRIs) [14]. For the rural development, Government of India have started various schemes and programs such as Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA),Monitoring & Evaluation DIKSHA (Training Portal), Pradhan Mantri Awaas Yojna, National Rurban Mission (NRuM), Pradhan Mantri Gram Sadak Yojana (PMGSY), National Rural Livelihoods Mission, Deen Dayal Upadhyaya Grameen Kaushalya Yojana (DDU-GKY), and National Social Assistance Programme (NSAP) [15].

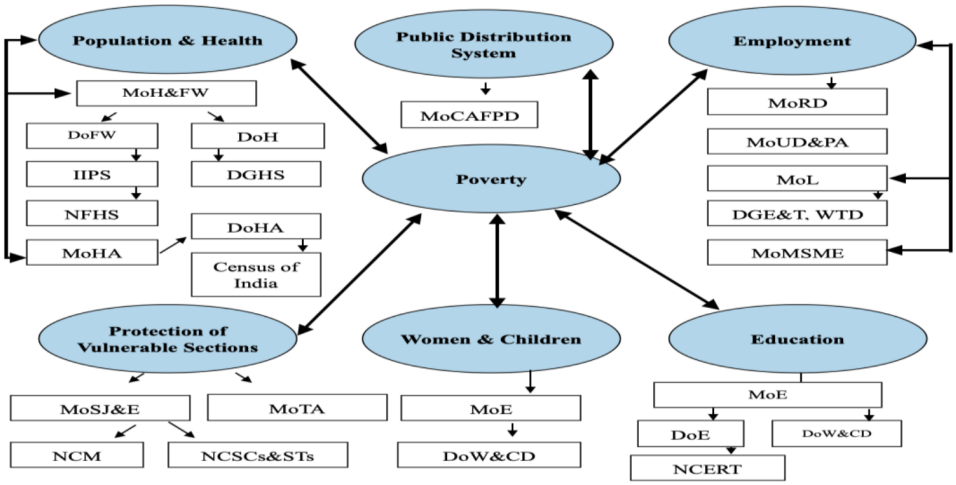

Fig. 3 Government organisations Involved in social sector programs (*Source*: [14])

The symbols used in Fig. 3 are as follows: MoHFW - Ministry of Health & Family Welfare; DoFW - Department of Family Welfare; DoH - Department of Health; MoHA - Ministry of Home Affairs; DoHA - Department of Home Affairs; MoE - Ministry of Education; MoCAFPD - Ministry of Consumer Affairs, Food and Public Distribution; DoW&CD - Department of Women & Child Development; DoE - Department of Education; MoMSME - Ministry of Micro, Small and Medium Enterprises; MoUD&PA - Ministry of Urban Dept. & Poverty Alleviation; MoRD- Ministry of Rural Development; MoSJ&E - Ministry of Social Justice & Empowerment; MoTA- Ministry of Tribal Affairs; DGHS - Directorate General of Health Services; NCM - National Commission for Minorities; NFHS - National Family Health Survey; NCSCs&STs - National Commission for Scheduled Casts & Scheduled Tribes; IIPS - International Institute for Population Sciences; MoL - Ministry of Labour; DoWCD - Department of Women & Child Development; DGE&T - Directorate General of Employment & Training; WTD - Women Training Directorate; NCERT - National Council for Educational Research and Training.

5. Rural Technology Action Group (RuTAG)

Office of the Principal Scientific Adviser (PSA) to the GOI realised the need for Science and Technology (S&T) intervention in the Rural sector (Farm and Non-farm Sectors). Therefore, the Rural Technology Action Groups (RuTAG) has been conceived as a mechanism to provide a higher level of S&T intervention and support through premier institutions to marginalised rural population. These interventions, which are essentially demand-driven, helps in bridging technology gaps, technology up-gradation, technology training and demonstration with the help of S&T NGOs at the grassroot levels. The objective of the RuTAG is to synergize and catalyse the rural development by intervention,design, development and delivery of appropriate technologies. Today, RuTAG is being present in seven IITs situated in Uttarakhand (IIT, Roorkee), Tamil Nadu (IIT, Madras), North East (IIT, Guwahati), West Bengal (IIT, Kharagpur), Uttar Pradesh (IIT Kanpur) Delhi (IIT, Delhi), and Mumbai (IIT, Bombay). Currently 52 different demand driven technologies have been developed by various RuTAG centres at seven IITs which are ready for dissemination. These demands driven technologies caters various sectors like assistive technologies, rural agriculture, draught animal power, rural

energy, rural environment/water, rural handicrafts, and rural textile [16]. With an objective to transfer and disseminate the demand driven technologies, a facility has been created by RuTAG IIT Delhi in collaboration with Foundation for Innovation and Technology Transfer (FITT) at IIT Delhi under the scheme of "Innovative Product Delivery". Field tested technologies are being sold directly to the hands of the users on payment basis through this scheme which are shown in Fig. 4.

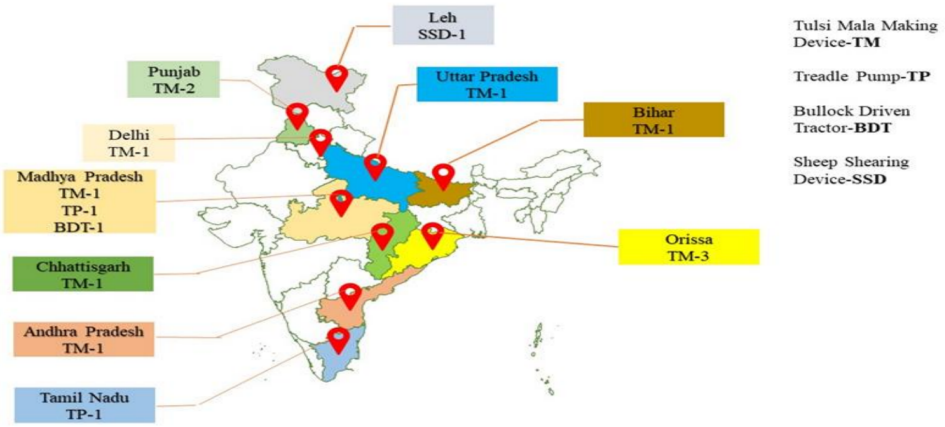

Fig. 4 Various RuTAG IIT Delhi Technologies Sold through FITT IIT Delhi across India

6. RuTAG Technologies at IIT Delhi: Quest for Improvements

Though RuTAG IIT Delhi have done several interventions and developed many field worthy products, its quest for further improvement of the product continues. Feedback from the stakeholders is always incorporated for the product refinement. The journey of the two products, viz. Tulsi mala making device and Treadle pump are mentioned here as examples.

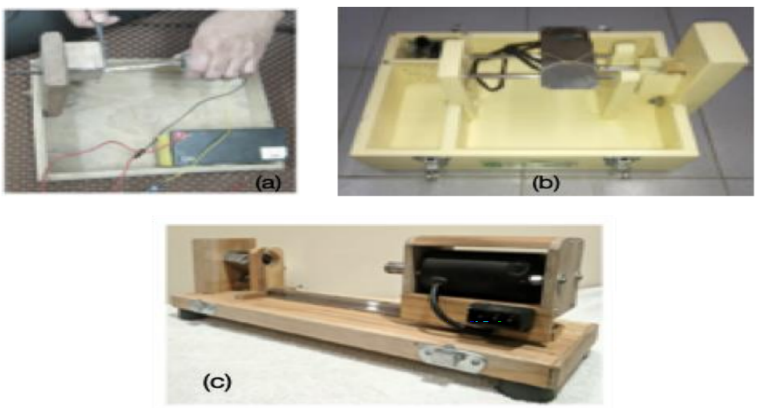

Fig.5: (a) Old version of Tulsi Mala Device; (b)Modified version of Tulsi Mala Device 5mm to 12mm; (c) Latest version of Tulsi Mala Device 5mm to 25mm

Tulsi Mala Device: Various shapes of beads are made from the stems of Holy Basil (Tulsi), Neem, Sandal wood etc. in many villages of India as there is a good demand and consumption of garlands (Malas) throughout the year. Though artisans had devised their own conventional arrangements (refer Fig. 5(a)) for turning, drilling, polishing and cutting of beads from the stem, the process was tiresome which resulted in low productivity and inconsistent quality of beads. As per the need and demand for developing a low-cost device to carry out the effective operations with high productivity and consistent quality of the beads, an ergonomically designed bead making device was developed at RuTAG IIT Delhi [17]. As shown in Fig. 5 (b) and (c), currently two models of the device have been developed according to the need of the artisans. Figure 5(b) shows the model which has the capacity of producing beads of 5mm to 12mm beads and runs on DC as well as on AC supply, Fig 5(c) shows the model which has the capacity of producing 5mm to 25mm and runs on AC supply [17]. Both the models have been evolved through continuous feedback and engagement with the artisans of different clusters.

Treadle Pump: Though treadle pumps have been used extensively, farmers expressed the need for improving their ergonomic design to make its operation less cumbersome. Further, the problem of rapid wearing out of the piston washers was also reported [16]. As per the demand and requirements, more efficient and user-friendly models of treadle pumps were developed by RuTAG IIT Delhi. Figure 6 (a) shows the model which was developed as per the skills of the existing fabricator at the village and Fig. 6 (b) shows the model which was made using standard plumbing and handpump spare parts. Both were improvised from the feedback of the stakeholders. A complete ergonomic study on the improvised version of treadle pump is under investigation by a Ph.D. research scholar.

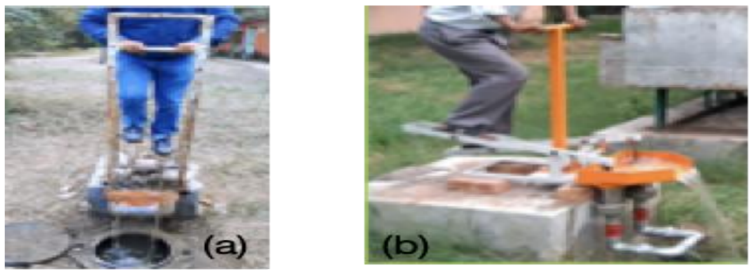

Fig. 6: (a) Treadle pump as per the skills of the fabricator and (b) Treadle pump using standard plumbing and handpump spare parts

7. RuTAG: Research Connect and Internationalization

In order to emphasise the strong need of basic research and disseminate the research results, Rural Technology Development and Delivery (RTDD), an International Conference added a new dimension in 2018 to the RuTAG by providing an international platform to integrate the RuTAG activities with rest of the world. It has motivated researchers, students, and academic/Research and Development (R&D) institutions, and rural entrepreneurs for getting them involved as well as acquainted with the challenges associated with developing

appropriate technology development for rural areas in India as well as across the world. Already, two international conferences were held at IIT Delhi (2018) and IIT Madras (2020). This effort has strengthened the academic integration of the RuTAG activities which should continue synergizing with other similar initiatives of collaborating with national and international academic institutions. RuTAG Club is an initiative by RuTAG IIT Delhi to create awareness about rural problems and develop interests for rural technical interventions among IIT Delhi students. Moreover, IIT Delhi students and faculty members from various disciplines have taken up various RuTAG problems for their mini projects as well as Summer Undergraduate Research Award (SURA) projects to fulfil their academic requirements. Further, RuTAG IIT Delhi promotes multi-institutional collaboration through which students from various institutes can take up RuTAG project as their internship projects. So far, RuTAG IIT Delhi has collaborated with NIT Durgapur, College of Engineering and Mangement, Kolaghat, and S.R. Engineering College Warangal. RuTAG IIT Delhi publishes half-yearly newsletters which showcase valuable source of information on the rural research going on at different parts of the countryby various RuTAG centres, and various activities of RuTAG IIT Delhi. In order to reach out RuTAG technologies in regional areas, recently, RuTAG newsletters are also being translated to some regional languages viz. Bengali and Odia.

The integration of RuTAG with an international institution with similar mandate for helping the rural communities, RuTAG IIT Delhi started collaborating with EPICS (Engineering Projects in Community Service) at Purdue University in Indianapolis, USA. The basic objectiveof this collaboration is to promote sharing of technical knowledge among countries by jointly solving rural/community problems. EPICS has been acquainted students to RuTAG program since September 2017 and ever since students have taken up various problems from rural India and tried to provide solutions with different perspectives. Currently students at EPICS are working two RuTAG problems Bullock Driven Tractor (BDT) (refer to Fig. 7) and Prevention of Stone Dust Inhalation. Also, Shah Global Innovation Labs at Purdue university have expressed their willingness to jointly solve the community problems along with RuTAG IIT Delhi.

Fig. 7 EPICS students working on BDT

8. Conclusions

A great thrust has been generated towards the development and widespread applications of Science and Technology for sustainable development at the grassroot levels. A tangible and real thrust towards sustainability can only occur through a change in the worldview identifying the purpose, needs and relationship with other human being and rest of nature correctly. It is crucial to acquire right understanding about sustainable "happiness" and "prosperity". Then, it is also essential to recognize the co-existential and highly interconnected characteristics of existence and accordingly identify our own role. This realization will lead to mutually fulfilling human relationships and mutually enriching interaction with rest of nature which is so vital for promoting sustainability. Endowed with such a worldview, we shall be able to chalk out effective strategies to move towards inclusive sustainable development. Rural Technology Action Group (RuTAG) is one of such strategies aiming development and dissemination of demand driven technologies for inclusive sustainable development. The present study also gives a brief review on the need for inclusive sustainable development, SDGs, and science and technology interventions at the grass root level technologies.

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