November 2022

Kurukshetra

A JOURNAL ON RURAL DEVELOPMENT

Science and Technology

PERFECTION IAS

परिshram TEST SERIES

FOR BPSC 67 MAINS

SCHEDULE

Date	Day	Test	Paper
15 Oct. 2022	Saturday	Test 1 (Sectional Test)	GS-I
22 Oct. 2022	Saturday	Test 2 (Sectional Test)	GS-II
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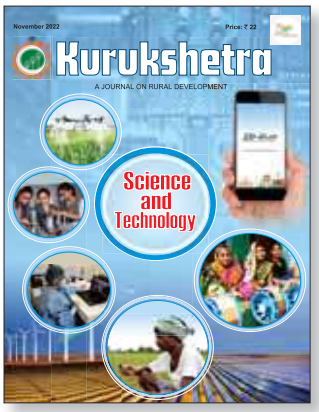

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Editorial

The government has been making efforts to transform the country and empowering people with greater involvement of science and technology. Science, technology and innovations are the constant ways to ensure development and growth in different key areas which are touching the human lives.

The November issue of Kurukshetra is focusing on 'Science and Technology'. The lead article 'Technology and Innovation in Healthcare' talks about teleconsultation, e-pharmacy, and remote monitoring that have gained the trust of all stakeholders. Another article 'Smart Water Future' states that since water is an essential but scarce resource, consuming each and every drop of water is necessary. In order to ensure the sustainable supply of water in a smart format, we need to focus on two key points- reduction in non-revenue water and encouraging wastewater recycling and reuse.

The government's thrust on new digital technologies, innovations and focus on research and development in the agricultural sector, has helped not only boost farmers' income but also ensure that the country remains self-sufficient in most of the agricultural commodities. Digital technologies are finding increasing use in the agricultural value system, and farmers are increasingly becoming more informed, as various measures are taken to provide them ready access to technology and information. Government has taken various initiatives to give a push to digital agriculture in the country.

No doubt that technology has a pivotal role to play in empowering the people across the country. The article 'Technology- Empowering the Masses' mentions that for a developing country like India, the role that science and technology can play in bettering the lives of its citizens. Whether it is agriculture, financial inclusion, education, roads and transport, healthcare or housing, technological interventions can not only help boost productivity, better service levels and efficiency, but also help ensure that the benefits of modern science reach the bottom of the pyramid, ensuring ease of living and access to various government schemes.

Energy occupies a pivotal position to facilitate the dream of a sustainably developed India. The authors of the article 'Non-conventional Energy Sources' writes that facilitation of transition to non-conventional energy sources holds the key for India's developmental aspirations. A revolutionary shift to non-conventional energy sources can bring about transformational opportunities for sustained economic development. Transition to non- conventional sources of energy is a crucial enabler for sustainable development and climate resilience paving its way towards creation of a more equitable, inclusive and sustainable society.

With this issue of Kurukshetra, we hope that our readers would be able to get valuable information in the field of science and technology especially in the rural context. Happy reading.

Technology and Innovation in Healthcare

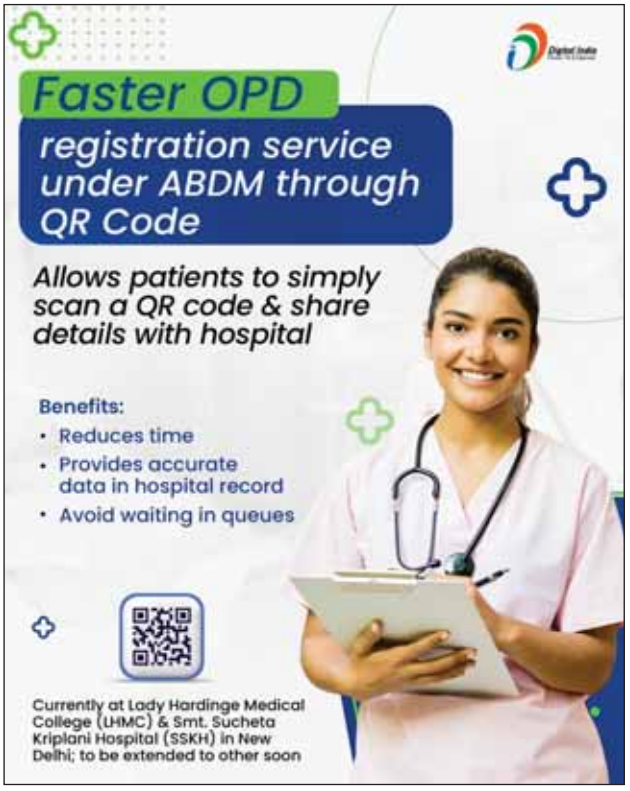
Neeraj Sinha
Naman Agrawal
Naba Suroor

An effective healthcare system of a nation is determined by its ability to deliver high-quality and efficient care that is affordable and accessible for all. Access to quality healthcare is a problem in the country, especially in the hinterland. However, government-led innovations are taking place within rural communities. It is critical that existing and new resources be deployed strategically, recognising the need to improve both the quality of individual-level care and the health of the rural populace. Adopting an integrated approach for addressing both the public's health needs and investing in robust information and communications technology infrastructure is the way forward.

The worst global pandemic hit the whole world in 2020, and the necessity for robust medicare management intensified with the COVID crisis. The world could not have anticipated a health crisis of such scale or proportion. We realised the inadequacy of healthcare infrastructure in developing countries like India and globally. Life-saving surgeries and transplants were postponed as patients chose to stay away from hospitals and other healthcare facilities fearing the COVID infection. This has driven providers to embrace digital technology to stay in business and continue to provide health services to patients, especially those unwilling to visit their facilities for treatment.

Technological Progress and Digitalisation of Healthcare

Care is slowly moving away from healthcare facilities, focusing primarily on patient (home) facilities, and technology is driving this transition. Fear of the COVID infection reduced physical OPDs, but this insufficiency gave virtual counselling through telemedicine a much-needed boost. Tele consultation has multiplied during the COVID pandemic, as there is a renewed acceptance among doctors, patients, insurers, and others in the wellness ecosystem.



In 2020, the Ministry of Health and Family Welfare (MoHFW), NITI Aayog, and the Board of Governors (BoG) Medical Council of India (MCI) issued the Telemedicine Practice Guidelines[1], enabling medical practitioners to provide healthcare using telemedicine. The regulation democratised the provision of health services, especially telemedicine, in the country.

It has also helped bridge the urban-rural healthcare gap by providing super speciality support to cities and rural tier 2 and tier 3 regions. Technology has made life easier for people living in rural and remote areas. The Indian healthcare system has witnessed a paradigm shift in ensuring quality healthcare delivery to citizens in the last decade. Increasingly, the technology has been leveraged for better reach and patient care. The application of digital technologies including artificial intelligence (AI), machine learning (ML), data analytics, Internet of Things (IoT), cloud computing, and robotics is increasing in each facet of the healthcare system. Although rural communities often have access to local health facilities, many other factors contribute to how they can access healthcare. Some factors include the cost of insurance and speciality services, reliable transportation for essential services, the time needed to attend appointments, and confidence in the quality of services. An integrated approach to healthcare that includes technology adoption is the ideal goal for rural communities.

Geographical Restrictions

India is one of the largest democracies in the world, with around 65 percent of its population residing in rural areas. Yet, access to timely and quality healthcare is lacking. In fact, it is a crisis that no other social sector is facing at the moment. Healthcare services in the country lean heavily towards urban areas even though the urban population makes up only about 35 percent of the total populace. Due to limited infrastructure and the retention of qualified health professionals in rural communities, residents often travel long distances to receive specialised treatment in cities. It is common for patients in rural communities, to travel more than an hour for a 10-minute appointment, a colossal waste of time, energy, and resources for the chronically ill.

Emergence of Digital Healthcare in India

Interoperability is the ability of systems to be able to communicate with each other and make use of the information obtained through each other without any restrictions. It is common in sectors like banking and finance and is independent of an individual's location. But, such is not the case within the healthcare sector. The Electronic Health Records (EHR) of people are not easily available or communicated within doctors, hospitals, pharmacies, etc. due to constraints like security, permission, cost, and platform to name a few. This results in the decline of good quality healthcare available to all.

Phones and other modes of communication are insufficient in providing doctors enough information to completely analyse their patient's condition so that the best treatment or advice could be provided to them. Also, the amount of healthcare-related data generated nowadays is humongous (big data). It is thus quite impossible to keep a track of every patient's medical record at all times. In India, a lack of awareness and healthcare for all citizens also adds on to the existing problem. All these ultimately raise the same question of ensuring platform of interoperability in the Indian healthcare system.

The Ministry of Health & Family Welfare (MoHFW) notified the EHR standards for India in September 2013. Revised EHR Standards for India were notified in December 2016. The review report by the Ministry of Electronics and Information Technology (MeitY) titled 'Adoption of Electronic Health Records: A Roadmap for India,' highlights that the country's government hospitals and dispensaries have very little ICT infrastructure, with only some major public hospitals having computers and connectivity.

To talk about competent healthcare systems, a very worthy example is of Israel. A country that has invested effectively in its healthcare system which has been paperless for the last 20 years. Although, the EHR systems of different hospitals are not the same, they are still very well connected.

In India, in the light of the COVID pandemic, the National Digital Health Mission (now known as Ayushman Bharat Digital Mission – ABDM) was lunched in 2020, which is the implementation of the

National Digital Health Blueprint. It seeks to create a single repository of medical records of all citizens. The National Digital Health Blueprint (2019) was prepared by a panel of Ministry of Health and Family Welfare with an objective to create a framework for the National Health Stack proposed in 2018 by the NITI Aayog. Prime Minister Narendra Modi had said that every Indian will get a unique Health ID under the National Digital Health Mission (NDHM). The Health ID will contain information about every test, disease, medicine, and associated reports of a patient which can be accessed by an authorised person from anywhere across the country.

Since then, the center has been working on developing digital modules and registries while the mission has been rolled out in six union territories (UTs) across the country. Three key registries of NDHM namely health ID, Health Professional Registry (HPR), Health Facility Registry (HFR), and digital infrastructure for data exchange have been developed and implemented in these UTs. As on date, Rs. 45 crore has been released to the National Health Authority (NHA) for implementation of ABDM. Till 28th March 2022, a total of 20,97,55,222 Health IDs (ABHA Number) have been created in the country.

A comprehensive EHR would be beneficial to rural patients, as it could soon include data from digital devices that display information about the patient's health problems and could include information about their lifestyle and habits. These include fitness bands, blood pressure monitors, and digestible tablets to monitor medication response and adherence. Most of these devices transmit data from a patch or sensor to an app on the smartphone.

Genomic data can also be added to the EHR, including certain drugs that may or may not match the patient's genome. Genomic data can help a doctor know if a specific type of drug will work for a patient without trying many different treatments. This can save both doctors' and patients' time by eliminating the need for multiple follow-up appointments, lowering the cost of treatment, and potentially reducing the risk of allergies and side effects. It can also help shift healthcare from reactive to proactive, allowing doctors to address potential problems long before they become a risk.

Scope of Remote Healthcare in India

Today, one of the main barriers to patient care is medical prescription and delivery, and this can also be done remotely. Medicine 'ATMs', already in use in rural areas of South Africa, ensure that patients obtain their medication in a medically safe way, without relying on inaccessible pharmacists, doctors, or other professionals. In the future, these 'ATMs' can effectively scale their capabilities to become an information kiosk and patient portal that can support diagnosis, testing, and medication prescription, thereby removing pressure on hospitals and community health.

One of the significant challenges faced by the rural communities is the lack of healthcare expertise.

It is difficult for communities to access specialised training, it is challenging to attract trained medical staff, and once they are there, their retention is unachievable. One of the most proven ways to solve these problems is to bring specialised training to the existing health professionals. In addition to solving the problem of specialisation, ensuring promising career and development opportunities for the local population must be promoted.

Virtual reality can be used in rural areas to assist healthcare professionals with training and experience through training simulations with a headset that places you in a natural healthcare environment. For example, training in an emergency department (ED) can be very stressful for patients and medical staff, where there is significant time pressure and patients' lives are at risk. With virtual reality, many scenarios can be played out that allow a person living in a rural area to get hands-on experience without actually being in the emergency room (ER), increasing pressure on staff and putting patients at risk. Virtual or tele mentoring groups with other communities and experts will ensure that training and support are continuous and ongoing.

The existing health model has endless potential for technology to deliver massive improvements, especially in the rural health sector. Today, challenges like connectivity and infrastructure are holding us back. However, these problems are being solved more and more every day, and the rural medical landscape in the coming years will be very different from today.

The purpose of incorporating technology into healthcare in rural areas is not to replace doctors but to improve healthcare and enable more efficient and accurate diagnoses where specialised knowledge is not always available in the field.

The Rise of Remote Healthcare

Another area in which technology plays a vital role is remote care. Due to severe shortages of intensive care staff in hospitals during the pandemic, many providers have built remote or smart ICUs. This facility allowed them to serve more patients simultaneously. Small towns and rural areas still lack such facilities, but this technology holds the answer to bridge this existing gap during future health crises.

The Internet of Medical Things (IoMT) is changing the nation's healthcare system for the better. IoMT is the collection of medical devices and applications that connect to healthcare IT systems through online computer networks. IoMT devices that are Bluetooth enabled can transmit all essential clinical data to the consulting physician in real-time. This setup closely mimics face-to-face consultation and helps the treating physician make appropriate clinical decisions down the line of treatment. AI and predictive analytics support many of these IoMT tools that help predict a patient's likely future condition based on longitudinal (periodic) data. These tools are helpful in preventive medicine and wellness, especially in providing healthcare in neglected areas.

McKinsey's latest report projects that tele health will be a quarter-trillion-dollar industry post-COVID. According to this report, the use of tele health has increased 38-fold from the pre-COVID baseline. The industry is projected to reach USD 10.6 billion[2] in India by 2025. It has a broad reach in India, a relatively untouched area with hardly any serious players. What contributes to the growth is the integration of tele health with other virtual health solutions and hybrid models of virtual/in-person (physical) care. These systems can improve the consumer experience, quality, accessibility, affordability, and outcomes. Doing so has resulted in a drastic reduction in treatment costs while making deliveries more accurate.

Remote Healthcare for Rural India

In small towns and villages, virtual consultations alone are not enough. These should be complemented by physical/OPD counselling so patients can develop more confidence in the care provided. This physical model also facilitates post-operative care and second opinions for patients in smaller cities, thus eliminating the need to travel to larger metropolises for treatment, saving them time, money, and lost productivity. Remote care also protects them from any hospital-acquired infections.

Most Primary Health Centers (PHCs) and Community Health Centers (CHCs) in rural areas lack the necessary equipment and diagnostic expertise needed by the growing population. Technology can bridge this gap. Innovative start-ups across the nation are providing healthcare

services enabled with the latest and most efficient technologies. Many of these start-ups and companies are being supported by the government itself. The Atal Innovation Mission (AIM), housed in the NITI Aayog, has been set up by the Government of India to promote a culture of innovation and entrepreneurship in the country. Under one of its many initiatives, AIM supports the establishment of new incubation centres called Atal Incubation Centres (AIC). AIC LMCP Foundation, Gujarat is one such AIC that has incubated a start-up named Rises Analytics Solutions. Rises is working on high-tech healthcare AI solutions at scale. It has the vision to bridge the gap between patients and timely medical intervention and to extend diagnostic decision support to healthcare professionals in order to serve patients with efficacy, accuracy, and insights, with innovative technology TRAP (Treatment Response Assessment and Predictions). It gives chronic and critical care solutions for cancer and pulmonary conditions including COVID-19.

Focusing on the rural parts of the country, Ziffytech Digital Healthcare has introduced ZiffyHealth. The start-up is incubated at AIC Pinnacle Entrepreneurship Forum, Maharashtra, and is aspiring to evolve a robust and scalable healthcare platform, whereby all stakeholders such as patients, doctors, diagnostics, and pharmacies can plugin to have a seamless yet highly secured flow of health data so as healthcare delivery can be far more accessible and affordable. They are working towards making healthcare accessible to the bottom of the semi-urban and rural Indian population, endeavoring to contribute to building social capital through quality healthcare delivery. Another such start-up is Volar Alta, incubated at AIC-RNTU (AIC-Rabindranath Tagore University), Madhya Pradesh. Volar Alta is the one-stop shop for drone-based services. They specialise in surveillance, asset inspections, and transportation of medical essentials in rural and hard-to-reach locations using drones, minimising the time, and ensuring safety. Their drones are capable of carrying out internal and external inspections to generate meaningful, actionable insights.

Conclusion

The scope for the digitisation of rural healthcare in the nation is massive as we have only just skimmed the surface. Once Internet connectivity improves, the rural-urban divide can be bridged more efficaciously. Additionally, our healthcare systems need viable platforms that enable doctors and extended medical staff to transform their services systematically, reliably, and sustainably to improve quality of life. We should gradually move from the current provider-centric volume-based model to a patient-centric value-based model. Once a secure Health Information Exchange (HIE) is set up, technological intercession will be the next logical step to revolutionise healthcare delivery services. Leveraging technologies such as AI, Machine Learning, and Blockchain to advance interoperability in healthcare is an incredible prospect for the government looking at creating jobs and better employment opportunities.

Teleconsultation, e-pharmacy, and remote monitoring have gained the trust of all stakeholders. The private sector's contribution will help meet the goals of universal health coverage and ensure India's progress towards a USD 5 trillion economy with a healthy population. The country still has a long path to dwell on, for bringing its rural areas at par with the urban and also with global standards. With the embracement of state-of-the-art tele health technologies, development of enterprise-wide portfolios, and the commitment to data transparency, benefits shall reach the last rung of the ladder. This is bound to consolidate the rural economy into a sustainable model which is an absolute necessity for the development of the nation. What is expected is a more secure, interoperable healthcare system with the goal of accomplishing better healthcare for Indian citizens, empowering both the urban and rural landscape in the coming years.

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2. http://bwhealthcareworld.businessworld.in/article/How-Are-Advances-In-Digital-Technology-Making-Healthcare-Delivery-In-Rural-India-More-Efficient-/20-09-2021-405256/

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Conservation of Natural Resources

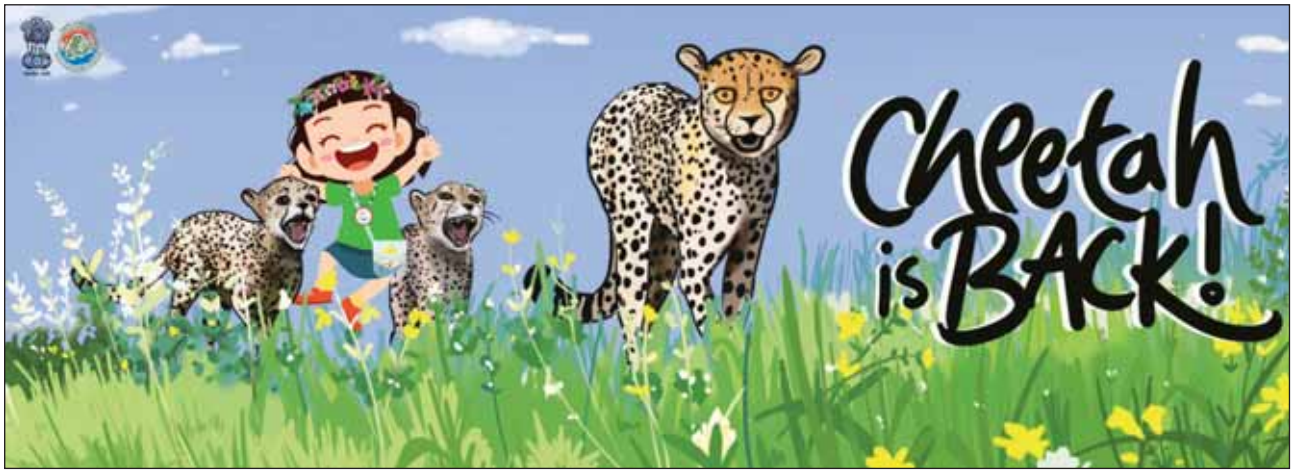
Kanchan Puri
Ritesh Joshi
S.C. Garkoti

On the occasion of National Science Day (28th February 2022), Hon'ble Prime Minister of India while sharing his thoughts urged families to begin with small efforts to develop scientific temperament among their children. Today when climatic conditions are changing, there is a need to inculcate effective environmental education along with the use of technology for environment protection, which will play an important role in sensitising the people about environmental issues. Environment protection is enshrined in our Constitution of India wherein the State's responsibility has been laid down under Article 48-A. Recently, LiFE - Lifestyle for Environment was unveiled at Conference of Parties (COP) - 26 at Glasgow, which aims to promote environment conscious lifestyle. Science and technology for environment conservation has immense potential to strike the economic and ecological balance. Satellite Remote Sensing technology has emerged as powerful tool in providing reliable information on various natural resources of a region. Such technologies definitely help and complement government's policies, enhance efficiency and transparency to make sound decision making.

The term "environment" was introduced in the Constitution of India for first time in the year 1976 and the State's responsibility with regard to environmental protection was laid down under Article 48-A, which reads as : "The State shall endeavour to protect and improve the environment and to safeguard the forests and wildlife of the country". Also, Article 51-A (g) on Citizens' fundamental duties mentions "It shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures". The "Environment" comprises all entities, natural or manmade, external to oneself, and their inter relationships, which provide value, now or perhaps in the future, to humankind. National Environment Policy 2006 of India formulated by Ministry of Environment, Forest and Climate Change for the protection and conservation of environment identifies the following seven objectives:

1. **Conservation of Critical Environmental Resources:** To protect and conserve critical ecological systems and resources, and invaluable natural and man-made heritage, which are essential for life support, livelihoods, economic growth, and a broad conception of human well-being.

2. **Intra-generational Equity-Livelihood Security for the Poor:** To ensure equitable access to environmental resources and quality for all sections of society, and in particular, to ensure that poor communities, which are most dependent on environmental resources for their livelihoods, are assured secure access to these resources.



3. **Inter-generational Equity:** To ensure judicious use of environmental resources to meet the needs and aspirations of the present and future generations.

4. **Integration of Environmental Concerns in Economic and Social Development:** To integrate environmental concerns into policies, plans, programmes, and projects for economic and social development.

5. **Efficiency in Environmental Resource Use:** To ensure efficient use of environmental resources in the sense of reduction in their use per unit of economic output, to minimise adverse environmental impact.

6. **Environmental Governance:** To apply the principles of good governance (transparency, rationality, accountability, reduction in time and costs, participation, and regulatory independence) to the management and regulation of use of environmental resources.

7. **Enhancement of Resources for Environmental Conservation:** To ensure higher resource flows, comprising finance, technology, management skills, traditional knowledge, and social capital, for environmental conservation through mutually beneficial multi-stakeholder partnerships between local communities, public agencies, the academic and research community, investors, and multilateral and bilateral development partners.

For the protection and conservation of Environment, several legislations exists namely Environment Protection Act, 1986; Water (Prevention and Control of Pollution) Act, 1974; Water Cess Act, 1977; Air (Prevention and Control of Pollution) Act, 1981. The law in respect of forest and biodiversity are Indian Forest Act, 1927; Forest (Conservation) Act, 1980; Wild Life (Protection) Act, 1972 and Biodiversity Act, 2002. Recently under the visionary leadership of Hon'ble Prime Minister of India, LiFE (Lifestyle for Environment) was unveiled at COP 26 at Glasgow, which aims to promote environment conscious lifestyle. And to combat climate change, Panchamrit were given that are: (1) India will get its non-fossil energy capacity to 500 gigawatt (GW) by 2030, (2) India will meet 50 percent of its energy requirements from renewable energy by 2030, (3) India will reduce the total projected carbon emissions by one billion tonnes from now onwards till 2030, (4) By 2030, India will reduce the carbon intensity of its economy by less than 45 percent and (5) By the year 2070, India will achieve the target of Net-Zero.

To enjoy the benefits of quality life, effective environmental education is another important pre-requisite. Moreover, it is an essential component of education at all levels that

enable the individuals to adopt green habits for sustainable social development and preserve a cleaner and greener environment for our future generation. Understanding and addressing the environmental crisis is not an easy task, in fact it needs proper examination of the problem and its source. Confronting with the environmental glitches needs scientific, educational and political interventions. Innovative solutions are needed to counter environmental deterioration and to ensure sustainable development. India has around 23 percent of the population in the 6-17 age group, and to ensure that this young population saves the environment, it is utmost important that they are provided with quality education with respect to environment. Of the 17 Sustainable Development Goals (SDGs), SDG '4' refers to 'ensure inclusive and equitable quality education and promote lifelong learning opportunities for all'. And if this percentage contributes its small bit towards environment protection and conservation of natural resources, then one can imagine the cascading effect it will have for nature's protection. In Strategy for New India @75 by NITI Aayog, 2018 indicates the need to broaden the scope of Massive Open Online Course (MOOCs) and Open and Distance Learning (ODL) and tap their potential to provide access to quality education beyond geographical boundaries. It is imperative that such MOOCs are scaled up for the environment education with the necessary adaptations in respect of the current environmental issues. Also National Education Policy of India (2020) has climate change, pollution, waste management, sanitation, conservation of biological diversity, management of biological resource, forest and wildlife, and sustainable development and living as some of the thrust areas for environmental education.

Talking about science and technology for environment conservation, it has immense potential to strike the economic and ecological balance. The knowledge of spatial land cover information can help in proper management and monitoring of natural resources. Satellite Remote Sensing technology has emerged as powerful tool in providing reliable information on various natural resources of a region. The changes in land use/land cover can be linked to the human and natural activities. For example, forest fire risk areas can be predicted and an early warning of forest fires through risk modeling can be conducted. Available literature also highlights the use of Geographic Information System (GIS) technology in corridor mapping, forest dynamics, forest fragmentation and its relation with the wildlife movement in the corridor complexes (various studies conducted by researchers).

Off- farm technologies like "bio-briquetting" can also help in preventing forest fire hazard as well as loss of biodiversity. This is a sustainable technology which is efficient, simple, cost-effective and which can generate energy on a local scale (http://gbpihedenvis.nic.in). Biomass energy from pine needles can be generated by using simple technology of biomass briquetting. Under the niche of G.B. Pant National Institute of Himalayan Environment, Almora (autonomous body of MoEFCC) by manufacturing of bio-briquettes and bio-globules, under its RTC (Rural Technology Complex), one seeks to involve lower and marginalised group of villagers to provide them with resource utilisation training and furthermore livelihood generating capacity.

Technological Interventions of Ministry of Environment, Forest and Climate Change (MoEF&CC)

- **PARIVESH:** In pursuant to the spirit of 'Digital India' initiation and capturing the essence of Minimum Government and Maximum Governance, a single-window integrated environmental management system named PARIVESH (Pro-Active and Responsive facilitation by Interactive, Virtuous and Environmental Single window Hub) has been developed by the Ministry of Environment, Forest and Climate Change through NIC [www.parivesh.nic.in]. Launched on 10 August 2018, it has an automated process starting from submitting of application, preparation of agenda, preparation of minutes to grant of clearances. It facilitate sound and informed decision-making, real time information about the status of application with alerts at each of the stages through SMSs and emails, standardisation of processing and real time monitoring/compliances. There will be single registration and single signing for all types of clearances (Environment, Forest, Wildlife, CRZ). It has paved a way for constituting the Centralised Processing Center in the Ministry and has resulted in a paradigm shift in the environmental clearance process with hallmarks such as transparency, accountability, efficiency, consistency, etc.
- **Decision Support System (DSS):** This is a web GIS application developed to provide qualitative and quantitative information with respect to forest area. It uses different spatial layers for providing the information like state and district boundary, tiger reserves, tiger corridors, forest type maps, biological richness, hydrological layer, etc. available at www.fsigeoportal.gov.in/dss.
- **Climate Change Knowledge Portal:** India's Climate Change Knowledge Portal (https://www.cckpindia.nic.in/) is a single point information resource which captures sector-wise adaptation and mitigation actions that are being taken by the various ministries in one place including updated information on their implementation. The knowledge portal will help in disseminating knowledge among citizens about all the major steps the Government is taking at both national and international levels to address climate change issues.
- **National Mission on Himalayan Studies (https://nmhs.org.in):** MoEF&CC attaches highest priority to protect unique but highly fragile Himalayan ecosystem. This portal covers the aspects of National Mission on Himalayan Studies which is a Central Sector Grant-in-aid Scheme through holistic understanding of system's components and their linkages, in addressing the key issues

relating to conservation and sustainable management of natural resources in Indian Himalayan Region. Mission strategy is to focus on enhancing livelihoods of local communities in line with the National Environment Policy, 2006 of the Government, with a basic premise that the most secured and effective basis for conservation is to ensure that people dependent on particular resources obtain better livelihoods from the act of conservation than from the degradation of the resources.

- **Wetlands of India portal:** This portal (https://indianwetlands.in/) is an initiative to provide a single point access system that synthesises information dissemination regarding wetland sites of the country, projects, initiatives and trainings. Wetlands are shallow water-bodies, transitional between terrestrial and aquatic systems, with high biodiversity and productivity. Twelve National Biodiversity Targets, framed by the MoEF&CC in line with the Convention on Biological Diversity's Strategic Plan 2011-2020 also cover wetlands significantly. The portal provides a platform for the people of the country to learn more about wetlands and get involved in their conservation and management.

In the year 2020, Ministry of Science and Technology initiated formulation of fifth draft of National Science, Technology, and Innovation Policy, which aims to bring about profound changes through short-term, medium-term, and long-term mission mode projects by building a nurtured ecosystem that promotes research and innovation on the part of both individuals and organisations. To attract, nurture, strengthen and retain critical human capital through a 'people-centric' science, technology and innovation ecosystem, has been kept as one of the broader vision of the policy. It also aspires to ensure a clean environment for people and future generations through green initiatives based in science that promote sustainability and clean energy, water, air, rivers, forests, parks, and neighborhoods (https://dst.gov.in). Kishore Vaigyanik Protsahan Yojana, National Science Olympiad Programme, India Innovation Growth Programme and Million Minds Augmenting National Aspirations and Knowledge Awards Programme under the Innovation in Science Pursuit for Inspired Research' (INSPIRE) scheme are some of the programmes being conducted by the Department of Science and Technology individually and in cooperation with different organisations, to foster a creative thinking towards scientific education. This year on the occasion of National Science Day (28 February 2022), Hon'ble Prime Minister while sharing his thoughts with the people through his monthly radio programme 'Mann Ki Baat', has urged families to begin with small efforts to develop scientific temperament among their children. The application of both science and technology for environment conservation must go hand in hand, for the country to achieve the objective of sustainable development. These technologies shall definitely help and complement government's policies, enhance efficiency, transparency to make sound decision-making.

It is rightly said by environmentalist and green activist Dr. Anil P. Joshi (Padma Bhushan and Padma Shri) that true capital of a nation is its natural resources, and future demands balance between economy and ecology. Through science and technology, environment conservation can be achieved in holistic manner with the convenience of citizens in accessing information. Further, environmental attitude is directly linked with the level of knowledge regarding environmental issues possessed by an individual. Today when climatic conditions are changing, there is a need to inculcate effective education along with the use of technology for environment protection, which will play an important role in sensitising the people about environmental issues. This will also facilitate people to adopt green social responsibility for the protection of environment.

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Smart Water Future

Dr. Namrata Singh Panwar

Water is an essential but scarce resource and therefore consuming and managing each and every drop of water is vital. Since this management involves decisions related to billions of lives and the vast quantities of invigorating resource, usage of technology can be a correct path towards redemption. Technology and innovations can indeed play an essential part in scarcity and safety, efficiency, utility operations, monitoring, treatment, and data analytics related to the water sector and lead India to the path of a smart water future.

The last few years in the history of mankind are text book examples of chain events indulging denial, chaos, dismay, and hope. One thing which preceding years have taught us is that the world is a global village where the countries are having similar opportunities and have same challenges to deal with. The recent outbreak of COVID-19 pandemic, an outburst of locusts, and the persistent issue of climate change have substantiated the fact that the world needs to collaborate and fight the global challenges in times ahead. One of such global challenges is water scarcity where,

- some 1.1 billion people worldwide lack access to water, and
- a total of 2.7 billion find water scarce for at least one month of the year
- two million people, mostly children, die each year from diarrheal diseases alone.
- by 2025, two-thirds of the world's population may face water shortages. (In business as usual scenario)

The existence and sustenance of mankind depend on water- safe potable water, primarily for drinking and other domestic purposes. However, for millions of people in India and worldwide, water is a cause of constant worry in a context as water tables are constantly falling and water quality rapidly diminishing. Due to the increasing population, the per capita annual availability of water in India, which was 1816 cubic meters (cu m) in 2001, got reduced to 1544 cu m in 2011 which will reduce to 1140 cu m in the year 2050. Any situation of availability of less than 1000 cu m per capita is considered by international agencies as scarcity. By 2030, the country's water demand is projected to be twice the available supply and if business as usual continues, it may imply severe water scarcity for hundreds of millions of people.

Another aspect of water that needs to be addressed urgently is the management of wastewater. The per-person disease burden due to unsafe water and sanitation was 40 times higher in India than in China and 12 times higher than in Sri Lanka in 2016. With a country generating 140 Billion Cubic Metre (BCM) of wastewater annually, mismanagement of wastewater which also contaminates groundwater, lack of liquid waste management, poor sanitation conditions, and poor hygiene habits has contributed

to a major portion of the population suffering from water-borne diseases.

Also, water is a necessary and irreplaceable resource for economic growth. As per the UN report on water and jobs, it has been estimated that half of the world's workforce i.e. about 1.5 billion people are dependent and employed in one of the eight water and natural resources dependent industries. In India, if we don't take this water scarcity seriously, then by 2030, we can lose 6 percent of our GDP due water-related disasters.

Therefore, it is a right time to work on the water management part for our sustained future. Water management is not new to the world but in times of deepening water crisis aggravated due to incessant urbanisation, increasing population and inconsistent climatic trends, the need of the hour is to resolve the situation of global crisis with local know how and available resources while leveraging technological innovations. Environmental technologies combined with an intelligent, systemic approach to water management can help ensure a sustainable water supply in our economy. Technology and innovations have an essential part to play in scarcity and safety, efficiency, utility operations, monitoring, treatment, and data analytics related to the water sector. In this article, we are going to explore some of the ways in which technology specifically related to water management, can save our days on this planet and some best practices of the sector prevalent in India which help us to pave our way towards smart water future.

Smart Water Future

Smart Water broadly means the management and distribution of water whilst maintaining its quality. In order to ensure the sustainable supply of water in a smart format, we need to focus on two key points- reduction in non-revenue water and encouraging wastewater recycling and reuse.

Under water supply management, loss due to non-revenue water can be considered as a threat to water-scarce economies of the world. Defining Non-revenue water, International Water Association (IWA) described that all physical and commercial losses due to theft, pipe burst, overflow of reservoirs, unmetered and ill-metered water bill along with unbilled authorised consumption could be considered, as water loss under the term 'non-revenue water. Indian utilities face huge distribution losses because of the non-revenue water. It has been estimated that about 40-70 percent of water distributed, is lost on account of leakages, unauthorised connections; billing and collection inefficiencies (World Bank, 2012). Moreover, the lack of relevant data at utility levels for non-revenue water also undermines the importance of the issue.

Therefore, the high physical (real) losses due to poor and decrepit water distributing infrastructure need to be reduced for efficient water supply management. Reducing non-revenue water losses has considerable benefits including efficient management of water resources and revenue generation for water utilities. There are four basic leakage management activities that can be undertaken by water utilities to reduce distribution losses, namely: (i) pressure management; (ii) active leakage control; (iii) speed and quality of repairs and pipe asset management; (iv) maintenance and renewal (ADB, 2010). These steps holistically feature conventional yet necessary steps to manage leakage

while reducing physical losses. For the second step of leakage management i.e active leakage control, it is required to introduce some level of technological intervention. Real-time monitoring of water supply infrastructure, by using GIS tools, installing smart devices, and telemetry, offer utilities the scope to take timely action in repairing the leakages and finding out the illegal connections easily, thereby saving millions of liters of water along with time and energy.

Since water is an essential but scarce resource, consuming each and every drop of water is necessary. Degradation of natural resources due to rising population makes it even more important to devise a circular path of water by using and reusing water in the system. Besides drinking water, there are innumerable non-potable uses of water in a domestic household which can be taken care of by treated wastewater. Wastewater can be treated at centralised or decentralised levels depending up on the level of readiness, amount of waste water generated and funds available in the system. Currently, India generates approximately 61,948 MLD of sewage against the treatment capacity of 23,277 MLD i.e. 37 percent of wastewater generated only (CPCB, 2015). Moreover, even the installed sewage treatment plants either do not run at maximum capacity or do not comply with standards prescribed. Hence, there is an urgent need to promote and push economy to inculcate the habit of reusing, recycling and treating wastewater in the system.

There are a number of technologies that can be used for the above purpose. Depending upon the purpose of recycled water, the effluent filtration technology is decided. Besides this, advanced green techniques (AGTs) are also in rage nowadays. They are environment-friendly, relatively inexpensive, and efficient. The most common and advanced AGT used for wastewater treatment is Bioreactor.

Apart from reducing non-revenue water and encouraging wastewater recycling and reuse, there are a number of smart solutions which India can undertake to move towards smart water future. Some of these are:

1. Implementation of Internet of Things (IoT) technology. This technology will require the data of the water to be transmitted over a longer distance, wirelessly, and uninterrupted to a central dashboard to analyze and monitor the water system.
2. Sensors, remote sensing, geographic information systems (GIS) technologies, and visualisation tools are some key elements to managing water resources at the service area, watershed, and regional scales.
3. Remote sensing/imaging technologies such as satellites and drones, can be used separately or together, to provide data for mapping water resources, measuring water fluxes, and utility asset management. Data from such technologies can better prepare water resource managers and utilities for incidences of heavy storm water flow, indicate when conservation practices should be enacted during periods of drought, and ensure all treated water is delivered to customers. In addition, satellite data can be used to provide water quality data (e.g., turbidity, algal blooms, etc.) and hydrological forecasts, which, when used in conjunction with in situ measurements, allow utility operators to prepare for and react to water quality issues and other challenges.
4. New and existing sensors, both fixed and mobile can be used to provide near real-time data on water quality, flows, pressures and water levels, among other parameters. Sensors can be dispersed throughout systems to aid daily operations by optimising resource use, detecting, diagnosing, and proactively preventing detrimental events such as pipe bursts, water discoloration events, sewer collapses/blockages, etc. It can also provide useful information for preventative maintenance and improved longer-term planning for water utilities.
5. Smart meters can be used to record customer water usage that will provide a clear picture of water consumption and convey data to both consumer and utility, allowing for improved water management.
6. Artificial Intelligence in water can allow for the strategic and cost-effective operation of utilities, including better planning and execution of projects, better tracking and understanding of resource loss in real-time, more efficient collection and distribution

networks, and maximum revenue capture and customer satisfaction.

7. Augmented Reality and Virtual Reality (AR and VR) technologies provide their own, unique contributions to digital water. AR and VR technology has the potential to support decision-making in the field by providing holographic representation of pipes, cables, and other assets, and offering immersive, scenario-based training for employees.

8. Blockchain applications have the potential for direct, secure transactions between resource providers and consumers, peers, utility, and other players in the water sector.

9. Use of Satellite/ drones/ GIS/AI in reservoir operation, flood forecasting, and inundation mapping can help to mitigate floods and save thousands of lives.

Good Practices

India is already on the way ahead in adopting various water sector-related technologies. For example- World Bank-funded Karnataka Urban Water Sector Improvement Project (KUWASIP) has reduced NRW from 50 percent to 7 percent and increased the hours of supply from 2 h every few days to 24 h water supply.

Jamshedpur Utilities and Services Company (JUSCO), Jamshedpur has introduced NRW management, and since then the level of NRW decreased from 36 percent to 10 percent with continuous water supply from 7 hour per day.

In one of the unique initiatives, the Andhra Pradesh government has launched the Andhra Pradesh Water Resources Information and Management System (APWRIMS) which is a Smart Water Solution platform targeting the overarching objective of sustainable water management in Andhra Pradesh. The APWRIMS collects data from 1,254 piezometers on a real-time basis across all the 13 districts of the state and correlates the information with all 15,00,000+ bore wells used for agricultural purposes in the state. Soil moisture data is also collected from 900+ locations across the state. The platform has data related to 100+ reservoirs, 40000+ Minor Irrigation tanks, 15 lacs agriculture

Technology also plays an important role in tackling water-related disasters like floods and it is very heartening to see that we as a Nation have deciphered the way to it. The Central Water Commission is collaborating with M/s Google Inc., to provide inundation alerts based on the Flood Forecast available in Common Alerting Protocol (CAP) platform using high-quality digital Terrain Models available with Google using Artificial Intelligence and Machine Learning. The system started functioning in 2018 when inundation alerts were provided for Patna Gandhi ghat forecast stations. In a similar manner, Odisha is the first State in the country that has implemented an Early Warning Dissemination System (EWDS) which aims at establishing a foolproof communication system to address the existing gap of disseminating disaster warning from the State, District and Block levels to communities. The Government of Kerala has also entrusted the Kerala State IT Mission (KSITM) to set up an ICT Platform comprising of Web based backend and a mobile app-based field survey application to document the flood related damage caused to houses and commercial establishments in affected districts. Recently, students from IIT Madras have developed an AI-enabled drone that can help authorities provide vital information on people trapped in disaster-hit areas. All these examples show that innovations in flood forecasting and management can lead the way for timely evictions and minimise the losses from the flood.

In the era of mobiles, satellites, and the digital world, one cannot shy away from the concept of not only life-changing but also life-saving technologies. Technologies give us the leverage to perform tasks that were unimaginable to our past generations. But, the important point to note over here is that technology alone cannot combat the disasters created by our species. They are just a way to mitigate the losses from these catastrophes. If we want to fight back against the challenges of water scarcity and looming water disasters, we have to change ourselves. We have to change our habit to take nature for granted and work as a single unit to make our planet again a giant green and blue beautiful sphere of life.

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Technology- Empowering the Masses

B S Purkyastha

Policies and programmes of the government not only outline the blueprint for economic development of the country but also ensure that the fruits of economic development reach the weaker sections of the population. The key to success of any regulations and schemes run by the government is implementation, continuous monitoring and audit. The rapid adoption of digital technology in the last few years has laid the framework for making delivery of government schemes easier and more efficient.

At the recently concluded State Science and Technology Ministers' Conclave at Science City, Ahmedabad, Prime Minister Shri Narendra Modi called for taking research in science and technology to the local level. "Since 2014, there has been a substantial increase in investment in the field of science and technology. Due to the efforts of the government, India is ranked 46th in the Global Innovation Index today, whereas India was at 81 position in 2015. We have covered the distance from 81 to 46 in such a short time, but we do not have to stop here, we have to aim higher now.... The need of the hour is that every state should focus on innovation to create local solutions according to their local problems," he said.

For a developing country like India, the role that science and technology can play in bettering the lives of its citizens cannot be over-emphasised. Whether it is agriculture, financial inclusion, education, roads and transport, healthcare or housing, technological interventions can not only help boost productivity, better service levels and efficiency, but also help ensure that the benefits of modern science reach the bottom of the pyramid, ensuring ease of living and access to various government schemes.

Policies and programmes of the government not only outline the blueprint for economic development of the country but also ensure that the fruits of economic development reach the weaker sections of the population. However, the key to success of any regulations and schemes run by the government is implementation, continuous monitoring and audit. While over the years, many programmes for economic and social upliftment of the weaker sections of the population, especially for those living in rural and remote areas, have been rolled out, lack of transparency, high implementation costs and pilferage would mean that only a minor percentage of the total benefits or subsidies would reach the people they are meant for. For instance, the Public Distribution System has been historically bogged down by

diversion of foodgrains to the open market, bogus ration cards and corruption at the last mile. Again, the public healthcare system has been affected by non-transparency; little or no accountability and bureaucratic failures, particularly in the poor states. Lack of awareness about their rights and difficulty in accessing healthcare benefits are another obstacle in the attempt of rural and poor people to optimally utilise the government healthcare system.

In the last few decades, technology has been the proverbial catalyst, turning the tide in favour of citizens and their ability to access government schemes. The rapid adoption of digital technology in the last few years has laid the framework for making delivery of government schemes easier and more efficient, ensuring that these reach the beneficiaries in the shortest possible time in a manner convenient to both the dispenser and the receiver of these welfare schemes. Let us look at the some of the major developments spearheaded by technological advancements.

India Stack and Aadhaar

The foundation of India's digital revolution was laid by the development of India Stack – the unified software platform which brought India's 1.4 billion-plus population into the digital age. Defined as a set of open APIs and digital public goods it aimed to unlock the economic primitives of identity, data, and payments at population scale. Adoption of India Stack by billions of individuals and businesses has helped promote financial and social inclusion and positioned the country for the Internet Age. The bedrock of India Stack is a set of digital identity products centred around Aadhaar, the country's national identity programme. More than 1.31 bn (95 percent) Indians today possess an Aadhaar number, making access to various government and non-government services easier for the ordinary citizen. Aadhaar has enabled ease of living for the citizens, especially the most marginalised and deprived class through seamless delivery of subsidies, benefits, and other services under various state welfare schemes. Aadhaar has also been the foundation of multiple Building Blocks. More than 17 transactional stacks have been launched pan-India for digital identity, payments, data empowerment and open ecosystems.

Direct Benefit Transfer

It was this Aadhaar identification programme that ensured the success of the Direct Benefit Transfer system. Direct Benefit Transfer or DBT has travelled a long path since its early initiation by the government of India in 2013 to change the mechanism of transferring cash subsidies and benefits. The programme was aimed at transfer of subsidies and cash benefits directly to citizens through their Aadhaar seeded bank accounts with a hope that crediting subsidies into the bank accounts would substantially reduce leakages, and associated delays owing to the flow of fund in a multi hierarchy of administrative offices till it reaches the end beneficiary. Central Plan Scheme Monitoring System (CPSMS), the earlier avatar of the Public Financial Management System (PFMS), of the Office of Controller General of Accounts, was chosen to act as the common platform for routing of the Direct Benefit Transfer. CPSMS was used for the preparation of beneficiary list, digitally signing the same and processing of payments in the bank accounts of the beneficiary using the Aadhaar Payment Bridge of NPCI. Today, DBT has emerged as a high priority focus area of the government, in reforming government delivery system by re-engineering the existing process in a variety of welfare schemes for simpler and faster flow of information/funds, ensuring accurate targeting of the beneficiaries, de-duplication and reduction of fraud. DBT has become the accepted way of delivering development schemes with the delivery of over 450 schemes including the Public Distribution System (PDS), PM-KISAN, Mahatma Gandhi National Employment Guarantee Scheme (MGNREGS), National Social Assistance Program (NSAP), Prime Minister's Matru Vandana Yojana (PMMVY), National Rural Livelihood Mission (NRLM), National Health Mission (NHM), scholarship schemes of various ministries through the National Scholarship Portal (NSP), PM-AWAS, DBT-PAHAL, and many more to more than 900 million people through this mode. In addition, states like Uttar Pradesh, Bihar, Madhya Pradesh, Tripura, Maharashtra, Jammu and Kashmir, Andhra Pradesh have also leveraged the DBT platform of PFMS to deliver the benefits of their respective welfare schemes to the people. The total Direct Benefit Transfer (Cumulative) since inception stands at Rs. 25,03,145 crore with estimated gains of Rs 2,22,968 crore up to March 2021. All thanks to Aadhaar and PFMS!

TABLE 1: Direct Benefit Transfer: Making Welfare Schemes Efficient

	FY 2022-23	FY 2021-22	FY 2020-21	FY 2019-20
Total Direct Benefit Transfer (Rs crore)	2,35,129	6,30,264	5,52,527	3,81,631
Total No. of Transactions	212 cr	717 cr	603 cr	438 cr
No. of Schemes	319	319	319	
Ministries covered	53	53	53	

Source: https://dbtbharat.gov.in/

Digital Platforms for E-Governance

Parallelly, the National Informatics Centre (NIC) under the Ministry of Information Technology is playing an instrumental role in executing key IT projects, in close collaboration with Central and State Governments, making the last-mile delivery of government services to the citizens a reality, through a variety of digital solutions. NIC, as the technology partner of the government of India, endeavours to cater to ICT needs at all levels of governance including central, state, districts, judiciary, and legislative layer. A large number of Government initiatives such as Swachh Bharat Mission, My-Gov, e-Hospital, fertiliser distribution, e-Courts, e-Transport etc. have been completely managed using digital platforms developed by NIC. NIC offers a wide range of services which includes multi gigabit nationwide networks NICNET, NKN, National Data Centres, National Cloud, pan India VC infrastructure, Command and Control Centre, multi-layered GIS based platform, Domain Registration and Webcast. This plays a significant role in delivering citizen centric e-services. It has also developed several digital platforms for the socio-economic development of the country with 'One-Nation One-Platform' initiative to empower citizens digitally.

Unified Payments Interface

The Unified Payments Interface (UPI), developed by the National Payments Corporation of India (NPCI), has emerged as a game changer in the payments space. Rolled out in 2017, this indigenous disruptive technology today accounts for 16 percent of total retail payments, with more than 30 million UPI QR codes registered by merchants. The number of UPI transactions in August this year stood at 657 crore, up from 6.28 billion (628 crore) in July 2022. The value of UPI transactions in FY 2021-22 was Rs 84.15 lakh crore, five times the amount of debit- and credit cards combined. In August 2022 alone, digital payment transactions value through UPI stood at Rs. 10.73 lakh crore, indicating how UPI has become the ubiquitous payments alternative for a majority of citizens, especially for those making payments of small denominations. Whether it is the vegetable vendor, the e-rickshaw driver or the petty shopkeeper, the UPI is clearly becoming the default payment option.

In particular, UPI system has helped India morph from a country largely dependent on cash for everyday transactions to a significantly less cash economy. UPI has allowed users to safely transfer money on a real-time basis and across multiple bank accounts without revealing the details of one's bank account to other parties. In the case of the weaker sections, neo-literates and migrant workers, it is the easiest way to transfer money today. Today, several countries across the world are trying to emulate the success of UPI. Already, UPI has gained acceptance in Singapore (March, 2020), Bhutan (July, 2021) and recently with partners in UAE and Nepal (February, 2022).

Since the launch of UPI, India has been improving financial inclusion at a CAGR of five percent plus, and since 2018, the country has more than doubled the extent of digitisation of payments, as per the Reserve Bank of India's Digital Payments Index and Financial Inclusion Index. This spectacular growth in UPI transactions, at a CAGR of 381 percent over the last five years, has been the prime mover in the rapid adoption of digital payments in India. This growth has been powered by a confluence of technological developments and progressive government policies and regulations. While UPI has been the prime game-changer, other digital payment options such as Bharat Bill Payment System (BBPS), BHIM Aadhaar, Aadhaar Enabled Payment System (AEPS) and *99# service, all developed within the

country, are propelling the rapid adoption of digital payments. AEPS and BHIM Aadhaar, especially, are enabling digital payments in rural areas. NPCI has conducted a pilot for face authentication and IRIS based AePS to promote contactless AePS, to further drive financial inclusion in rural areas. Earlier this year, RBI launched a version of UPI which can be used on feature-phones – phones that the poor primarily use. The move will further bolster financial inclusion, and bring more than 40 crore feature phone users into the fold of digital-payments.

Smart Cities Mission

Moving on from the virtual digital economy to the brick-and-mortar world, one of the most visible and palpable examples of the impact of technology in changing the lives of our people is the evolution of our Smart Cities. Launched in 2015, the Smart Cities Mission (SCM) identified 100 cities across the country for higher economic growth and better quality of life of people by enabling local area development and harnessing technology, especially technology that leads to Smart outcomes. So whether it is solid waste management, lower air and water pollution levels, better space utilisation, beautification of the cities, efficient urban mobility, improved city infrastructure, more health and fitness facilities for the citizens, at every stage and segment, application of Smart Solutions enable these cities to use technology to improve infrastructure and services. Application of smart solutions involves the use of technology, information and data to make infrastructure and services better. For example, applying Smart Solutions in the transport sector (intelligent traffic management system) and reducing average commute time or cost to citizens will have positive effects on productivity and quality of life of citizens. Another example is waste water recycling and smart metering which can make a substantial contribution to better water management in the city.

The nerve centre in each Smart City is the Integrated Command and Control Centre (ICCC) which monitors all the activities taking place in the city from a technology enabled and responsive, central location. The ICCC is designed to aggregate the information across multiple applications with the help of sensors deployed across the city to provide actionable information with appropriate visualisation for decision-makers. What makes a CCC different from a surveillance system or an IT dashboard is the ability to control the utilities and their sub-systems in case of an emergency. As of March 2022, ICCCs have been operationalised in 76 Smart Cities in the country. These ICCCs are playing an important role in ensuring better monitoring and efficiency in areas like traffic management, crowd management, detection of crimes, disaster management, etc. Cities have taken up various projects in areas of Integrated Transport Management (ITS), Intelligent Traffic Management Systems (ITMS), Adaptive Traffic Control Systems (ATCS), development of complete

streets, public bicycle sharing systems, automated parking management systems, multi-modal transit hubs, etc., to reduce traffic congestion and provide efficient urban mobility.

During the COVID-19 pandemic, these ICCCs were converted into COVID-19 war rooms and became the epicenter of coordinated actions amongst various stakeholders for dealing with the pandemic. Monitoring of hospital beds especially oxygen, ventilator and ICU bed availability; continuous follow-up of reported, recovered, active cases was made possible through solutions deployed in these ICCCs. Cities like Puducherry, Rourkela, Chennai, Ahmedabad, Belgaum, Karimnagar and many other Smart cities created similar solutions. Centralised dashboards and ICT solutions to effectively trace, test, track and treat were deployed by many cities. Cities like Shimla, Tumakuru, Vellore, Amritsar, Dehradun and many other Smart cities created dedicated helplines for telemedicine, e-counseling, and other COVID-19 related complaints/concerns for their citizens.

At the India Smart Cities Awards Contest 2020, Surat and Indore were adjudged as Best City while Uttar Pradesh was awarded the Best State. The success stories coming in from the various Smart Cities across the country are living proof of how technology can improve the quality of life of ordinary citizens. There is a tendency to think that Smart Cities are advantageous only for the well-off urban citizen equipped with smartphones and laptops, but actually it is the low income urban citizen – the blue-collar worker commuting by public transport, the street vendor who has to get his tehbazari licence, the auto driver who burns extra petrol at every traffic hotspot, the government school student who needs well-equipped classrooms, the women living in slums who need clean toilets – who benefit in multiple ways as access to government-supported facilities becomes not only easier but the quality of the facilities also improve substantially.

For instance, in the pilgrim town of Solapur in Maharashtra, E-Toilets (or electronic toilet system) have been installed for the large visiting/ floating population of the city. These are unmanned, automated/ self-cleaning toilets with remote monitoring facility. The e-Toilets deploy integrating electrical, mechanical and web mobile technologies. Again, Surat is implementing a city-wide integrated system – "Intelligent Transit Management System" (ITMS) -- to manage diverse set of transportation needs for the city. This includes public transport and vehicles related to civic services like Solid Waste Management, Drainage, Heavy Engineering, Emergency Services, etc. Meanwhile, in order to promote bicycle ride and provide for first and last mile connectivity to BRT, Smart City Bhopal has initiated a public bicycle-sharing program in the city. A public bicycle-sharing app is available, where users may register themselves, choose a suitable bicycle-sharing plan and pay for the same. Smart City Aligarh has installed surveillance cameras, adaptive traffic control system (ATCS), public announcement and emergency calling system (ECS), environment sensors and variable message signboards (VMS) at various junctions around the city. It has installed Health ATMs around the city hospitals that focus on reducing the time for medical check-up of the residents of the city without any long queues, and easy appointment. At the ICCC in Prayagraj, crowd analytics is used for surveillance of entry/exit points and bathing ghats, thus making this heritage city much safer. Further, with the help of number plate detection software, the authorities are tracking the movement of vehicles through 1,150 cameras installed across the city. Indore is slated to be the country's first smart city with smart addresses after the implementation of a fully digital addressing system. It already has an integrated revenue generation system through collecting property & water tax online, integrated Solid Waste Management (ISWM) for tracking real-time door to door garbage collection vehicles, smart classrooms in government schools, the Indore 311 (Citizen Grievances and Redressal System) mobile app, and is looking at solar integrated EV charging stations in the city. Behind all these is a silent technological revolution, geared to meet the changing needs of today's citizens.

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Non-conventional Energy Sources

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India is gradually transitioning from conventional sources to non-conventional sources of energy, for its needs. This is particularly significant as being one of the fastest growing countries in the world and fifth largest economy, as on date, India holds a strategically important position in the global arena and India's efforts in climate change will pave a direction for the future generation.

Energy occupies a pivotal position to facilitate the dream of a sustainably developed India. With erratic monsoons and frequent droughts, global warming is no longer a mere threat but a reality. Source of energy play a dominant role in determining the pace of global warming. Conventional energy sources such as the burning of fossil fuels including coal is the largest contributor to global climate change. In fact, fossil fuels account for about 75 percent of the total global greenhouse emissions and about 90 percent of the total carbon dioxide emissions. Apart from adverse ecological implications, excessive reliance on conventional sources of energy will result in their exhaustion as well, as it is a non-renewable energy source.

In the past few decades, there has been extensive research on the global climate change phenomenon and how the usage of conventional sources of energy particularly fossil fuels may be reduced. These researches also led to the formation of United Nations Framework Convention on Climate Change (UNFCCC), an international environmental treaty, in 1992 to combat the excessive greenhouse emissions. One of the first major measure undertaken under UNFCCC was the Kyoto Protocol which was signed in 1997. The Kyoto Protocol made the industrialised countries and economies to commit and reduce emission of Green House Gases as per their agreed individual targets. Subsequently, the Paris Agreement was also signed wherein around 196 countries signed a global framework to avoid dangerous climate change by limiting global warming to well below 2°C and pursuing efforts to limit it to 1.5°C. Despite all these efforts, the carbon-dioxide emissions are alarming and calls for a shift towards non-conventional sources of energy.

India is gradually transitioning from conventional sources to non-conventional sources of energy, for its needs. This is particularly significant as being one of the fastest growing countries in the world and fifth largest economy, as on date, India holds a strategically important position in the global arena and India's efforts in climate change will pave a direction for the future generation. Also, considering the developmental requirements of India and growing energy needs, shifting to non-conventional sources of energy is essential for the country's sustainable and holistic development.

Non-conventional energy sources refers to those renewable sources of energy that are obtained from the nature and are replenished at a rate faster than its consumption unlike the conventional energy sources like coal, natural gas etc. In other words, the energy sources do not get depleted when used. They constitute clean and inexhaustible source of energy. The most important characteristic of non-conventional sources of energy is the way they impact the environment, which is much less hazardous compared to conventional sources of energy.

The popular sources of non-conventional energy sources in India are as follows:

Solar Energy

Solar energy refers to the energy received from the sun in the form of light and heat. It can be harnessed by converting solar energy into electric energy in solar plants. India, being a tropical country and its geographical location makes it a conducive source of energy. There has been a significant impact of the solar energy in India in recent years. Solar energy has penetrated to the rural belts of the country making regular activities like cooking, lighting and other energy needs eco-friendlier and cheaper. Further, the solar energy sector in India has evolved as one of the key sunrise sectors with lots of potential. The country's need for the solar energy has resulted in Production Linked Incentive scheme for manufacturing of solar Photo-Voltaic (PV) modules with an outlay of Rs. 24,000 crores. The scheme supports setting up of integrated manufacturing units of high efficiency solar PV modules by extending support through Production Linked Incentive (PLI). It is expected that the scheme will create additional 10,000 MW capacity of integrated solar PV manufacturing plants. It will further reduce imports of solar PV cells and modules and provide adequate impetus to Research and Development to achieve higher efficiency in solar PV modules.

Recently, India has achieved 5th rank globally in solar power deployment by surpassing Italy. Also, the efforts of the Government have resulted in increase of solar power capacity by more than 11 times in the last few years.

Wind Energy

The kinetic energy of wind in motion is used to generate wind energy. The expansion of the wind industry in the country has created a strong ecosystem with efficient project handling and operation facilities and manufacturing base of about 10,000 MW per annum. As on 31st March, 2021, India with total installed capacity of 39.25 GW has the fourth highest wind installed capacity in the world. India with its long coastline of around 7,500 km has immense potential in harnessing offshore wind energy. The government has installed over 800 wind-monitoring stations across the country and has issued wind potential maps at 50 m, 80 m, 100 m and 120 m above ground level. The recent assessment by the government has indicated a gross wind power potential of 302 GW in the country at 100 meter and 695.50 GW at 120 meter above ground level.

Tidal Energy

The energy produced from the surge of ocean i.e from rise and fall of waves is called tidal energy. Tidal energy is yet to take in a full fledge form for commercial purposes and is still in the research and development phase. Relatively high cost and limited availability of sites with sufficiently high tidal ranges or flow velocities poses constraints on its total availability.

Geothermal Energy

The energy generated from the heat derived from sub surface of earth is called geo-thermal energy. The gradual decline of radioactive particles in earth's core generates geo-thermal energy.

Hydropower

Hydropower, or hydroelectric power or hydel power, is considered to be one of the oldest and largest sources of renewable energy. It generates electricity by harnessing the flow of water.

Biomass Energy

Biomass energy is generated by living organisms or organisms that lived earlier. Biomass is an organic material and contains stored energy obtained from the sun. Burning of biomass results in release of chemical energy in biomass in the form of heat.

According to Ministry of New and Renewable Energy (MNRE), about 32 percent of the total primary energy use in India is still derived from biomass and more than 70 percent of the country's population depends on bio-mass fuel to cater to their regular energy needs. In a recent study by MNRE, it was estimated that the present bio-mass availability in India is around 750 million metric tonnes annually.

Fuel Cell

This refers to the source of energy which uses hydrogen and oxygen to generate electric power. Through chemical reaction with oxygen, fuel cells convert hydrogen obtained from diverse sources, into electricity. Water is the only end product of this process, making it a clean and sustainable energy source.

Significance of Non-conventional Sources of Energy

Transition to non-conventional sources of clean energy ensures the attainment of three Es that often finds mention in energy policies- energy security, economic development and environmental sustainability. The shift towards non-conventional sources of energy will make this planet a better place to live. Apart from addressing the issue of climate change and global warming, transition to renewable sources of energy will reduce air pollution and will further contribute to better public health outcomes.

Additionally, thrust on non-conventional sources of energy can fetch economic gains to India. The shift towards non-conventional sources of energy can bring down the cost of energy supply and can also ensure enhanced delivery of affordable clean energy that is accessible to all. The realisation of India's AatmaNirbhar Abhiyaan also depends on the enhanced accessibility and affordability of green/clean energy sources.

Apart from environmental aspects, the economic benefits are also significant. The transition to renewable energy sources will aid Indian economy to delink itself from volatile international oil prices. It can also ease out subsidy burden of government currently spend on conventional energy sources including kerosene. Further, the transition to non-conventional sources of energy results in more employment and entrepreneurship opportunities in the domain of renewable energy. India can also lead in exports of non- conventional energy sources such as wind electric generators, bio-mass gasifiers, solar energy systems, electric vehicles etc. Further, India could also handhold other developing nations to explore the path of sustainable development via making best utilisation of non-conventional sources of energy.

Governmental Interventions to Foster Renewable Energy Sources

In recent times, non-conventional sources of energy have received greater momentum with government taking numerous measures to facilitate the transition to clean sources of energy that can lead India's de-carbonisation initiatives.

As per government sources, as on February 2022, a total of 152.90 GW of renewable energy capacity projects have been installed in India which comprise of 50.78 GW from solar power, 40.13 GW from wind power, 10.63 GW from Bio-power, 4.84 GW from small hydro power and 46.52 GW from large hydro power. With greater momentum, India is committed to achieving 500 GW of non-fossil fuel-based energy capacity by 2030. The governmental efforts are aligned with making substantial progress in achieving Sustainable Development Goal 7, which calls for "affordable, reliable, sustainable and modern energy for all" by 2030. The government initiatives along with contributing to long term energy security

needs and reducing carbon footprint, will also generate large direct and indirect employment opportunities.

Some of the recent governmental interventions for facilitating transition to renewable sources of energy are as follows:

- Permitting Foreign Direct Investment (FDI) up to 100 percent under the automatic route for renewable energy projects, including offshore wind energy projects.
- Setting up of ultra-mega renewable energy Parks to provide land and transmission to renewable energy developers on a plug and play basis.
- Waiving of Inter State Transmission System (ISTS) charges for inter-state sale of solar and wind power for projects to be commissioned by 30th June 2025.
- Laying of new transmission lines and creating new sub-station capacity for evacuation of renewable power etc under Green Energy corridor scheme for evacuation of renewable power.
- Pradhan Mantri Kisan Urja Suraksha Evam Utthaan Mahabhiyan (PM-KUSUM): PM-KUSUM aims for de- dieselisation of the farm sector along with providing energy security and increased income to farmers. The Scheme with a financial support of over Rs.34,000 crore from Central Government has aimed to create additional 30.8 GW of solar capacity. It has 3 components (i) creation of 10,000 MW of Decentralised Ground mounted grid connected solar power plants, (ii) solarisation of 15 lakh grid connected agriculture pumps and (iii) installation of 20 lakh agriculture pumps powered by solar energy.
- Rooftop Solar Phase – II Programme: Under this Programme 4000 MW rooftop solar (RTS) capacity addition is targeted through Central Financial Assistance (CFA) in residential sector including for households in rural areas.
- National Hydrogen Mission: The mission aims in making India, a green hydrogen hub, aiding India to fulfil its target of production of five million tonnes of green hydrogen by 2030 along with allied development of renewable energy capacity. The Mission proposes a framework for inter alia generating demand for Green Hydrogen in sectors such as petroleum refining and fertiliser production; support for indigenous manufacturing of critical technologies. In tune with the National Hydrogen mission, recently in August 2022, India's first indigenously developed Hydrogen fuel cell bus developed by KPIT-CSIR was launched.
- National Offshore Wind Energy Policy was notified by Government of India on 2015 for the development of offshore wind power in the country. Post notification, Government through National Institute of Wind Energy has also issued guidelines for Offshore Wind Power Assessment Studies and Surveys. These guidelines are expected to enable private sectors to carry out offshore wind resource assessment.
- National wind solar hybrid policy was adopted in 2018 by MNRE and it aims at providing a framework for promotion of large grid connected wind-solar PV hybrid projects for optimal and efficient utilisation of transmission infrastructure.
- Ministry of New and Renewable Energy sources has also implemented numerous schemes to foster bio-energy such as scheme to support Promotion of Biomass based cogeneration in sugar mills and other industries, Programme on Energy from Urban, Industrial and Agricultural Wastes/ Residues, Biogas Power (Off-Grid) Generation and Thermal application Programme (BPGTP), New National Biogas and Organic Manure Programme (NNBOMP) etc.

The initiatives of Government in facilitating transition to renewable energy sources has been echoed in the international forums as well. In COP 26 summit held at Glasgow, Hon'ble Prime Minister, depicting India's efforts to cope up with climate change, has announced 'Panchamrit' (five nectar elements) which lays great emphasis on non- conventional energy sources. It includes the following; (i) India will take its non-fossil energy capacity to 500 GW by 2030, (ii) India will meet 50 percent of its energy requirements from renewable energy by 2030, (iii) India will reduce the total

projected carbon emissions by one billion tonnes from now till 2030. (iv) By 2030, India aims to reduce the carbon intensity by more than 45 percent. (v) By the year 2070, India aims to achieve the target of Net Zero which effectively means to completely negate the production of greenhouse gases.

Thus, much emphasis has been placed on the development of non-conventional energy sources to fight global warming. Over the years, development of renewable energy in India has attained greater momentum. India, today ranks 4th in the world in installed renewable energy capacity. India's non-fossil fuel energy has increased by more than 25 percent in the last 7 years and now it has reached 40 percent of our energy mix.

Challenges in Transition to Non-Conventional Energy Sources

The transition to non-conventional energy sources is a transformational step necessitating a system overhaul and hence poses many challenges. Ensuring an enabling infrastructure and conducive ecosystem for facilitating a smooth transition to renewable energy is a matter of concern. This also includes the challenge of expanding power infrastructure to permit increased use of diverse energy sources and ensuring system flexibility. Massive investment is inevitable for facilitating smooth transition to non-conventional energy sources. Ensuring viable financing mechanism to raise long term funds at low interest rate to facilitate this transition is thus a formidable challenge. International green finance flows to India are gradually increasing but are still relatively low while compared to India's lofty climate goals. The landscape of green finance is marred by issues like long gestation gaps, increased capital cost, potential risk factors associated etc.Further, investment in renewable energy sector is disproportionate in nature. For instance, despite its growth potential, wind energy sector attracts relatively fewer international investments as compared to solar energy sector.

Another impediment pertains to resolving the issue of low credit worthiness and resulting lack of investor confidence in the renewable energy sector. Renewable energy sector merits individualistic attention and it should be ensured that investments in conventional energy sources does not crowd out renewable energy investments. Leveraging private sector investments to its optimal level to foster the transition to clean energy is also a prevalent challenge. The poor financial strength of some of the distribution companies and their resulting inability to make timely payments to renewable energy developers is also a formidable hindrance. It can also affect the viability of renewable energy sector and further slow down it space of development.

Further coping up with immediate job and revenue loss due to switch from fossil fuels will also be a challenge. Addressing this requires strategic planning for raising necessary finance and upskilling of our human resources.

Way Ahead

Facilitation of transition to non-conventional energy sources holds the key for India's developmental aspirations. A revolutionary shift to non-conventional energy sources can bring about transformational opportunities for sustained economic development. It will also ensure energy security and disaster resilience, apart from generating employment, improving health outcomes and offering other societal benefits. To facilitate a smooth and sustainable transition to non-conventional sources of energy, mobilisation of green finance needs to be adopted at a faster pace. Greater deployment and optimal utilisation of innovative financial instruments like green bonds, crowd funding, infrastructure debt bonds can help in this regard. Further facilitating increased public private partnership for funding and meeting necessary technological requirements is also needed. This also necessitates a conducive regulatory and institutional setup which is responsive to the dynamic needs of renewable energy sector. The existing government policies in this sector goes a long way in mitigating these challenges.

It is also important to further escalate research and development spending on the domain of clean energy sources, so as to come up with sophisticated enabling technologies. It will foster innovation, and aid in the creation of energy systems that are resilient to future economic and environmental shocks. Incentivising non-renewable sources of energy via fiscal tools and incentives

can further provide greater vigour to facilitate the transition to renewable energy sources. Further, ensuring greater synergy among all the concerned stakeholders through a participatory approach and awareness generation, can further help to fasten the pace of shift towards renewable sources of energy. Transition to non- conventional sources of energy is a crucial enabler for sustainable development and climate resilience paving its way towards creation of a more equitable, inclusive and sustainable society. The facilitation of such a transition is indeed possible with greater synergy and untiring efforts from all the concerned stakeholders and sectors involved.

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S&T: Towards Women Empowerment

Adita Joshi

Having women leaders at tables of power is crucial to bring a sustained and focussed change in lives of both urban and rural women. This article talks about the initiatives of science leaders, women scientists, national science academies and the government for promoting gender equality and empowering women in Science and Technology. The developments captured mostly represent those from the year 2000 onwards.

On the occasion of the Independence Day on 15th August, 2022, honourable Prime Minister Shri Narendra Modi emphasised that women power is significant for the growth of India as he said, "If we look at 'Nari Shakti' in law, education, science and police, our daughters and mothers are making major contributions to India". Globally, governments and organisations are focussing on promoting gender equality and women empowerment to untap the potential of women as the precious human capital. The first steps date back to the UN Conference on Women in Mexico to mark 1975 as International Women's year followed by the 4th U.N. World Conference on Women held at Beijing in 1995. The objectives of the conference highlighted full gender equality and integrating women in developmental activities by creating opportunities for full participation at diverse workplaces.

Women in Science and Technology in India (1950-2000's)

Science and technology is the most powerful enterprise that drives a nation's development, but ironically women in this area are under represented globally, and India has been no exception. The first Science and Technology policy in India (Scientific Policy Resolution, 1958) acknowledged women's role in science and technology and stated: "To ensure that the creative talent of men and women is encouraged and finds full scope in scientific activity." However, the intent was more in words than in action and women continued to be absent from research and technology spaces for various socio-cultural barriers and economic reasons.

From 1960s- 1980s, the number of women who rose high to leadership positions could be just

counted on fingertips. For example, E K Janaki Ammal who headed the Botanical Survey of India. Similarly, the three national academies of science (INSA, NASI, IASc) had miniscule number of women scientists as elected members and women researchers would hardly be selected for any accolades or awards owing to selection committees dominated by men and inherent gender bias. For example, the most coveted Shanti Swarup Bhatnagar prize incepted in 1958 was awarded to only eight women researchers until the early years of the 21st century.

Even women who had access to higher education were subjected to gender biases and had restricted career advancement opportunities. Thus, decision making bodies within the science and technology sphere lacked any women leaders or administrators. The first focussed move on women empowerment in science and technology was when Dr. M S Swaminathan initiated a chapter on 'Science and Technology for Women' in the Sixth Five Year Plan (1980-85) which was included in the plan document on 'Women and Development'. The chapter was prepared by Dr. Manju Sharma who later became the first woman president of National Academy of Sciences, India (NASI) and later Secretary, Department of Biotechnology (DBT). Dr. Sharma and other noted women scientists at pan India level led several initiatives to create opportunities to women and address the issue of leaky pipeline for women in science and technology and promote career advancement of women researchers.

Winds of Change – The 21st Century for Women in S&T

The former Prime Minister Atal Bihari Vajapayee declared the year 2001 as the year of empowerment of women. To quote his words, "Developing countries that have made remarkable social progress, have done so primarily through the empowerment of women, which has had enormous impact in terms of literacy, health and economic well- being of families".

In the new millennium, the Indian Science and Technology leadership focused on women enabling policies and initiated implementation of programmes to increase participation of women in STEM (Science, Technology, Engineering and Mathematics) disciplines.

The Science and Technology Policy 2003 emphasised; "To promote the empowerment of women in all science and technology activity and ensure their full and equal participation."

A few important scientific and technological empowerment goals were identified:

1) Capacity Building 2) Promoting Gender Neutral Workspaces 3) Providing Access to information to women in science and technology 4) Increasing the number of girls in science and providing ways to overcome the challenges of the issue of 'Leaky Pipeline' at tertiary and mid-career level.

INSA Report (2004): A breakthrough for Women in Science

In 2002, Prof. MVS Valiathan, the President of Indian Nation Science Academy (INSA) constituted a committee to examine the status of women in science in India and to investigate factors influencing the same using data from a study conducted by Research Centre for Women's Studies (RCWS), SNDT University, Mumbai. The recommendations of the INSA report on 'Careers of Women in Science' prompted the Scientific Advisory Committee of the Prime Minister (PM -SAC) to constitute a National Task Force for Women in Science in December 2005 under the Department of Science and Technology (DST).

Initiatives taken by the Government

National Task Force for Women in Science

The taskforce conducted ten nationwide meetings with women scientists to identify reasons for lower retention of women in S&T and propose related solutions with gender enabling measures. The task force identified several issues—female students in science were less than the ideal fraction of 50 percent and the percentage was even less in certain geographic regions and states, engineering disciplines had least number of women, recruitment policies and family responsibilities led to the 'leaky pipeline' with the number of women drastically decreasing from post-doctoral level to regular faculty/scientist positions. Owing to these gaps the number of women science leaders in senior administrative and policy making bodies was majorly low.

The following initiatives were taken by the task force – a book on achievements of prominent women scientists was proposed to be brought out by Dr. C S Lakshmi (SPARROW, Mumbai), a project on analysing gender representation in science textbooks and how it would influence young school girls was awarded to Dr. Sugra Chunawala, HBSCE, Mumbai, and a national conference showcasing the achievements of women scientists was organised on Women's day, 8th March, 2008 at Vigyan Bhavan.

Recommendations of the Task force

The task force made several recommendations, these include –recruitment of deserving women scientists in institutions, selection/hiring committees to include women scientists; committee members to avoid asking questions with inherent gender bias and age relaxation for exceptional female scientists

Refresher training, mentorship programs and schemes for career advancement and re-entry to enable women who had been on a break due to family reasons were rolled out. In addition, women friendly workplaces with availability of creches, campus housing and safeguarding policies against sexual harassment at work were proposed.

To promote scientific temper among school girls, summer / winter science camps and interaction with established women scientists (role models) was suggested. New policies with focus on maternity leave, setting up gender units in state S&T councils, establishing women's universities in geographical areas/ states with low numbers of women in science; developing avenues to promote entrepreneurship and self-employment for women scientists were other key recommendations. Many of these recommendations were later developed into schemes and programs as discussed in the upcoming sections.

KIRAN (Knowledge Involvement in Research Advancement through Nurturing) is a division reconceptualised at DST in 2014 to cover all the women-exclusive schemes to bring gender parity in S&T and provide a framework for gender mainstreaming. It supports Women Scientist Scheme (WOS), originally launched in 2002-2003, Curie Program(2008-09) and the more recently launched 'Mobility scheme'.

Women Scientist Scheme (WOS)

WOS-A provides opportunities to women researchers who have taken a break in a career primarily due to family responsibilities, relocation, etc for pursuing research in basic or applied sciences in frontier areas of science and engineering. WOS-B provides grant support to women scientists for developing S&T solutions for solving grassroots level issues and promoting social benefit. Women Scientists Scheme-C (WOS-C provides a one-year internship in the domain of Intellectual Property Rights (IPRs). Participants who participate in this scheme go forward to pursue a career in IPR.

CURIE Programme (2008-09) – Promoting S&T infrastructure

One of the major goals that was identified by the National Task force was to increase the number of women in S&T by providing them access to cutting edge S&T infrastructure and promote scientific skills training. Towards this, DST conceptualised and initiated a special programme "Consolidation of University Research for Innovation and Excellence in Women Universities (CURIE) and supported nine women universities across India for enhancing their R&D infrastructure.

Currently, the program is expanding via a new component 'Support for Women PG Colleges' with a focus to improve STEM education and research in post graduate colleges to provide quality science education to girls in small cities.

Mobility Scheme

Many women scientists face difficulties in their present job due to relocation (marriage, transfer of spouse to a different location etc) and struggle to search career options at a new place. Mobility scheme offers a contractual research award towards conducting independent research in any location. This enables women to undertake research during early phases of their career while fulfilling key domestic responsibilities.

Biotechnology Career Advancement and Re-orientation Programme (BioCARe) was launched by DBT in 2011 for career development of employed/ unemployed women researchers up to 45 years of age by providing extramural research grant support. This scheme is focussed towards bringing women

researchers to mainstream science after a career break. So far, 361 women scientists have benefitted of which 10-12 percent have been successfully employed by research institutions.

Role of National Science Academies

The three science academies in India initiated their work towards empowering women in science. Indian Academy of Sciences (IASc) formed a panel for Women in Science (WiS) in 2005 and came out with a collection of life journeys of Indian women scientists compiled in a book called "Lilavati's Daughters: The Women Scientists of India" (2007) and another with a title, 'A girls guide to life in Science' (2012) for young girls interested in pursuing science. IASc further focussed on mentoring women scientists to realise their full potential and to generate awareness on gender issues in science and academia. NASI under its mandate of science and society launched a pan India programme on 'Technological Empowerment of Women' during the year 2012-13 that included a series of workshops themed on issues related to urban and rural women such as health, nutrition, agriculture, animal husbandry, horticulture, aquaculture etc. A few recommendations of these workshops were later implemented by government agencies.

The WiS panel at NASI also conducted a survey along with National Institute of Advanced studies (NIAS) called " Trained Scientific Woman Power: What fraction are we losing and Why?" NASI published a compendium on 'Nobel Laureate Women Scientists' in 2008.

The three science academies came together to establish a committee that reports to the President and Council on the status of women empowerment in science as well as the role of women scientists in bringing technology to the rural women to uplift them from drudgery. An inter academy panel on Women in Science in India was constituted in June 2015 that came out with a vision document called, 'A roadmap for Women in Science and Technology', 2016 which led to constitution of a 'Standing Committee on Women in Science' by DST in 2016. Together, WIS efforts of the three national science academies have generated a robust traction for generating awareness on scientific careers for women and young girls, created mentoring opportunities via workshops and generated nationwide survey data on the status of women in science.

Application of S&T for Women's Welfare

Rural women contribute to about 60 percent of work in livelihood areas that involve intersection with science and technological advancements and economic activities such as agriculture, animal husbandry, post-harvest operations, fisheries etc. However, all of these involve significant drudgery related to sowing, transplanting saplings, weeding, harvesting etc. To reduce this hard work and provide better methods and solutions to rural women, Indian council of Agriculture Research (ICAR) along with NASI has initiated many programs and have instituted awards to honour contributions of scientists and technologists who design innovative solutions to reduce the labour of rural women in agri-based livelihoods.

'S&T for Women' is a special scheme rolled out by DST in 1981-1982 to primarily engage women scientists to foster research and development of technology with a potential to improve the quality of life of rural women. Since its inception more than 2000 projects have been sponsored and around 500 technologies have been transferred in various areas for upliftment and empowerment of rural women.

Under this scheme, rural women are not only provided access to technology solutions but are given training to adapt innovative methods to improve their working conditions. Women scientists are supported to focus on developing technologies for development of rural women in hill, coastal and arid regions. Some of the key themes and areas of intervention include – R&D in post-harvest technology such as thrashing, winnowing and milling; developing or improvising tools and equipment used by rural women for easy use in works such as shelling of maize and groundnuts and training women on the use of such new innovative methods and tools. Promoting skill development of rural women for tapping the potential of local resources and moving towards developing entrepreneurship avenues is another key focus area.

Women Technology Parks are another innovative concept that highlight women empowerment via S&T in true sense – these represent a link between rural women workforce and scientists and researchers. The key mandate of women technology parks is to – promote technology development and its demonstration and adaptation to promote women's

employment in the areas of dairy, poultry, sheep and goat farming, aquaculture, floriculture, mushroom cultivation, vermiculture and vermicomposting. Other areas include focus on value added products, bee-farming, bio-fertilizer production, coir and jute products, fruit and vegetable based products, etc.

Women technology parks are centres that are strategically placed near women farmer's community to facilitate demonstration of methodology by scientist-cum-technologists. The goal is to make rural women develop an attitude that adoption and practice of such transforming technologies will help them build their own micro-enterprise and pave way towards self-reliance. These centres work in co -ordination with panchayats and state who provide financial assistance. A national award for 'Women's Development through Application of Science and Technology' has been instituted to honour individuals/institutions who have made significant S&T advancements for women's development at grass root level.

DBT also supported setting up a Golden Jubilee Women's biotech park at Siruseri, Kanchipuram District in 2001 as a joint project with the Government of Tamil Nadu with an investment of Rs. 400 lakhs. The Park is an entrepreneurial facility primarily supporting first generation women entrepreneurs and women scientists and provides support towards making small-scale investments to independently take up production of value added products such as herbal cosmetics and essential oil, bio-pesticides, bio-fertilisers, ready to eat snacks etc.

Application of science and technology have also been sought for –providing a healthy lifestyle to rural women with special focus on nutritional needs, hygiene and sanitation and education and training projects.

Environment conservation is also an issue that hugely impacts lives of rural women and thus scientists are nudged to undertake environmental sustainability projects with a provision for realising the objectives by involving the rural women.

Vigyan Jyoti, a programme introduced by DST in the year 2019-20 with an aim to provide exposure to meritorious young girls in tier 2 cities and remote and rural areas to pursue a career in STEM. The programme promises hand-holding and mentoring for girls from their school stage till PhD. A spectrum of activities such as science camps, special lectures, counselling of parents and interaction with women scientists are planned for girls as a part of early exposure to science and related careers. The Navodaya Vidyalaya Samiti (NVS), is the implementation partner of Vigyan Jyoti with 100 JNVs currently acting as 'Vigyan Jyoti Knowledge Centres' to girls from Govt. schools, of small cities and rural areas.

Recent Developments

On 28th February 2020, India celebrated National Science Day with 'Women in Science' as the focal theme. Underscoring the fundamental need of guiding principles to normalise gender equality across all scientific institutions and enterprises, DST launched GATI (Gender Advancement for Transforming Institutions) as a mission mode program. GATI aims to push higher education institutions, research institutes and universities towards supporting diversity, equity and inclusion (DEI) with a belief that attracting a diversity in talent will ultimately allow institutions to flourish to their best. The participating pilot institutions are expected to acknowledge and overcome cultural and systemic blockers that impede the academic and professional advancement of women in science. The institutions will be required to create policies, practices, action plans for the intended self- sustainable and accreditation model and will be assessed for a GATI award. Apart from accrediting and recognising institutions through certification and awards, GATI would mentor, coach and provide training support to institutions to develop global best practices in gender equality.

Attention to women's concerns has revealed the value of cognitive diversity in the scientific process. There are still many 'Firsts' to be conquered, for example recently Dr N Kalaiselvi became the first women DG, CSIR and Secretary, DSIR. With the ongoing efforts, the coming years shall hopefully see S&T workspaces where women representation is normalised in all roles starting from entry to reaching higher echelons of leadership and policy making.

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Science and Technology in Agriculture

Sandip Das

The government's thrust on new digital technologies innovations and focus on research and development in the agricultural sector, has helped not only boost farmers' income but also ensure that the country remains self-sufficient in most of the agricultural commodities.

The green revolution initiated in the 1960s was to boost country's foodgrains production thus reducing import dependency through the introduction of irrigation, fertilisers, high yielding varieties of wheat and rice and usage of pesticides and insecticides. Through continuous development of new varieties of rice, wheat, cotton, pulses, oilseeds and other crops in the last five decades, India has emerged as a prominent producer of several commodities. Besides achieving self-sufficiency in foodgrains production, India has emerged as the biggest producer of rice in the world since last decade.

The agriculture and allied sector play a critical role in rural livelihood, employment and national food security. The sector provides the largest source of livelihoods in the country. Proportion of the Indian population depending directly or indirectly on agriculture for employment opportunities is more than that of any other sectors. It is estimated that around 55 - 60 percent of its rural households depend primarily on agriculture for their livelihood. According to the agriculture census (2015-16), there are 14.5 crore farmers families in the country; around 82 percent of farmers belong to small and marginal categories, who own less than one acre of land each.

According to the Economic Survey (2021-22), the agriculture sector in the country has experienced buoyant growth in the past two years. The sector, which is the largest employer of workforce, accounted for a sizable 18.8 percent (2021- 22) in Gross Value Added (GVA) of the country registering a growth of 3.6 percent in 2020-21 and 3.9 per cent in 2021-22. The survey stated that the growth in allied sectors including livestock, dairying and fisheries has been the major drivers of overall growth in the sector.

Digital Technologies

The Committee on Doubling Farmers' Income in its report 2018 has noted the role of digital technology, which can play a transformational role in modernising and organising how rural India performs its agricultural activities.

Digital technologies are finding increasing use in the agricultural value system, and farmers are increasingly becoming more informed, as various measures are taken to provide them ready access to technology and information. Government has taken various initiatives to give a push to digital agriculture in the country.

The Government has finalised the core concept of India Digital Ecosystem of Agriculture (IDEA) framework which would lay down the architecture for the federated farmers' database. The databases related to the schemes governed by the department have been integrated. The IDEA would serve as a foundation to build innovative agri-focused solutions leveraging emerging technologies to contribute effectively in creating a better Ecosystem for Agriculture in India. This ecosystem shall help the Government in effective planning towards increasing the income of farmers in particular and improving the efficiency of the agriculture sector as a whole. Several measures have been initiated to boost use of science and technology in Indian agriculture.

Under the national e-Governance plan in Agriculture (NeGP-A), the funds are released to the States and Union Territories for projects involving use of modern technologies such as. Artificial Intelligence, Machine Learning, Robotics, Drones, Data Analytics, Block Chain etc.

The sub mission on Agricultural Mechanisation being implemented since April, 2014, aims at 'reaching the unreached' by bringing to the small and marginal farmers in the core and giving the benefits of farm mechanisation, by promoting Custom Hiring Centers (CHCs), creating hubs for hi-tech and high value farm-equipments, distribution of various agricultural equipments, creating awareness among stakeholders through demonstration and capacity building activities, and ensuring performance-testing and certification at designated testing centers located all over the country.

e-NAM: Online Marketplace

The National Agriculture Market (e-NAM) is a pan-India electronic trading portal which networks the existing Agricultural Produce Market Committee (APMC) mandis to create a unified national market for agricultural commodities. Digital services are provided to traders, farmers, Farmers Producer Organisations (FPOs), Mandis through various modules of e-NAM platform such as FPO trading module, warehouse-based trading module. Under the scheme, three reforms are mandatory for States/ Union Territories (UTs) in their respective APMC Acts for integrating their mandis with e-NAM platform - provision for e-trading, single point levy of market fee and unified single trading license for the State. States without APMC Act need to provide legally enforceable guidelines and institutional mechanisms for implementing e-NAM.

So far, 1260 mandis of 22 States and 3 UTs have been integrated with the eNAM platform for providing market access to farmers to sell their agricultural produce. More than 1.73 crore farmers and more than 2.26 Lakhs traders have been registered on e-NAM platform. Trading parameters for 193 agricultural and horticultural commodities such as cereals, pulses, oilseeds, fruits and vegetables, spices, flowers and fiber crops have been provided. FPO trading module has been launched whereby FPOs can trade their produce from their collection center/ premise without bringing the produce to APMC. Warehouse based trading modules are provided in e-NAM to facilitate trade from warehouses based on e-NWR. Further, the e-NAM platform is made interoperable with Rashtriya e Market Services Private Limited (ReMS) platform of Government of Karnataka which will facilitate famers of either the platforms to sell their produce in other platforms thereby increasing their market access.

In July, 2022, the Agriculture Ministry launched the Platform of Platforms (PoP) under e-NAM intended to promote trade and marketing of agricultural produce wherein farmers will be facilitated to sell the produce outside their state borders. The PoP would increase farmers' digital access to multiple markets, buyers and service providers and bring transparency in business transactions with the aim of improving price search mechanism and quality commensurate price realisation. So far, 41 service providers from different platforms are covered

under POP that facilitate various value chain services like trading, quality checks, warehousing, fintech, market information, transportation etc. The platform creates a digital ecosystem for farmers who are benefited from the expertise of different platforms in different segments of the agricultural value chain.

Through e-NAM, GPS based e-NAM Mandi Locator: Farmers / Sellers can locate their nearby e-NAM mandi using GPS based mandi locator feature through e-NAM mobile app. According to an Agriculture Ministry official, this helps the farmers to easily locate and reach the selected mandis and sell their agri-produce. The platform has been integrated with AGMARKNET platform: Farmer can access the prevailing commodity prices & arrival information of e-NAM mandi as well as non e-NAM mandi on e-NAM mobile app. prior to even going to the mandi. Currently, the e-NAM portal is available in several languages - Hindi, Bengali, Marathi, Gujarati, Tamil, Telugu, Punjabi, Odiya, Dogri, Malayalam and Kannada and English to facilitate farmers to use e-NAM in the language of their choice.

PM KISAN Digital Payment

Under the PM KISAN scheme, Rs. 6,000 annually in three installments is directly transferred into the bank accounts of the eligible farmers under Direct Benefit Transfer mode. According to agriculture ministry data, since its launch in February-2019, 11 instalments have been disbursed under the PM-KISAN. More than Rs 2 lakh crore has been transferred to about 11.37 crore eligible farmers through this scheme. Farmers can do their self-registration through the farmers corner in the portal.

The PM-KISAN mobile app was launched to broaden the reach of the scheme where farmers can view the status of their application, update or carry out corrections of name based on their Aadhaar card and also check the history of credits to their bank accounts. A database is being created by the agriculture ministry for quick identification of eligible farmers for PM-KISAN and other schemes and farmers' welfare schemes to be launched in the future. The database will have all the information including Aadhaar, bank account of farmers and the land records of farmers will be linked with their records. The land records of the States will have to be digitally converted to create the database.

AGMARKNET portal

Integrated Scheme for Agricultural Marketing schemes (AGMARKNET) to promote creation of agricultural marketing infrastructure by providing backend subsidy support to State, cooperative and private sector investments Services are provided through AGMARKNET portal which is a G2C e-governance portal that caters to the needs of various stakeholders such as farmers, industry, policy makers and academic institutions by providing agricultural marketing related information from a single window. It facilitates web- based information flow, of the daily arrivals and prices of commodities in the agricultural produce markets spread across the country.

National Mission on Horticulture

It promotes holistic development of the horticulture sector (including bamboo and coconut). HORTNET project is a web enabled work flow-based system for providing financial assistance under the mission for Integrated Development of Horticulture. It is a unique intervention to accomplish e-Governance

in NHM where-in total transparency has been envisaged in all the processes of workflow -- online application filing, authentication, processing and online payment to the beneficiary's bank account through DBT.

Agriculture Infrastructure Fund

To mobilise a medium - long term debt finance facility for investment in viable projects for post-harvest management Infrastructure and community farming assets through incentives and financial support in order to improve agriculture infrastructure in the country. Financial assistance is provided digitally in the form of Interest Subvention and Credit Guarantee for setting up post-harvest management Infrastructure to beneficiaries such as Farmers, Primary Agricultural Credit Societies (PACS), Farmer Producers Organisations (FPOs), Self Help Groups (SHG), State Agencies/APMCs. The fund also allows convergence with other schemes so that benefits from other Centre/State government schemes can also be availed along with AIF. The total size of the fund is Rs 1 Lakh crore. All loans upto Rs 2 crore per project under this financing facility have interest subvention of 3% per annum. This subvention is available for a maximum period of 7 years.

National Project on Soil Health and Fertility

The Government has recommended soil test based balanced and integrated nutrient management through conjunctive use of both inorganic and organic sources such as manure, biofertilizers green manuring, in-situ crop residue recycling etc. of plant nutrients with 4Rs approach -- right quantity, right time, right mode and right type of fertiliser for judicious use of chemical fertilisers and to reduce use of chemical fertilisers. In addition, split application, use of slow releasing fertilisers including neem coated urea and growing leguminous crops are also advocated and use of resource conservation technologies are also advocated. Integrated Nutrient Management has been promoted through implementation of Soil Health Cards scheme since 2015.

Soil health card provides nutrient status of the soil along with prescription about balanced and integrated use of inorganic and organic fertilisers to maintain good soil health that results in increase in production. To issue soil health cards to farmers of the country, so as to provide a basis to address nutrient deficiencies in fertilisation practices. Soil Health Card Portal is available where farmers can track soil samples.

Kisan Suvidha App

Development of Kisan Suvidha mobile application to facilitate dissemination of information to farmers covering range of issues – weather forecast, extreme weather alert, market price of commodities, information about dealers of fertiliser, seeds, pesticide, seeds etc, plant protection for 12 major crops, agro advisories, soil health card, soil testing labs, cold stores and godowns, veterinary laboratories and diagnostic centres, crop insurance and government schemes. Besides, Pusa Krishi mobile app disseminates information about the latest technologies developed by the Indian Agricultural Research Institute. The app provided details about 185 technologies.

Usage of Drones in Agriculture

To promote the use of drones in agriculture, the Department of Agriculture and Farmers Welfare has released the Standard Operating Procedures for use of drones in pesticide and nutrient application, which provide concise instructions for effective and safe operations of drones. In order to make drone technology affordable and available to the farmers and other stakeholders of this sector, financial assistance of 100 percent cost of drone (upto Rs. 10 lakhs per drone) together with the contingent expenditure is provided under sub-mission on Agricultural Mechanisation to the Institutions of Indian Council of Agricultural Research (ICAR), Krishi Vigyan Kendras (KVKs), State Agricultural Universities (SAUs), State and other Central Government agricultural institutions, departments and public sector undertakings (PSUs) engaged in agricultural activities for its demonstration on the farmer's fields.

Farmers Producers Organisations (FPOs) are provided grants of 75 percent for purchase of drones for its demonstration on the farmers' fields. In order to provide agricultural services through drone application, financial assistance of 40 percent of the basic cost of drone and its attachments up to a maximum of Rs. 4.00 lakhs is also provided for drone purchase by the Custom Hiring Centers (CHCs) under

Cooperative society of farmers, FPOs and Rural entrepreneurs.

ICAR has also compiled more than 100 mobile apps developed by ICAR, State Agricultural Universities and KVKs and uploaded on its website. These mobile apps developed in the areas of crops, horticulture, veterinary, dairy, poultry, fisheries, natural resources management and integrated subjects, offer valuable information to the farmers, including package of practices, market prices of various commodities, weather related information, advisory services, etc. The Government is providing advisories services on various crop related matter to the registered farmers through SMSs.

Thrust on Genetic Improvement

The government's thrust has been on the use of new technology in agricultural research. The research by ICAR focuses on genetic enhancement of crops, livestock, fish for high yield, quality and climate resilience, conservation of resources and, development of intelligent information technology (IT) enabled platform for technology transfer among farmers and stakeholders. According to an official note, Indian Council for Agricultural Research (ICAR) during 2021-22 developed and released 309 varieties/ hybrids of field crops including 35 varieties with special traits and 94 varieties of Horticultural crops for cultivation by ICAR.

The Government, during 2020-21 and 2021-22, had allocated funds to the tune of Rs 1756 crore and Rs. 2422 crore to the states for introducing new technologies including drones, artificial intelligence, block chain, remote sensing and GIS etc in agriculture. Further, the Government also allocated Rs. 7302 crore and Rs. 7908 crore in 2020-21 and 2021-22 respectively to ICAR for undertaking Research and Development in Agriculture for developing new technologies, their demonstration at farmer's field and capacity building of farmers for adoption of new technology.

The Government has accorded due focus on ensuring improved service delivery and facilitating market access to farmers. Adequate emphasis towards reducing transaction costs, promotion of FPOs to improve their bargaining power. Development of infrastructure has also been given due attention to ensure better connectivity of farmers to the national and international market.

High-yielding, cost-saving, disease, pest resistant and climate-resilient varieties and technologies in crops, horticulture, animal and fisheries science developed besides precision farm equipment for production and post production

agriculture developed by ICAR have played important role in increasing production and productivity, reducing cost of production and enhancing income of the farmers. Adoption of Farming Systems Models developed by ICAR have also enabled farmers to enhance their income and strengthen their economic condition. Besides, State specific strategies for increasing farmers income, provided to States by ICAR, are also helping farmers to increase their incomes.

Collaborative Institutional Thrust on Research

National Agricultural Research System comprising of more than 100 Research Institutions, 63 state agricultural universities, three central agricultural universities and four universities having agriculture faculty besides 82 All India Coordinated Research Projects and Network Projects, each having a large number of coordinating centres across the nation, is amongst the largest and strongest research systems of the world.

Emphasis is given by ICAR to shift research from a commodity-based to farming systems based approach. ICAR has created multidisciplinary research complexes in different regions of the country to address this. A dedicated institute 'ICAR-Indian Institute of Farming Systems Research (IIFSR), Modipuram, Uttar Pradesh is working on characterising, creating, studying and refining the farming system models in all the agro-climatic regions. Another institute, ICAR - Mahatma Gandhi Integrated Farming Research Institute has been established to facilitate and promote coordination and dissemination of the technology for integrated farming through network/consortia approach. Sixty-three Region Specific Integrated Farming System models developed by ICAR are demonstrated through the network of research Institutes and KVKs all over the country.

ICAR's Roadmap for Food and Nutritional Security

ICAR has developed a clear roadmap for next 10 years harnessing the power of science and innovation for securing food and nutritional security of our people, farmers' prosperity and to enhance the natural resource base to promote inclusive growth and sustainable development of the Indian agriculture sector. The focused areas of research and developmental include Genetic enhancement of plants/animals/fish for higher productivity under increased intensity of biotic and abiotic stresses; productivity enhancement through sustainable intensification and mechanization of agriculture and food system; enhancing value, safety and income through food processing; development of energy efficient technologies and farming practices; education and human-resource development & developing and promoting innovations in technology transfer systems.

To ensure that the newer technologies like improved variety seeds of crops, new breeds/ strains of livestock and fish and the improved production and protection technologies reach the farmers and end users in shortest possible time, technologies are demonstrated and disseminated through central and State Government agencies, KVKs and through private sectors through licensing.

The governments' thrust has been to help farmers accessing latest farm technologies as well as new varieties of seeds to ensure that farmers' income get a boost and sustained in coming years besides ensuring that India remains self-reliant in production of most of the agricultural commodities.

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Technology and Innovation in Rural Economy

Manjula Wadhwa

Science and Technology can develop in rural communities, a learning and innovation capacity that increases the effectiveness of their efforts to solve problems and improve their lives. The technological advancements empower these communities and increase the effectiveness of their development efforts through informed decision making to achieve the objectives of poverty eradication, food security and sustainable development in rural areas. To effectively realise the positive impact of the fourth industrial revolution (a fusion of advances in artificial intelligence (AI), robotics, the Internet of Things (IoT), genetic engineering, quantum computing and more.), it is essential to use technology to bridge the gap between skilled and unskilled labour.

India is a land of villages and more than sixty nine percent[1] of India's population lives in villages, is an oft-repeated cliche but there is no getting away from the truth of it. In many ways, the rural areas have benefited from the developments in science, technology and innovations indirectly as well as directly. Scientific inputs in agriculture are of direct importance to the rural sector. So are the expansion efforts in telecommunications and roads, though much remains yet to be done. Technology for rural areas must be aimed at creating gainful employment, recycling wastes to create value-added products, human welfare through better housing, drinking water, sanitation, elimination of drudgery, promotion of non-conventional energy, climate change and decentralised techno-economic systems, particularly for remote areas. In fact, Science and Technology can develop in rural communities, a learning and innovation capacity that increases the effectiveness of their efforts to solve problems and improve their lives. The technological advancements empower these communities and increase the effectiveness of

their development efforts through informed decision making to achieve the objectives of poverty eradication, food security and sustainable development in rural areas. Agriculture, is the mainstay of India's rural populace.

Let us first glance at the five key services or functions that are very closely related to Science and technology. An access to information through different types of Agricultural Information Systems (AIS); Monitoring the situation of natural resources and environmental impact through different information processing tools (i.e. analysis of environment deterioration, soil erosion, deforestation etc.); Education and Communication Technologies that are playing a significant role in generating new approaches to learning and knowledge management; Networking where Science and Technology can contribute greatly to relating people/institutions among them and facilitating the emergence of 'Virtual Communities of Stakeholders' that generate and exchange information and knowledge among themselves; and Decision Support Systems (DSS) through which data and information provide relevant knowledge inputs for informed decision-making are playing an important role in converting information systems into knowledge systems. In fact, if well managed, networking is the first step in the direction of developing interactive knowledge development processes that may lead to learning networks.

The Government of India has rolled out schemes from education to financial literacy and agri-tech to skill development that cater to nearly 506 million[2] people living in rural regions. It is admirable to see that the central and state governments are united with a vision for the betterment of rural India. Digital literacy and connectivity have strengthened the labour market and provided a platform to educate and become financially independent. Enhanced innovation has helped the rural areas improve their growth prospects and the policymakers support reforms beyond subsidies and sector-specific approaches.

Center for Monitoring Indian Economy (CMIE) data from the consumer pyramid household survey shows the share of agriculture in total employment has gone up from 38 percent in 2019-20 to 41.49 percent in 2020-21. So, it has become highly apposite to work shoulder-to-shoulder to implement specific schemes and technological advancements in agriculture. In April 2016, the Government of India launched e-NAM (National Agriculture Market), an online platform for farmers that integrates agricultural markets pan-India with a theme of one nation-one market. The platform aids farmers and traders to view all Agriculture Produce Market Committee (APMC) related information, commodity arrivals, buy and sell trade offers, thus helping farmers bid for the best prices across markets, thereby promoting uniformity in agricultural marketing and remove the information asymmetry between buyers and sellers through technology. The number of registered farmers has risen to 1.66 crores, while 1.31 lakh traders transact on this platform. More than 1000 Farmer Producer Organisations (FPOs) have also been enrolled on this platform.

In view of the Jal Shakti Ministry's focus on saving and conserving rain water for creating appropriate rainwater harvesting structures in all the districts in the country, the Government of India is investing in mapping all of India's aquifers. Through national program on Aquifer Mapping and Management (NAQUIM) which aims at 3D mapping the aquifers and characterising them in terms of quantity, quality and spatial and temporal distribution of water level and resources. The Union Budget of 2022 has also pushed for an array of digital technologies and drones to propel growth in the farm sector. The promotion of drones to monitor the produce and spray insecticides will help scale up precision farming massively.

To effectively realise the positive impact of the fourth industrial revolution (a fusion of advances in artificial intelligence (AI), robotics, the Internet of Things (IoT), genetic engineering, quantum computing and more.), it is essential to use technology to bridge the gap between skilled and unskilled labour. As more and more men from rural areas start migrating to urban areas in search of employment opportunities, the brunt of agriculture is being borne by women who now have to perform highly labour-intensive jobs on their own, resulting in lower productivity levels. They further face a lack of access to land, irrigation, credit, inputs, and markets.

Digitalisation will go a long way in reducing traditional bottlenecks such as shrinking markets and low density that have been roadblocks in building long-term and sustainable rural economies. Often, issues like these can lead to economies of scale, wherein skilled individuals from rural areas cannot find the right employment opportunities and small businesses lose out on opportunities to grow. Digitalisation, undoubtedly, can provide new growth opportunities and opportunities for better and more diverse occupations in rural areas. Reduced trade times and prices, the exchange of unique sorts of products and services, and disruptive ways to work and join the labour market are some of the benefits of the digital era that might be beneficial for rural communities. Technological advancements can lower trade expenses, allowing rural areas to tap into new markets. Rural goods and services are likely to reach more distant markets at a lesser cost and at faster pace than they are now, thanks to new technologies. Driverless vehicles, for example, can operate 24 hours a day and travel farther distances than traditional trucks, lowering transportation costs and shipment time. Drone-based deliveries are also expected to be deployed in their initial phase in rural areas, where regulations are less stringent, and roads are not populated by high rise buildings, making it easier for drones to maneuver. This type of delivery system can help rural regions overcome geography and infrastructure challenges.

In rural economies, new technology can also help to improve the entrepreneurial business environment. Cross-border e-commerce or commerce through digital platforms has proven critical in lowering entry barriers for enterprises and SMEs looking to sell in worldwide markets. Similarly, new technologies such as additive manufacturing, for example, 3D printers, have the potential to lessen the need for economies of scale by making small-scale production more cost-effective. Small businesses can use 3D printers to create items and standard parts according to local demand without importing or storing vast quantities of materials from elsewhere, reducing their dependency on imports.

Over the last few years, especially, on account of the persisting COVID-19 pandemic, the financial inclusivity in the country has gained pace. Modern information and communication technology (ICT) has acted as a catalyst in establishing a platform that extends financial goods and services, even to remote and marginalised regions and individuals. These efforts have also helped banks reduce their cost, increasing customer reachability and efficient management of risk in businesses. Several efforts of the Government of India to utilise a technology's potential to harness financial inclusion in rural areas, are going on. For instance, the Direct Benefit Transfer (DBT) programme, launched by the Government of India, aims at initiating a direct transfer of benefits across the country. Cumulatively, more than 24.8 lakh crore[3] has been transferred through this mode as of September 2022. This platform, accompanied by the unique Aadhaar ID programme, has not only eliminated duplications and frauds but also has been instrumental in increasing transparency and accountability in financial transactions, including benefit transfers to pension owners and other beneficiaries of various schemes.

One of the important schemes for technology enabled rural development is Technological Advancement for Rural Areas (TARA): This scheme under the Skill Enhancement Education and Development Program (SEED) is critical in providing long-term core support to science-based voluntary organisations and field institutions in rural and other disadvantaged areas to promote and nurture them as "S&T Incubators" and "Active Field Laboratories" to work and provide technological solutions and effective delivery of technologies for livelihood generation and societal benefits. Similary, e-Shram is a platform designed by Ministry of Labour and Employment to benefit unorganised workers who are not member of Employees Provident Fun Organisation (EPFO) or Employees' State Insurance (ESIC). Signing up for the Shramik Yojana and acquiring an e-Shram card entitles them to many benefits. The country's 177250[4] gram panchayats have already been linked to National Optical Fibre Network (NOFN) by June 2022 using existing Public Sector Undertaking (PSU) fibres (BSNL, Railtel, and Power Grid) and laying new fibre to connect all 250000 Panchayats in the near future, thus filling the connectivity gap between gram panchayats and blocks.

Common Service Centres (CSC), the Digital India's mission mode project, serve as the access points for essential public utility services, social welfare programmes, healthcare, finance, education, agriculture services and a variety of business-to-consumer (B2C) services to citizens living in rural and distant areas of the country. It is a pan-India network that caters to its regional, geographic, linguistic, and cultural diversity, enabling the government to fulfil its mandate of a socially, fiscally, and technologically inclusive society. Digital India Land Records Modernization Programme (DILRMP): is another worth mentioning scheme aimed at leveraging existing commonalities in land records to develop an appropriate Integrated Land Information Management System (ILIMS). Individual states can also add state-specific requirements as deemed necessary and proper.

It is the universal assumption that support for the latest technology and innovation for entrepreneurship development is the sine-qua-non for accelerating the overall development of rural India. Rural India is becoming digitally savvy, with smartphone and internet usage increasing 30 percent+CAGR in the last four to five years. Online classes during the pandemic were a major catalyst for digital adoption amongst rural population because they forced many new users to explore advanced functionalities. There has been a significant decline in the cost of technology access as well. Data costs have decreased 64 percent over the last three years, from Rs. 18.5/GB in 2018 to ~Rs. 6.7 in 2021. While looking at Financial inclusion initiatives, we find Aadhaar and Aadhaar-enabled banking and payments systems boosted rural financial inclusion. The system eased documentation requirements for processes like opening bank accounts and availing the benefits of government schemes and subsidies. The Pradhan Mantri Jan Dhan Yojana (PMJDY) with roughly 46.25 Cr[5] bank accounts already opened as of August 2022, has made significant strides in channelling all government benefits from the centre, state and local bodies to the beneficiary accounts and furthering the Digital India mission of GOI. Evidences clearly suggest an established link between the DBTs and a reduction in women's financial dependence. Ensuring that women have control over their bank accounts, can transform women's labour force participation, financial independence, bargaining power and overall economic decisions. The Reserve Bank of India set up an Rs. 345 Cr Payment Infrastructure Development Fund to create 30 lakh digital-payment touch points every year.

The surge of start-ups have drawn multiple new players into the market to offer technology-based solutions like off take marketplaces, storage and transportation services and agronomy advisory services. Large traditional players are adopting technology to reduce operational costs and scale, either by developing in-house solutions or by partnering with emerging players. Several global tech giants (e.g., IBM, Microsoft) see this space as a new growth opportunity and are investing in innovative solutions for crop health monitoring and yield estimation.

In the next few years, India's food and agriculture ecosystem will be on the cusp of massive disruption. Multiple players are disrupting the value chain now, and will evolve and replace traditional agriculture with new farming models, advanced agri-tech services, and new food products. In the last six years, several start-ups have emerged to reduce systemic inefficiencies among inputs and marketplaces, precision farming, processing and storage. For example, new players like Ninjacart and WayCool are improving distribution efficiencies, which can cause 17 percent to 22 percent leakage when perishable commodities are moved from farm to mandi.

Technology is streamlining access to FPOs and enabling real-time information sharing and greater transparency. For example, WhatsApp groups have become a common communication platform for reaching farmers. When ITC partnered with NITI Aayog on its Transformation of Aspirational Districts programme, they had built upon their e-Choupal ecosystem's experience and leveraged ~6.1K Whats App groups in ~11K villages and enabled capacity building of ~5.66 lakh farmers through digital training and dissemination of farming-related information. Leveraging local languages and voice messages for two-way communication proved to be major facilitators for increasing engagement. Innovation in digital payments has enabled faster and easier access to cash, particularly in rural areas that have been cash-strapped due to lower

penetration of ATMs and banking products. As far as access to credit in rural areas is concerned, Digital-first banking models also helped lending organisations scale into the sector. Cash is still the dominant method of payment for rural financing, however, digital payments penetration is increasing, driven by government interventions like the Payment Infrastructure Development Fund, which subsidises the deployment of payment acceptance infrastructure in Tier 3 to Tier 6 centres. India Stack, a set of application programming interfaces (APIs) open to governments, businesses, and start-ups, also encourages digital payments adoption. It created a single interface for Indians to transact from any bank account. RuPay, the Indian card-payment network, is also boosting the cashless economy. As of October 2021, close to 32 Cr RuPay debit cards have been issued to PMJDY account holders, up from almost 20 Cr at the end of 2016.

Access to data has also spurred credit growth because it supports better decision making among fintech players. With digitisation, transaction history is captured, even on small-ticket borrowers and more robust lending profiles can be created. Better visibility leads to better profiling and credit scoring of borrowers. High-quality weather data also helps lenders predict bumper crops and probable defaults. These enablers have significantly lowered the time, human effort, and cost of onboarding new borrowers. Multiple processes can be fast-tracked, such as identity and background verification. Fast verification through government APIs has lowered the turnaround time for loan disbursement from 21 days in 2017 to just three days today. Small Finance banks and non-banking financial companies (NBFCs) being an integral part of financing in the rural ecosystem, are adopting technology to expand their reach and offer credit solutions in rural areas. India's largest rural NBFC, Mahindra Finance, has operations in ~2.4 lakh Indian villages (~38% of Indian villages) and provides financing solutions for vehicles, small and medium enterprises, housing, insurance, and mutual funds. It built a proprietary, data-driven map of India to track village-level data like consumption, lending patterns, industry non-performing assets (NPAs), healthcare facilities, and irrigated land. It uses these data points to build machine learning-based models for lending.

The latest feather in the cap of Government is 'Buy now Pay later'(BNPL) scheme. In the rural economy of India consumption is high (~50 percent of total consumption) and credit penetration is low compared to the urban sector (~22 percent versus ~37 percent). Multiple start-ups are exploring partnerships and funding options to provide new credit solutions. Like Honda partnered with Canara Bank to offer car financing options and with Cholamandalam Investment and Finance Company for two-wheeler financing solutions in rural and semi-urban regions.

No doubt, Indian Agriculture has been facing multiple challenges for the last so many decades. However, now we are entering a new phase where technology and innovative strategies can address these challenges to a great extent. Since now we have the capacity to measure, transmit and assess a large amount of data in real time, at low cost and easy access, it is becoming easy to radically transform our agriculture over the next few years. Although the Farmer Producer Organisation concept is fast gaining ground, there is a significant variability in FPOs in terms of maturity, sophistication and management capabilities. Since the small farmers do not have access to low cost funds, their credit history is generally poor, they are not capable of developing Business Plans, FPOs can be instrumental in solving all these problems. Next, there is a need for govt. and private players to increase investment in post harvest infrastructure like warehousing and primary processing centres.

Access to funding is another major stumbling block. Hopefully, an Rs. 100,000 crore financing facility under the Agriculture Infrastructure Fund (AIF) launched by the government in August 2020 to aid farmer groups and private players to invest in post-harvest management infrastructure and community farming assets, will give respite to FPOs and FPCs. Further, access to reliable, real-time data has become imperative for credit risk evaluation, weather forecasting, crop management, and enabling price transparency for the farmers. Technology and connectivity have significant advantages in creating information symmetry and hence reducing the proportion of decisions, normally taken by virtue of habit rather than

analyzing real-time localised data. There is also a need to invest in weather stations for ensuring accurate weather forcasting. In this regard, the efforts by Indian Government to recruit private companies like Skymet Weather and IBM Weather Companies, are no doubt laudable.

Finally, the most important is the building of trust with farmers so that they can readily adopt new and innovative practices. For this, an effective collaboration among progressive farmer groups, government extension agencies, traditional large and trusted players.

To sum up, the utility of Science and Technology will be paramount in achieving the aim of rural development as it is the most important and effective tool for ensuring poverty alleviation, food security, life skills, and educating the masses. But only scientific and rational outlook can help us determine whether the technology is in harmony with nature or not. Else it may adversely affect our natural resources, flora and fauna. Only on inculcating this rational and logical thinking, we will be able to achieve the goal of sustainable development. Technologies should be used in a sustainable manner and only to the extent that they do not interfere with the nature and ecosystem. The key to a developed and prosperous village lies in the sensible and rational usage of technologies which are in harmony with nature.

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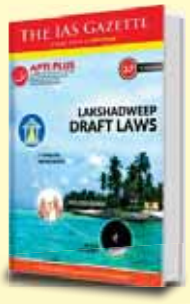

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